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IV. DETONATION AND OTHER COMPRESSION WAVE PHENOMENA.

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CARL ZEISS

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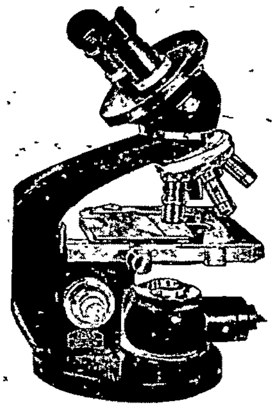

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SCIENTIFIC PAPERS AND SCIENTIFIC LANGUAGE

THE recent report on "Science in the U.S.A. in 1954", issued by the British Commonwealth Scientific Office, North America, directed attention to the interest now being taken in mechanical translation in the United States. A research group at the Massachusetts Institute of Technology is compiling a bibliography on this subject, and one at the Battelle Memorial Institute is seeking to construct a mechanical dictionary which would permit word-by-word or literal translations to be made. The possibility of producing grammatical English translations of selected Russian sentences using an electronic data processing machine has already been demonstrated at the Institute of Languages and Linguistics, Georgetown University; in Great Britain Mr. B. C. Vickery made some comments on the subject in his paper before the Library Association at Southport last September, in discussing the language barrier in science.

More recently, the tenth report of the Nuffield Foundation, in recording the offer of a grant of £7,200 over three years to Birkbeck College, University of London, to support the work carried out by Dr. A. D. Booth, head of the Computational Laboratory there, on mechanical translation, indicates the importance attached by the Foundation to the possibilities opened by the digital computer in translation from one language into another.

This project arose out of the work done in recent years on the development of the electronic computing machine at Birkbeck College under Prof. J. D. Bernal. When this project was first considered, attempts were made to use only those words which can be found in a dictionary; but it has since been found more practical and effective to separate the dictionary into two parts, one for stems and the other for endings, thus bringing the dictionary storage space required well within the capacity of the machine. A preliminary survey indicated that if some one thousand stems and the same number of endings are available, and if these are so chosen as to relate to one special subject, such as biophysics, X-ray crystallography, plant genetics or neurosurgery, addition of about a thousand words of common parlance will enable the machine to translate more than ninety per cent of the texts presented to it.

Here word-for-word translation is unsatisfactory, however, and to solve the problem of word-order, the grammatical structure of the language must be investigated in detail and micro-glossaries—stem-ending dictionaries in the specific subject—must be compiled and coded. Investigation of the adaptability of the machine to tabulate alternative meanings, and the possibility of achieving a literary quality in the end-product has already led to a satisfactory way of handling idioms being evolved. Although it requires a larger storage capacity than is at present available, Dr. Booth is optimistic that even the problems of machine-translation of literary work may prove less complex than they at present appear, and it is expected that the machine will ultimately be able to translate 3,000 words an hour.

How far such developments can be used for dealing with the problem of communication between the scientist and the non-scientist cannot yet be judged; but it is possible that ultimately they could offer some contribution to overcome the difficulty of 'scientific language' which has been the subject of considerable debate since it was discussed by the Parliamentary and Scientific Committee early in November. Meanwhile this research has stimulated work on a further project, that of 'recognition' of texts by the computer, so that it can 'read' or 'take dictation'. For mechanical translation to be useful, the machine must be able to absorb the texts by either sound or sight, otherwise the cost will be prohibitive.

These projects are, however, only one of the ways in which new grants from the Nuffield Foundation during the past year are assisting the solution of problems of human communication. There is at present no organization for collecting and disseminating bibliographical information on the social sciences as a whole and, in particular, on peripheral subjects. To improve the bibliographical organization in this field, which has lagged much behind the development of research in it, the Foundation has made a grant of £2,500 a year for three years in the first place to the International Committee for Social Science Documentation. The National Book League will administer the grant and provide accommodation for the research, the aim of which is to produce good bibliographical tools by elaborating a series of consistent schemes or recipes which will facilitate the provision of abstracts or bibliographies in this field, while keeping duplication to the minimum and ensuring that contributions on peripheral subjects are not overlooked. A survey will be made, in London in the first instance, of the adequacy of the existing library and research facilities for social scientists, and it is hoped that, as a result, similar surveys will be made for other regions.

Such a project, by recording, for example, the location and availability of certain categories of matter, provides a firm basis for co-operation between librarians in improving the resources of their libraries for social scientists. As such it may be said to contribute to the improvement of the marshalling yards and dispersal places of knowledge, if we may adopt the analogy with transport which Mr. R. H. Coats recently used in discussing human communications. On that same analogy, the work on mechanical translation contributes to the improvement of the assembly places of knowledge or the effectiveness of contact with those who wish to use it.

Yet another new grant made by the Nuffield Foundation last year in this field of human communication, which is of special interest to the scientist, is concerned with the medium which is used for communication. The Foundation has been examining in some detail the best way of assisting the learned journals, many of which are to-day in acute difficulty. Mostly these difficulties are economic, resulting from the sharp rise in the costs of paper, printing, accommodation and staff since the end of the War, while the equivalent general rise in the cost of living makes it very difficult to raise subscriptions to the necessary level. Moreover, the changes proposed in the postal rates for printed matter and parcels in the autumn budget threaten to make the position in 1956 onwards acutely difficult for many learned societies which seek to further the spread of technical or scientific knowledge. The Textile Institute, for example, which already spends more than £30,000 a year on the publication of its *Journal*, will now have to find an additional £1,000 for distribution charges. Nor does the effect end there. Libraries and institutions are equally affected by these higher postal rates, and the sums available for subscription to such periodicals or for the circulation of copies are proportionately diminished.

The Foundation recognizes that the learned periodicals vary enormously in the strength of their endowment, the size of their circulation, and the potential increase of their circulation by use of sound professional methods. Its examination of the publishing and distribution techniques of the learned periodicals has indicated the existence, on the whole, of a conservative attitude towards new printing processes and sales methods. A few have adopted type-photo-offset and similar formats, with an approximate saving of twenty per cent in printing costs. Production economies in size of margin or type, or even quality of paper, have scarcely been considered; and no group of periodicals seems to have examined the economies that might be achieved by bulk-buying of paper or the increased sales which might result from an attractive but still dignified cover. Although the rise in production costs is now less marked, there is little prospect that costs will drop below their present level in the near future. The only hope of narrowing the gap between costs and returns seems to lie in improving the technique of production and sales, and in some measure of centralization of effort.

However strong a case could be made for government assistance to some particular periodical—certainly a strong case could be argued in respect of postal charges on all learned periodicals—that case can scarcely be presented until the possibilities just indicated have been fully explored. It is welcome news, therefore, that the Nuffield Foundation has set aside a sum of £43,750 over five years to be spent on the support of journals in fundamental subjects. The British Academy and the Royal Society have been informed that a sum of £8,000 a year will be available for that purpose during the next five years, and that a further sum up to £750 a year will be set aside for the payment of any professional advisory fees that may be necessary.

The distribution of the grant will be entrusted to two special committees, one for the humanities, appointed by the British Academy, and one, appointed by the Foundation in consultation with the Royal Society, for the scientific periodicals. Each grant will be on a yearly basis, and no periodical will be supported unless, in the opinion of the allocating committee, it is doing all within its power to make its economic position stable or else is prepared to accept and act upon the advice offered by a panel of advisers. This panel will comprise a small number of highly experienced commercial publishers and printers invited to serve by an executive liaison committee, consisting of the Secretary of the British Academy, the Assistant Secretary of the Royal Society, and the Director of the Foundation, which will review, year by year, the distribution of funds between the Royal Society and the British Academy. Mr. Robert Lusty is already carrying out for the Foundation a pilot survey of the publishing and distribution practices of the learned periodicals.

The Nuffield Foundation is thus assisting an attack on this problem of communication of knowledge in three different fields, and the cumulative effect of the several projects may well be considerable, particularly in the light of the climate of opinion revealed at the first International Congress on Documentation of Applied Chemistry in November. At that Conference, Dr. R. S. Cahn, for example, speaking on the role of the professional and learned societies, suggested the reorganization of publishing methods and cuts in costs, along with an attempt to secure greater support from industry and a users' conference, while mechanical methods in documentation generally were summarized by Dr. E. Pietsch, director of the Gmelin Institute. Moreover, the current discussion on scientific language is of fundamental importance, for the full benefit of mechanical aids and modern methods of production and distribution will only be realized as the content of the paper is adapted to its purpose—that is to say, as it is expressed in language which conveys fully and clearly the ideas in the mind of the writer to the particular type of reader he wishes to address.

That lies at the heart of the argument about scientific language. The scientist has a duty to make himself comprehensible to the readers or audience he wishes to address; and the choice of words is a matter of sense, not of arrogance—of choosing the tools appropriate to the job. It should not be confused with the question of education, even if the education which the scientist himself has received or the character of public education generally is involved. But it is worth bearing in mind that the maxim of Bentham which Dicey included more than fifty years ago among the four points he laid down for the expression of thought is still valid: one word for one thing; another word for another thing—this is the whole secret of style. If scientists consistently remembered with this even one of Dicey's own maxims—that arrangement of thought, more than anything else, is the secret of a good style—many of our difficulties in the communication of knowledge would be greatly simplified, and we should be in a stronger position to reap the full advantages from the new developments which the Nuffield Foundation is helping to explore.

SIMON STEVIN—A FOUNDER OF MECHANICS

The Principal Works of Simon Stevin

Edited by Ernst Crone, E. J. Dijksterhuis, R. J. Forbes, M. G. J. Minnaert and A. Pannekoek. Vol. 1: General Introduction; Mechanics. Pp. v+617. (Amsterdam: C. V. Swets and Zeitlinger, 1955.) 52 guilders.

SIMON STEVIN or Stevinus or Stevens, for the name occurs in all three forms, is probably best known to the general student of the history of science from the attention given to his fundamental work on statics in Mach's celebrated history of mechanics. Some index of his importance is that Lenard includes him in the forty-odd biographies that make up his "Grosse Naturforscher". In particular, Stevin is symbolized by the inclined plane surrounded by a closed chain of spheres, with the inscription: *Wonder en is gheen wonder*—a marvel and yet no marvel. Arguing from this and the impossibility of perpetual motion, which he took as an axiom, he deduced the force required to keep a smooth body in equilibrium on an inclined plane and used this as the basis of his investigations into the laws of statics, including the parallelogram of forces, by the aid of which he solved quite complicated problems concerning weights supported by connecting strings. He carried out important work on hydrostatics, including the establishment of Pascal's paradox, that the pressure on the base of a vessel containing a liquid depends only on the depth, and in no way on the form of the vessel, with the familiar consequences for communicating vessels. He also treated the stability of floating bodies—"floating top-heaviness", as he called it.

However, this is but a small part of Stevin's performance. His work on arithmetic and algebra earned him an honourable place in Cantor's "Geschichte der Mathematik". He was the first to introduce the systematic use of decimal fractions, but with a clumsy notation, and he advocated the general use of the decimal system in coinage, weights and measures. His very rare little tract on terrestrial magnetism, "De Havenvinding" (1599), translated at the time into English under the title "The Haven-finding Art", contains valuable records of the magnetic declination, which he proposed to make a basis of navigation. As adviser in scientific and technical matters to Prince Maurice of Nassau, he was extensively concerned with many aspects of engineering, in particular with matters of drainage and hydraulic engineering generally. He was a leader of the Dutch school of fortification which arose early in the seventeenth century. On all these practical matters he wrote extensively. Among his inventions was a sailing chariot, long one of his most popularly celebrated achievements, which comes in for comment in "Tristram Shandy". He was, above all things, an experimenter, and his fundamental experiment on the time of fall was both earlier and more conclusive than that of Galileo. He let fall together two spheres of lead, one ten times heavier than the other, from a height on to a board. The sounds of impact were simultaneous. He was quite clear on the part played by air resistance in the fall of light bodies.

The fame of Stevinus was much hindered by the fact that, for reasons of principle, he published the greater part of his work in the Dutch language, on the history and merits of which he wrote extensively, and sometimes fantastically. He was for this reason little read outside the Netherlands until the posthumous appearance of an important part of his work in French. An accessible and critical edition of his work has thus long been desirable.

This volume under review is the first of a new edition of the "Principal Works of Simon Stevin", which is being produced by the Koninklijke Nederlandse Akademie van Wetenschappen, with the financial support of several Dutch organizations interested in learning. The complete works are not contemplated, both because of the forbidding bulk and because several of them are not of sufficient originality or interest to demand reprinting. This first volume bears the general description "Mechanics" and is edited by E. J. Dijksterhuis. It contains "De Beghinselen der Weeghconst"—"The Elements of the Art of Weighing"—which includes the work on statics already referred to, and "De Beghinselen des Waterwichts"—"The Elements of Water Pressure" (that is, of hydrostatics). The Dutch text is given in facsimile on the left-hand page and an English translation, by Miss C. Dikshoorn, on the right—an excellent arrangement. So far as I know, this is the first English translation, and the French translation, by Albert Girard, issued in 1634 as part of a large folio, the "Œuvres Mathématiques", leaves out certain parts that the editor thought of little interest. This is, then, clearly the text that the student requires. Considering the present eclipse of classical learning, it might have been well to furnish a translation of the Latin and Greek prefatory verses by Jan de Groot.

The book is prefaced by an introduction giving the scanty facts known of Stevin's life and a sketch of his work. There is also a bibliography which cannot be said to be very satisfactory, a comment which needs no amplification in face of the frank admission: "For readability's sake no attempt at bibliographical correctness has been made". The books in question are so rare—of one booklet the only copy then extant was lost when the library at Louvain was burnt in 1914—that a full and conventional bibliographical description would have been appropriate.

The undertaking so well launched is sure of a warm welcome from all students of the history of science, and the future volumes are awaited with pleasant expectation.

E. N. da C. Andrade

THE OUTLOOK FOR MAN

The Foreseeable Future

By Sir George Thomson. Pp. viii+166. (Cambridge: At the University Press, 1955.) 10*s.* 6*d.* net.

THIS book is not so much about the future of mankind as about the tools which man is likely to possess for shaping his future during the next few decades and the technical limits within which the advance of civilization is possible. In non-technical language Sir George Thomson first explains clearly the scientific principles which will determine the broad lines of technological progress; and then, in a series of fascinating chapters, he shows even the non-technical reader just how these principles of impotence, as he terms them, set the limits to the increase of supplies of energy and its more effective utilization, to the exploitation or improvement of the materials available for us, to our powers of handling very complex problems (for example, by means of the new electronic digital computers) and to the great extension in biological knowledge. These are the four fields in which he anticipates the major advances of the future, and the possibilities are indicated realistically as well as with vision.

The chapters in which this is done for energy and power, for materials, for transport and communications and for meteorology are the best in the book. Those on food and on some applications of biology are equally imaginative but are sometimes less convincing, and some of his suggestions may be open to challenge. Where Sir George's predictions do not lend themselves to interesting discussions, they should go far to correct unreasonable expectations, as, for example, when he discusses the prospects and implications of nuclear energy. He sees limits to the extension of television for entertainment, but discusses its possibilities in regard to business communications and also gives reasons for believing that the practical limits of speed in transport have now been reached. It will surprise some to find the Master of Corpus Christi College, Cambridge, discussing space travel seriously, even if he thinks it unlikely to yield practical advantages which will offset the many technical difficulties. Climatic change is also regarded as a serious possibility, whether by the production of artificial rain or by the biological method of growing plants in desert areas and so obtaining the absorption of radiation by the ground.

Here, at least, Sir George reflects that schemes of this kind may have to wait for a world government; but when he discusses food and the applications of biological science, he is apt to disregard the social, moral and political factors which are involved in the prospects he expounds so imaginatively. He does not expect that any one line of advance will supply the complete answer to feeding the world's growing population; but he predicts that, in the long run, plants, moulds and bacteria bred for the purpose will compete successfully with the chemist in making some of the more complicated compounds, and he looks to a large increase in synthetic foods, particularly for feeding cattle, for which purpose he suggests they may be delivered automatically at distributing centres. Improvements in plant and animal breeding will also make a big difference to agriculture and to the world's supply of food. On the population question as a whole, however, his most interesting suggestion is that medical research should concentrate increasingly on the prevention, and at first the postponement, of old age rather than on the further reduction of the killing diseases.

One interesting possibility he suggests is that domestication of the monkey could put at man's disposal for crop picking a combination of hand and eye through a moderately intelligent brain that is one of the best bargains Nature has to offer us. When, however, he comes to discuss the social consequences of technological advances, Sir George is less satisfactory and convincing. He admits that civilized man is at present rather like a child who has been given too many toys for his birthday; but none the less he seems to lay all the stress on the tools rather than on the men and women who use them. In the transformed and enriched world he contemplates, there appears to be no real place for values. His treatment of thought is purely materialistic and leaves no room for art, religion, patriotism, humanitarianism or the like. There is no apparent recognition in this book that even the advance of science and technology does not depend simply on material conditions but on such values as freedom of thought and investigation and tolerance, for example, the future of which depends ultimately on ideas and man's spiritual outlook.

Such conditions and ideas, far more than nuclear power, the electronic computer or biological advances, may yet determine the extent and pace of mankind's development, or indeed whether civilization continues and does not collapse; and it is for this reason that there is a certain naïvety about some of the discussion in this book of social questions, as when, for example, Sir George is worried about the consequences of the elimination, by mechanization or automation, of routine work and the onus of finding work for the more stupid and also the more rapidly multiplying part of the population. The solutions, he suggests, involve moral judgments, and in this field the rate of advance is apt to be set not so much by what is technically possible as by what is politically and socially feasible.

Here, of course, we enter on the question of education, on which Sir George has some interesting comments, even if sometimes, as when he refers to the release of man's brains from past hindrances and to the possibility of biological improvements, he seems to be reaching into a very distant if not a doubtful future. He visualizes a much larger proportion of people engaged on work which demands some training in science, and he recognizes the dangers of specialization and the increasing difficulty of acquiring width of knowledge. He stoutly champions the interpreter or expositor of scientific and technical knowledge, and however much one may wish that Sir George had dealt adequately with the human values, the book at least establishes his own claims as an expositor of the first order.

R. BRIGHTMAN

TECHNOLOGY OF SOUND

Sonics

Techniques for the Use of Sound and Ultrasound in Engineering and Science. By Theodor F. Hueter and Prof. Richard H. Bolt. Pp. xi+456. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 80*s*. net.

SOME years ago I was asked by a farmer the best method of improving his wheat crop recently harvested. He had read in the press that it is possible to refine grain by the application of ultrasonic power! Information on the applications of acoustic vibration in processing, analysis and instrumentation has only been available to the reader of a large assortment of journals, and to those fortunate people having access to the classified literature of the research establishments of the Armed Services. It is not surprising that these techniques have been hailed in not too well-informed quarters as the panacea of all evils. This is doubly unfortunate because it has led to more than the occasional attempted application where a more thorough knowledge of the physical limitations would have precluded the attempt. It has also meant that particular applications have not always been investigated sufficiently to determine their full technical and economic promise. The book under review should do much to help those interested in techniques for the use of sound and ultrasound in science and engineering.

'Sonics' is defined by the authors as "the technology of sound as applied to problems of measurement, control and processing". The authors wisely ignore the usual division of acoustics into sound and ultrasound, which is of no significance in this technology. The first three chapters of the book are concerned with establishing in some detail the fundamentals of vibration and sound, and of radiation. Here we find an introduction to such concepts as acoustic analogy, acoustic impedance, reflexion and transmission, energy density and intensity, radiation pressure, the decibel scale and diffraction. In Chapters 4 and 5 the principles and design of piezoelectric and magnetostrictive transducers are considered. Chapter 5 is particularly useful in that it summarizes in some detail much that has not been readily available.

The remainder of the book deals with the three facets of the technology—power or processing applications, testing and analysis of fluids and materials, and instrumentation and control. Information is given on the physical principles involved in processing and the practical design of transducers. This latter covers, as well as the transducers already considered, electrodynamic, fluid dynamic and siren sources. There is a useful section on cavitation. Under testing and analysis, the various methods at present available for determining the propagation velocity and attenuation are discussed, as is also the relation of these quantities to the physical properties of the medium. A mainly theoretical appendix effectively summarizes our knowledge of acoustic relaxation mechanisms in fluids.

It should be emphasized that the authors have attempted to discuss the general principles of the technology rather than to consider all known applications. This approach should be of greater value. In their presentation they have sought to steer a middle course between a script intelligible only to the advanced physicist and one dealing with technical details of specific designs. They have also assumed little knowledge of acoustics proper, but some understanding of electronics. Substantially, they have succeeded in their plan by using a relatively simple presentation and recourse to intuitive arguments, with the addition of footnotes and sections in small type to augment the discussion. The inclusion in the book of design tables, graphs and formulæ, together with practical instructions, considerably increases its usefulness. The M.K.S. system of units is used; but other units are also indicated on some graphs and tables. Tables for the conversion of units from one system to another are included. Many references to the literature are given, including those to extensive bibliographies. It has been a pleasure to read and review this book.

H. D. Parbrook

LAND AND PEOPLE: 1955–80

World Population and Resources

A Report by PEP. Pp. xxxvii+339. (London: Political and Economic Planning, 1955.) 30s. Distributed by George Allen and Unwin.

THE Demographic Revolution has joined the Agrarian Revolution and the Industrial Revolution as a significant mechanism of change in the course of human history. Whether one regards it as an embarrassment in a specific historical situation is largely a matter of one's political or national affiliations, but it remains a fact to be faced. In this report Political and Economic Planning (PEP) discusses the wide range of problems attendant upon the almost inevitable increase of 25 or 30 per cent in the world population (now estimated at 2,500 million) within the life-time of an already adult generation. Many have said that this generation is frightening itself with phantoms of Neo-Malthusianism which the next generation will exorcise using the formulæ of nuclear energy, algæ culture, watered deserts, and the rapid diffusion of 'Western' standards of 'social responsibility' through Africa and Asia. Political and Economic Planning, however, does not anticipate that any significant new technological contribution will alleviate a deteriorating situation during the twenty-five years ahead. It recognizes, of course, that fundamental discoveries are being made, but argues in terms of distribution and costs to the peasant whose income is only a fraction of our own.

The ecology of human societies embraces the mastery of techniques of production and distribution, and of social organization. In assessing the balance of populations against their respective resources, one can scarcely avoid finding that solutions to specific problems are not judged by scientific standards alone, but also in terms of politics and morals. It would be very convenient if the willing gift of mortality control to the under-developed lands were acknowledged by equally willing acceptance of fertility control, but there are ancient prejudices to be overcome. A highly urbanized society with a high standard of living moves spontaneously towards low fertility; the most immediate problem is the control of fertility in illiterate rural societies. Mortality control finds ready and public acceptance; but fertility control remains a sensitive and controversial issue for the individual. Here is the basic social problem.

Theories of control based on the 'rhythm' method can be viewed against the account given here of the difficulties of teaching it in an Indian village. Interested readers might refer to the Milbank Memorial Fund Report for 1954 for a considered statement and discussion of the Catholic attitude. Incidentally, the Marxist thesis that there is no population problem, only a social problem, and that every mouth brings with it a productive pair of hands, is considered and rejected. In brief, Political and Economic Planning is not optimistic about the prospects of the poor and densely populated countries combining a stable population with an increasing standard of living in any future we can usefully consider. It couples recognition of the values of family and social responsibility with an appeal to biologists to work energetically (and with increased support!) towards the new philosopher's stone, an oral contraceptive which is cheap, effective and acceptable to all creeds and cultures.

The report falls into three major sections: a general survey of population and resources, a series of comparative studies of countries at various stages of economic and demographic development, and thirdly, a study of "Nation and Family" in the context of attitudes towards fertility control. The whole provides an extremely valuable summary of the most useful facts (closely up to date), clearly arranged and leading to a carefully accurate review of the problems and issues at stake. Discussion throughout is brief to the point and realistic, and based on authoritative sources and opinion. Its value as a text for students will be enriched if read along with Prof. W. A. Lewis's important chapter on "Population and Resources" in his recent "Theory of Economic Growth".

Maurice Kirk

Into the Blue

The Lake Tana Expedition. By Lionel Ferguson. Pp. 255+16 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 16*s*. net.

NUMEROUS undergraduate expeditions have gone, either privately or under the auspices of clubs such as the Oxford University Exploration Club, to many parts of the world in recent years. Their success generally depends upon the adequacy of their preparation and organization, the nature of the guidance received from individuals and from institutions like the Royal Geographical Society, the assistance given by governments and commercial firms, and, above all, upon the enterprise and determination shown by the individual members. Success came to this party of five Cambridge undergraduates —three geographers, a historian and an economist— because their expedition showed signs, in varying degrees, of all these requirements.

As an expedition to undertake a geographical survey in the Lake Tana area of Ethiopia it failed, since barely two out of the eighteen weeks of the expedition could be spent there. Thus its 'findings' are superficial and of no scientific value, which is unfortunate, for there must be a wealth of unrecorded material in the region. The party met with a long chain of misfortunes, including frequent mechanical trouble with their car, and the withholding of official permission to follow certain routes across the Sudan. All types of people, whatever their colour, status or wealth, showed great kindness and gave much practical help, both before and during the expedition. From the geographer author one might have hoped for more about the landscape and the people of the areas through which the party travelled in three continents; and the accounts of the social contacts of the several lengthy enforced halts might have been considerably shortened.

But any blemishes of content, like those of style, are insignificant alongside the many traces of the perseverance and determination of these five young men who overcame so many difficulties, actual and political. They fully deserve the kind words of Sir Brian Robertson who, having met them in Cairo, contributes a foreword. "To travel is always good," he writes, "but to travel hard and far on little money and in limited time is first-class education."

R. W. Steel

Some Fundamentals of Petroleum Geology

By Dr. G. D. Hobson. Pp. x+139. (London: Oxford University Press, 1954.) 18*s*. net.

THIS book descends to basic principles of petroleum in no uncertain manner. It is not, however, a recapitulation of time-honoured theories of origin, migration and accumulation, for this, as the author observes, "has already been written many times in the voluminous literature on this subject". Dating the industry from Drake (1859), if we consider all happenings since then—the enormous, world-wide, technical evolution, with its vast ramifications and impacts on the progress of mankind—then it is incongruous that to questions of oil-genesis, mechanism of mobility and factors governing its selection of resting places, answers are still tentative, especially concerning beginnings.

In my experience, most authors of 'petroleum geologies', while proclaiming their own fancies, sooner or later return to conventional treatments of prevalent theories, discarding some from now accepted weaknesses, and then forsaking the reader to sort it all out for himself. This tendency to leave things 'in the air' is the reason why, to-day, there is no scientific unanimity on vital issues. Dr. G. D. Hopson here steps in with a new broom, skilfully manipulated, to sweep away dead wood of unprofitable theory within a compass of five original and stimulating essays.

The first essay, "Nature of an Oil Accumulation", deals with reservoir rock, fluid distribution and final retention. "Reservoir Fluids: their Composition and Properties" follows, and next is "Origin of Petroleum", embracing conditions of formation; source-material; amount, distribution of organic matter; agents; and thermal, radioactive and biochemical transformations. "Migration and Accumulation", comprising buoyancy, interfacial tension, compaction and general mechanics of fluid movement and other conceptions, leads to a final dissertation on "Reservoir Pressure". This book is not only a critical survey of past controversial thoughts, but also an incitement to clearer thinking on this complex substance—petroleum—from which every oil technologist will benefit.

H. B. Milner

1er Symposium International de Bactériologie Alimentaire

Organisé par la Section de Microbiologie des Produits Alimentaires de l'Association Internationale des Sociétés de Microbiologie, Institut Pasteur de Lille, 10–14 Octobre 1954. Bactériologie des Semi-Conserves de Viandes—Rapports, Communications et Discussions. (Annales de l'Institut Pasteur de Lille—Vol. 7, 1955.) Pp. 266. (Paris: Éditions Médicales Flammarion, 1955.) n.p.

THIS symposium dealt with the bacteriology of non-sterile processed meats, participation being limited to specialists, invited from sixteen different countries. The volume gives a complete account of their scientific proceedings: sixteen substantial papers (reports), and nineteen shorter communications, with discussions. Seventeen of the papers are in English and fourteen in French; four in German are provided with English and French summaries. Major papers have reference lists.

The topics range over the whole subject. After definitions, and an exposition of characters desired by the user, several papers deal with the processes to which these products are subjected. Two papers surveying the whole bacterial flora are followed by several on the occurrence and significance of the important types of bacteria: *Cl. botulinum*, other clostridia, staphylococci, members of the Enterobacteriaceae, streptococci, lactobacilli, corynebacteria, micrococci, and the *Achromobacter–Pseudomonas* group. Next the bacteriological condition of ancillary ingredients like gelatin and spices is considered. Techniques used in different countries for the bacteriological examination of these foods are then compared, and the problems of representative sampling described. Finally, after discussion of the translation of such observations into bacteriological standards, there is a description of the bacteriological conditions generally agreed as desirable in canned ham.

Much of this information, especially that from overseas, is not readily available elsewhere. Because it is uniquely comprehensive, up to date and authoritative, the volume might be regarded as indispensable to all—from the manufacturer to the analyst and inspector—who are concerned with the bacteriology of such foodstuffs.

M. Ingram

SCIENTIFIC CENTENARIES IN 1956

By JOAN M. EYLES

THE ranks of well-known scientists have always included not only those who have made major contributions to their branch of science, but also those who have been responsible for some standard text-book, which has caused their name to become familiar to thousands of students. One of the earliest of these successful authors was John of Holywood, better known as Sacrobosco—the Latinized version of his name. A Yorkshireman by birth, he studied at Oxford and then taught mathematics in Paris. Sacrobosco flourished in the thirteenth century, and manuscript copies of his treatise on spherical astronomy, "Sphaera Mundi", must have been circulated widely. Two centuries later, the advent of printing greatly increased its circulation. The first printed version appeared at Ferrara in 1472, to be followed by another twenty-six editions before 1500, and fifty more in succeeding years. The last, bearing the Leyden imprint, was dated 1647. Sacrobosco wrote other treatises, including one on the art of numbering, which played an important part in popularizing the use of Arabic numbers. He died in Paris, and the year of his death is usually taken to be 1256.

Passing on three hundred years, we come to Luca Ghini, an Italian botanist who died on May 4, 1556. He was appointed "Reader in Dioscorides" at Bologna in 1527, and many of his pupils became famous, including Aldrovandi and the English botanist William Turner. Ghini is thought to have been the first to use dried plants for scientific purposes, and the earliest known herbaria, in the modern sense, were all made by his pupils.

Another botanist, who died a century after Ghini, was Walter How, born in London in 1620 and educated at the Merchant Taylors' School and at St. John's College, Oxford. How practised as a physician in London, and was the author of "Phytologia Britannica", which appeared anonymously in 1650. This has been regarded as the first British flora, though some local lists preceded it. How died when only thirty-six, on August 31, 1656, and was buried at St. Margaret's, Westminster.

During the Civil War, Walter How was captain of a cavalry troop on the side of King Charles. On the opposing side we find Edmund Wingate (1596–1656), mathematician and lawyer, who chose to support the Parliamentarians, although he had been tutor to Queen Henrietta Maria when she was a girl in Paris. Wingate's career bears some resemblance to that of Sacrobosco, for he too was a Yorkshireman, studied at Oxford and taught at Paris, and was also the author of some frequently re-printed books. His "Arithmetick made easy" achieved a nineteenth edition in 1760, although by that time it was so altered that it would scarcely have been recognized by its author. Wingate was member of Parliament for Bedford in 1650, and died in London in December 1656.

Jean Baptiste Morin (1583–1656), who in 1630 became professor of mathematics at the Collège Royal in Paris, has been called the last of the astrologers. His horoscopes were highly thought of, and he was consulted regularly by Cardinals Richelieu and Mazarin, receiving from the latter a handsome pension.

An eminent Italian of this period was Marco Aurelio Severino (1580–1656), who became professor of anatomy and surgery at Naples in 1610, and whose teaching drew students to Naples even from regions north of the Alps. His "Zootomia Democritae", published at Nuremberg in 1645, was the first comprehensive treatise on comparative anatomy. In the last section of this book he describes methods of dissection and recommends the use of the microscope, "invented in our life-time". He was in his seventy-sixth year when he died of the plague in Naples. His books, particularly the "Zootomia", are extremely rare.

The most important tercentenary of the year is undoubtedly that of the birth of Edmond Halley, the gifted mathematician, astronomer and pioneer meteorologist who is also remembered for the part he played in the production of Newton's "Principia". Halley was born on October 29, 1656, in the parish of St. Leonard's, Shoreditch, and received his education at St. Paul's School, and at Queen's College, Oxford. His first paper (one on astronomy) was read to the Royal Society when he was only nineteen, and during the next sixty years more than eighty papers appeared in the *Philosophical Transactions* under his name. Towards the end of 1676 Halley went to St. Helena, where he spent more than a year making astronomical and meteorological observations, publishing on his return a catalogue of southern stars, which was followed a few years later by the first map of the trade winds. In 1684 he made his famous visit to Newton at Cambridge which led the latter to prepare the "Principia". In 1686, after the first part had been delivered to the Royal Society, Halley not only undertook to supervise the printing, but also made himself responsible for the entire cost. This was because at that time the finances of the Royal Society were so low that it was not only unable to carry out its original resolution to pay for printing the "Principia", but was even unable to pay Halley, then assistant secretary, his promised stipend of £50 a year. In July 1687, in the same month that Halley sent Newton twenty copies of the "Principia" to "bestow on your friends in the University", he accepted seventy copies of Willughby's "De Historia Piscium", published the previous year by the Royal Society, in lieu of some eighteen months salary.

The rest of Halley's career must be passed over quickly. It includes two sea voyages in command of H.M. Pink *Paramour*, the principal object of which was to make observations on the variations of the compass; sixteen years as Savilian professor of geometry at Oxford; and twenty-two years as Astronomer Royal at Greenwich. Seventeen years after his death the comet whose orbit he had calculated returned as he had predicted, thereafter to be known as Halley's Comet.

A friend and correspondent of Halley, William Molyneux (1656–98), was elected a Fellow of the Royal Society in 1685. He was founder and first secretary of the short-lived Dublin Philosophical Society, the forerunner of the Royal Dublin Society founded in 1731. In 1692 Molyneux published "Dioptrica Nova", which contained an appendix by Halley.

Another contemporary scientist interested in optics was the Dutch microscopist Nicolaas Hartsoeker, born on March 26, 1656. He published in 1694 an "Essai de Dioptrique" in which he illustrated his invention, the screw-barrel microscope, generally associated with the name of Wilson, who introduced it to England. Hartsoeker was elected a foreign associate of the French Academy of Sciences, when it was re-constituted in 1699. He died in 1725.

The celebrated French botanist, Joseph Pitton de Tournefort, was also born in 1656, on June 5, at Aix, in Provence. Tournefort studied medicine at Montpellier, and made many botanical journeys, particularly in the Pyrenees, where he suffered great hardships. He was appointed demonstrator at the Jardin des Plantes, Paris, in 1683; and during 1700–2 travelled in Greece and Asia Minor. He died in 1708 as the result of a street accident in Paris. An account of his travels in the Near East appeared in 1717 and was translated into English in the following year. Tournefort's system of plant classification, first described in his "Élémens de Botanique", 1694, was artificial, being based on differences in the corolla, but it was popular and widely used until that of Linnæus was adopted.

The two hundred and fiftieth anniversary of the birth of Benjamin Franklin, American philosopher and statesman, occurs on January 17 (N.S.). The anniversary of the death of John Evelyn, on February 27, 1706, also calls for mention here. Evelyn, best known as a diarist, was closely connected with the early years of the Royal Society, and on two occasions was urged to accept nomination for the presidency, but refused the honour. His book "Sylva" was a valuable account of arboriculture, and his "Fumifugium: or the Inconvenience of the Aer and Smoak of London dissipated" strikes quite a modern note.

It is surely unusual, if not unique, for four generations of a family to succeed one another as directors of a scientific establishment. Jacques Cassini (1677–1756) was the second member of the famous family of French astronomers who for well over a hundred years were in charge of the Paris Observatory. All became Academicians and also Fellows of the Royal Society. Cassini II opposed Newton's theory that the Earth was an oblate spheroid, flattened at the poles, he and his supporters holding that it was flattened at the equator. Two celebrated expeditions, sent by Louis XV to measure a degree of latitude, one in Lapland and the other near the equator in South America, had by 1745 proved that Cassini was wrong and Newton right. Cassini died at Thury, near Clermont, on April 18, 1756.

Not many years after the French expedition had returned from South America, a young Welshman, Lewis Evans, who had emigrated in his youth to North America, was busy carrying out a topographical survey of Pennsylvania. His map of this region, published in 1749, was followed by one that is better known, his "Map of the Middle British Colonies", showing the valley of the Ohio and its tributaries. It was a remarkable achievement, and was re-printed many times—mainly in pirated editions. Evans was a keen observer and recorded many interesting physiographical and geological notes, both on his maps and in his journals[1]. He died on June 11, 1756.

The name of 'lieberkuhn' used to be given to the concave mirror once used on microscopes to illuminate small opaque objects. Its inventor, J. N. Lieberkuhn (1711–56), a German physician and microscopist, not only made excellent microscopes, but was also esteemed for his injected preparations, some of which he is said to have exhibited to the Royal Society, when he was in London about 1740. In particular he studied the structure of the small intestine, describing the Lieberkühn's crypts, as they were later named.

In the field of chemistry, the bicentenary of the birth of J. A. C. Chaptal (1756–1827) is of interest. Chaptal occupied for a time the chair of chemistry founded for him at Montpellier; but he concerned himself especially with applying the new chemical discoveries of his day for the benefit of industry and agriculture. His ability was recognized by Napoleon, who made him Minister of the Interior. During his tenure of office, Chaptal did much to promote applied science. After the fall of Napoleon he was obliged to retire, but in 1816 was nominated a member of the Academy of Louis XVIII.

Although the physician and mineralogist Dr. William Babington (1756–1833) made no outstanding contribution to science or medicine, he deserves remembrance as the senior member of those who founded the Geological Society of London in 1807. In his house this small group of enthusiasts first met, sometimes at seven in the morning, for Babington was a busy physician; and it was he who provided accommodation for the Society's mineralogical collection, until a room at 4 Garden Court, Temple, was obtained in 1809. Babington was president of the Society during 1822–24, and some years later, at the age of seventy-seven, his unabated enthusiasm led him to enrol in a chemistry class held at the new University of London (now University College).

Others born in 1756 include Sir Everard Home, brother-in-law of John Hunter, who gave nineteen Croonian lectures to the Royal Society; Francis Egerton, the eighth Earl of Bridgewater, whose will provided for the famous Bridgewater Treatises; and John Loudon MacAdam, who did so much to improve British highways.

First among those who died in 1856, and whose centenaries will be commemorated this year, is the Italian physicist, Amedeo Avogadro. To-day his name is familiar to every student of chemistry, yet during his lifetime his now famous hypothesis was almost ignored. Avogadro was born in Turin in 1776 and, like Lavoisier, trained as a lawyer, becoming a Doctor of Laws in 1796. But the laws of Nature appealed to him more than the laws of man, and turning to the study of science, in 1806 he began teaching mathematics and physics. The classical paper in which his molecular theory was first expounded was published in the *Journal de Physique* in 1811. This was followed by others, but his views remained unheeded by chemists for forty years or more. Avogadro died in 1856, and it was his countryman Cannizzaro who succeeded, a few years later, in convincing some chemists that Avogadro's hypothesis could be used for bringing order to the complicated matter of atomic weights and the correct formulæ of compounds. Some years were to elapse before acceptance became general, and not until then did Avogadro receive his due meed of recognition as one of the founders of theoretical chemistry. In 1911, a century after the publication of his first memoir, representatives of the scientific world gathered to see the King of Italy unveil a monument to Avogadro in the city of Turin, where all his work had been carried out.

A brilliant young French chemist, C. F. Gerhardt (1816–56), died only a month after Avogadro. With Laurent, he criticized the dualistic theory of Berzelius, and played an important part in the determination of atomic weights and concordant molecular formulæ. Gerhardt taught chemistry in Montpellier and in Paris, but in 1855 was appointed professor of chemistry in Strasbourg, where he died a year later.

Another scientist who, like Avogadro, was too much in advance of his time to receive adequate recognition from his contemporaries was the Russian mathematician Nikolas Lobatchewsky (1793–1856), who wrote the first book on non-Euclidean geometry (the name was given by Gauss). It was published in Russian during 1829–30, and was translated into German in 1840. Lobatchewsky was born in Nijni-Novgorod, but spent most of his life in Kazan, where he was first student, then professor and finally rector of the University. He has been called the Copernicus of geometry; but in his lifetime made little impression and was even, in 1846, inexplicably relieved of his chair and rectorship by the authorities. He died, infirm and sightless, on February 26, 1856.

Two well-known geologists, one English, one Scottish, died in 1856. The senior, the Rev. William Buckland, taught geology in Oxford for more than thirty years, first as reader in mineralogy, then in geology. He did much to render the subject popular, and his lectures and field-classes were always well attended. He was president of the Geological Society in 1824, the year its dining club was founded, and it is entertaining to learn that at the first meeting the Rev. Prof. Buckland bet Mr. Warburton (a former president) two bottles of champagne to one that of several toads enclosed in rock cavities by Mr. (later Sir Charles) Lyell, one would be found alive at the end of a year. As two toads were found alive a year later, the genial Buckland was adjudged to have won his bottle of champagne. Buckland was on excellent terms with Sir Robert Peel, who, while he was Prime Minister, frequently consulted Buckland on scientific matters. Peel nominated Buckland as Dean of Westminster in 1845. A few years later the Dean was overtaken by illness, and he died on August 24, 1856.

Hugh Miller (1802–56), the Scottish geologist, is widely known as the author of that popular and almost classic work, "The Old Red Sandstone". A stone-mason by choice rather than necessity, he worked for some fifteen years among the rocks in which he found so many treasures. His keen observation, coupled with a gift for prose description, resulted not only in remarkable reconstructions of the fossil fishes he collected so patiently, but also in books that were to awaken widespread interest in the methods and results of scientific inquiry. In 1839 he moved to Edinburgh, where he died in tragic circumstances on December 23, 1856. The little thatched cottage at Cromarty where he was born is still maintained as a memorial and museum. In 1938 it was taken over by the National Trust for Scotland, which in 1952 held a meeting there to celebrate the sesquicentenary of Miller's birth[2].

Among the geologists one might also include W. H. Pepys (1775–1856), for he was one of the original founders of the Geological Society. He was, however, better known as a chemist, and in particular as the constructor of some exceptionally large voltaic piles and batteries.

Two amateurs of science call for brief mention here. One is Agostino Bassi (1773–1856), an Italian microscopist who showed that a vegetable micro-organism could be a cause of infection, and thereby ranks as one of the pioneers of the germ theory of disease. The other is the British naturalist William Yarrell, a fine shot and angler, and the author of two works on British birds and British fishes which were for long the standard authorities for naturalists. Yarrell contributed many papers, including the first detailed description of the kiwi, to the *Transactions of the Linnean* and *Zoological Societies*.

Outstanding on the list of those born in 1856 is the name of J. J. Thomson, under whose direction the Cavendish Laboratory at Cambridge became a great centre of research. Thomson enjoyed a tremendous reputation as a leader of research, and not only did he himself gain a Nobel Prize in 1908 for his theoretical and experimental investigations into the transmission of electricity through gases, but no less than nine of those who had worked under him at Cambridge were also awarded Nobel Prizes. In 1918 he became Master of Trinity, and shortly afterwards resigned from the Cavendish professorship. Numerous honours came his way, including knighthood in 1908 and the Order of Merit in 1912; as well as the Royal, Hughes and Copley Medals of the Royal Society. He served as president of the Society during 1915–20. Thomson died on August 30, 1940, in his eighty-fifth year, and was buried in Westminster Abbey.

Among the names of French mathematicians, that of Emile Picard ranks high. Picard, born in Paris on July 24, 1856, was only twenty-four when he published the celebrated memoir on integral functions which made his name and inspired many others to make new discoveries in the field of analysis. His influence was profound, for he was an accomplished teacher as well as an outstanding mathematician. A member of thirty-seven foreign academies, and permanent secretary of the Academy of Sciences in Paris, in 1924 he was accorded the rare distinction of a seat in the literary section of the Institute of France. He died on December 12, 1941.

C. D. T. Runge, born at Bremen on August 30, 1856, was professor of mathematics at Göttingen during 1904–24; as well as attaining eminence as a mathematician, he also achieved distinction in physics, his work on spectral series giving him a place among those whose work formed the experimental basis of quantum mechanics. Runge died at Göttingen in 1927

In the field of botany, an interesting centenary is that of A. F. W. Schimper (1856–1901), who took a foremost place in establishing the science of plant ecology. His book, "Plant Geography", has become a classic. He travelled widely, and was one of the first to prepare a map of plant distribution.

Two biologists who were born in 1856 achieved distinction. Sir Edward Poulton, for forty years Hope professor of zoology at Oxford, was an enthusiastic Darwinist, and made the problem of mimetic resemblances his especial study. He was president of the British Association when it met at Nottingham in 1937. He died six years later at the age of eighty-seven. E. B. Wilson, American biologist, had a great influence on the study of embryology. He studied the growth of the nucleus, and introduced the conception of cell-lineage. A Foreign Member of the Royal Society, he gave the Croonian Lecture in 1913. Another American who should be remembered this year is R. H. Chittenden (1856–1943), who directed the Sheffield Scientific School at Yale during 1898–

1922. He was an early worker in the study of gastrochemical processes, and became world famous as an authority on nutrition.

Other centenaries falling this year include those of J. B. Senderens (1856–1937), the French chemist who was associated with Sabatier in the discovery of the hydrogenation of oils by catalysis; and E. J. Bevan (1856–1921), who jointly with C. F. Cross succeeded in obtaining viscose from cellulose in 1892. Two Americans who made notable discoveries in the field of technology were F. I. Ives (1856–1937), who invented the first successful half-tone process in printing in 1878, and was also an early worker in colour photography; and E. G. Acheson (1856–1931), who patented a successful process for the artificial production of graphite, and developed its use as a lubricant.

In the field of technical chemistry, however, the most important centenary of the year is undoubtedly that of the discovery of the first aniline dye, made by William Henry Perkin in 1856, which is to be marked by celebrations next May. It is proposed to set up a trust fund to finance Perkin Centenary Scholarships, so linking the past and the future, and this seems a particularly satisfactory way of celebrating a centenary.

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CENTENARY OF *THE ENGINEER*

By W. J. PRIEST

THIS week, *The Engineer* has celebrated its centenary. A special number of the journal has been published which contains, in addition to a short history, articles by twenty-six eminent authors, which constitute a study of influences on engineering advancement during the past hundred years.

The first number of *The Engineer* appeared on January 4, 1856, and apart from two gaps, caused by the general strike in May 1926 and by the national fuel crisis in February 1947, its weekly publication has been regular and continuous. Although it is not quite the oldest technical journal in Britain, *The Engineer* can claim to be the oldest weekly newspaper serving the interests of engineers in every branch of the profession and industry which it represents. The paper was founded by Edward Charles Healey, a young man of thirty-three, who, it is said, was interested, among many other things, in railway development. The Great Exhibition of 1851 had undoubtedly given an impetus to mechanical invention; there was a place for a journal in which the many engineering developments of the time could be recorded and commented upon. It was that place which *The Engineer* was destined to fill. For seventy-three years the journal continued in the ownership of its founder's family, his son, Sir Charles Chadwyck-Healey, Bart., and a grandson, Sir Gerald Chadwyck-Healey, Bart., in turn succeeding to the chairmanship of *The Engineer* Ltd., while a second grandson, Mr. O. N. Chadwyck-Healey, became managing director. In 1929, *The Engineer* Ltd. amalgamated with Morgan Brothers (Publishers) Ltd. and a new company was formed, retaining the second firm's name, with Sir Gerald Chadwyck-Healey as its first chairman, and Mr. O. N. Chadwyck-Healey as a joint managing director. Now, Mr. O. N. Chadwyck-Healey is the chairman, and Mr. C. A. Chadwyck-Healey, a great-grandson of the founder of *The Engineer*, is the assistant managing director of the owning company.

From the start, the journal promised impartiality in taking "cognisance of all new works relating to the useful arts and allied subjects". In addressing itself to its readers, in the first issue, *The Engineer* declared that "every new moon is witness to the advent of some invention, some happy discovery, or successful application, some change at least, which like more fuel, becomes new incitement to fresh efforts. There is, therefore, no want of scope under the title we have assumed". Certainly, as the years of its first momentous century have rolled by, the scope of the journal has been ever-widening; there can have been few developments in the vast field of engineering progress which have not had some place in its columns.

During its first century *The Engineer* has had five editors, and the service of three of them—the Pendreds—now extends over a period of no less than ninety years. For its first two years, the paper was edited by a Mr. Allen, about whom next to nothing is known apart from the fact that his office was at 32 Bucklersbury, in the City of London, while the publisher's headquarters were at 301 Strand. After Allen's resignation in 1858, an American engineer named Zerah Colburn was appointed by Edward Healey to "an influential position on the staff". Colburn had come to Britain a year earlier in order to study railway development. He was possessed of a photographic memory, wielded a brilliant pen, and in many respects has been accounted a genius. But Colburn's eccentricities were many, and by the end of 1864 his resignation was inevitable.

It was then that Vaughan Pendred, a young Irishman who had lately come to Britain to make his way as an engineer, was invited to take the editorial chair. His letters and articles had attracted the attention of the proprietor of *The Engineer*, and Vaughan Pendred's appointment undoubtedly marked the beginning of a new and greatly improved relationship between owner and editor. Vaughan Pendred missed no opportunity of extending the field and increasing the influence of his paper, and he took early steps to depart from such traditions of technical journalism as then existed. In its early years, *The Engineer* relied mainly on patent specifications for its illustrations; but Vaughan Pendred held that the current engineering practice of the day should be more fully represented, and he persuaded manufacturing and constructional engineers—not without some difficulty, it is said—to permit him to publish drawings of their actual products. For forty years, Vaughan Pendred, who was a master of technical description and criticism, edited the paper, and on his retirement in 1905, he was succeeded by his second son, Loughnan St. Lawrence Pendred, who had become his father's first full-time assistant nine years earlier. L. St. L. Pendred's editorship lasted for forty-one years. He guided *The Engineer* through two World Wars and through the period of depression between those Wars, he ensured that the paper kept pace with the demands of the day, and he rendered innumerable services to the engineering profession generally, among which must be recalled his presidency of the Institution of Mechanical Engineers in 1930. In 1934, L. St. L. Pendred was created C.B.E. in recognition of his work for engineers, and by that time his younger son, Benjamin W. Pendred, had joined the editorial staff. He succeeded his father as editor-in-chief in April 1946—a position which he still occupies.

It is impossible within the compass of this article to make more than a passing reference to the contents of *The Engineer* over its first hundred years. The paper has carefully reported engineering, and many other scientific, developments as they have occurred, but (as was promised in its first issue) it has not confined itself merely to furnishing "a dry register of the progress of machinery". The paper has always covered a broad canvas. There have been articles by many distinguished contributors, such as those, in 1866, by W. J. Macquorn Rankine on "Simple Rules for Practical Calculations of the Efficiency of Steam" and by Prof. John Tyndall on "Ice and Glaciers". In 1867 Samuel Smiles was writing in *The Engineer* about Richard Trevithick's place in the early history of the locomotive, while in 1937, much nearer to the present time, there appeared special articles like those by the late Sir Leonard Hill on "Air Conditioning" and by Sir Harry Ricardo on "Prospects of the High-Speed Heavy Oil Engine". Contributions of this order by distinguished authors have regularly had a place alongside descriptions of all kinds of engineering works, reports of technical meetings and exhibitions, and surveys of economic and labour affairs. At the same time, there has been a place for brief, and interesting, notes such as one, many years ago, setting down the time taken by the winner of "The Derby" as recorded by Benson's chronograph !

The diversity of interest revealed in earlier volumes of *The Engineer* continues unabated. The first hundred years of the journal cover a period in which steam power has reached its zenith and has declined as the utilization of electrical and internal combustion engine power has rapidly advanced. There has been outstanding progress in aeronautics, metallurgy, radio and telecommunications, while the construction of great civil engineering works, the development of mass-production methods, and, not least, the educational and sociological advances in engineering have time and again proved to be of outstanding importance. All of them are matters which have claimed the close attention of *The Engineer*. As the paper moves into its second century, subjects like the fuller development of the gas turbine, nuclear power and automation are prominent. The tempo of technological progress all over the world continues to increase ; but there is no doubt that *The Engineer* will continue effectively to record that progress.

ANTIPROTONS

By Prof. O. CHAMBERLAIN, Prof. E. SEGRÈ, Dr. C. WIEGAND and Dr. T. YPSILANTIS
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Since the development of Dirac's theory of the electron and the brilliant confirmation of one of its most startling predictions by the discovery of the positron by Anderson, it has been assumed most likely that the proton would also have its charge conjugate, the antiproton. The properties that define the antiproton are : (1) charge equal to the electron charge (also in sign) ; (2) mass equal to the proton mass ; (3) stability against spontaneous decay ; (4) ability to become annihilated by interaction with a proton or neutron, probably generating pions and releasing in some manner the energy $2\,mc^2$; (5) generation in pairs with ordinary nucleons ; (6) magnetic moment equal but opposite to that of the proton ; (7) fermion of spin $\frac{1}{2}$. Not all these properties are independent, but all might ultimately be subjected to experiment.

In cosmic rays, where such antiprotons could appear, some events have been observed which could be due to antiprotons ; but their interpretation is uncertain.

In order to generate antiprotons in the laboratory, an absolute lower limit of the necessary energy is $2\,mc^2 = 1{\cdot}88$ BeV. ; but the mechanism of the collision and the conservation of momentum influence this lower limit, which becomes 5·6 BeV. if the process is a nucleon–nucleon collision, or 4·4 BeV. if the process is a two-step one with the formation of a pion in a nucleon–nucleon collision followed by a pion–nucleon collision in which the nucleon–antinucleon pair is generated. These thresholds can be lowered appreciably by internal motions of nucleons in the nucleus. (Energies are quoted in the laboratory system.)

When the Berkeley bevatron was planned, the goal of 6 BeV. was set, in the hope that this energy would be sufficient to create antiprotons.

The methods of detection of the antiproton can make use of any of the seven properties listed above. It seemed that (1), (2) and (3) might be the easiest to ascertain ; (4) would also be highly desirable ; whereas (5)–(7) are at present very difficult to observe.

There are classical methods of measuring charge and mass of a particle that go back in their origin to J. J. Thomson. They entail the simultaneous measurement on the same particle of any two of the quantities momentum, velocity or energy, which in turn can be obtained from the observation of electric or magnetic deflexions, time of flight, range, scattering in photographic emulsions, etc. As for the charge, it is sufficient to measure its sign and its absolute value in a rough way only, because it is assumed that it is an integral multiple of the electronic charge.

After a detailed discussion, it was decided that momentum p and velocity v constituted the most promising combination for ascertaining the mass. The first successful experiment[1] was performed at the end of September 1955, as follows. The momentum was measured by passing the particles generated by bombardment of a copper target with 6·2 BeV. protons through two deflecting magnetic fields and two magnetic lenses. This ensemble let through only particles for which $p = 1{\cdot}19$ BeV./c, if their charge is equal to that of the electron, including sign. The velocity was measured by a time-of-flight measurement between two scintillation counters 40 ft. apart. The pulse-size in the scintillators showed that the particles were singly charged.

The chief difficulty of the experiment rests with the fact that the antiprotons are accompanied by many pions—44,000 pions per antiproton in the most favourable conditions. For this reason provision must be made for eliminating spurious background effects. One of the most important steps is the insertion in the beam of two Čerenkov counters: one that is activated by particles with $v/c = \beta > 0{\cdot}79$, and one of a special type that is activated by particles with $0{\cdot}75 < \beta < 0{\cdot}78$. Pions with $p = 1{\cdot}19$ BeV./c have $\beta = 0{\cdot}99$, while antiprotons of the same value of p have $\beta = 0{\cdot}78$, and their respective times of flight for an interval of 40 ft. are 40×10^{-9} sec. and 51×10^{-9} sec. Particles with β in the interval between 0·75 and 0·78 trigger the sweep of an oscilloscope in which the time of flight between two scintillation counters 40 ft. apart is displayed. This time of flight appears as the distance between the two 'pips' due to the traversal of the counters. From this time of flight the mass is determined with an accuracy of 10 per cent for each particle. Up to now, about 250 particles have been observed and the average mass is known to about 5 per cent. It is 1,840 ± 90 electron masses.

The functioning of the whole apparatus is checked by sending through it positive protons in a separate run. These are obtained from a subsidiary target, and their orbits are selected in such a way that they have the same momentum as the antiproton.

The particles are observable after a time of flight of 10^{-7} sec., which rules out particles with a mean life much shorter than 10^{-8} sec., in particular the known hyperons. These measurements are thus in agreement with points (1), (2) and (3) mentioned above, and the identification of the new particle with the antiproton is a natural one, although not absolutely established.

There are also some indications on the fourth point mentioned above, namely, the terminal process of the particle. Particles selected as antiprotons by the apparatus of ref. 1 were sent into a block of heavy glass and the Čerenkov radiation generated in it was measured[2]. This radiation does not correspond, of course, to the entirety of the energy released; actually it is only a small part of it. However, a calibration was performed, and from the pulse size the visible energy was estimated. Values up to 800 MeV. were found. This is consistent with the expected modes of annihilation for an antiproton, and with the energy it would throw into Čerenkov radiation in a detectable form; but it is not sufficient yet for positive identification on that score only.

Another type of observation on the terminal phenomenon accompanying the absorption of the antiproton was also performed[3] with the photographic plate technique. Particles of selected momentum obtained with an arrangement similar to that described in ref. 1 were slowed down by a copper absorber and finally stopped in a stack of photographic emulsions. Among a background of many pions one particle was found which has protonic mass, comes to rest and produces a star containing six black tracks, one grey proton, one pion of 58 MeV. and one minimum ionization track. The visible energy released is larger than 830 MeV. The total energy released cannot be known, because there are neutral particles emitted; but this amount of visible energy is also consistent with the annihilation of an antiproton.

Clearly many questions are raised by the new particle. Its identification should be further corroborated; it is important to study in detail its annihilation properties for complex nuclei and, possibly even more interesting, the annihilation with hydrogen and deuterium. In addition, the cross-section for nuclear interaction and the mechanism of production are clearly to be investigated.

The existence of the antiproton entails with virtual certainty the existence of the antineutron. Its experimental demonstration is a most interesting problem. Probably the neutron beam of the Berkeley bevatron contains an appreciable number of them, but their disentanglement from the ordinary neutrons appears a formidable task. It is likely that the best approach will be either: (1) to transform an antiproton into an antineutron by a collision with a proton; or (2) to convert an antineutron into an antiproton by collision with an ordinary neutron and detect either the final antineutron in (1) or the final antiproton in (2).

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INTERNATIONAL COMPARISONS OF RADIOACTIVITY STANDARDS

During the period May 1952–November 1954, international comparisons have been made of standard samples of the radioactive nuclides sodium-24, phosphorus-32, cobalt-60, strontium-90 + yttrium-90, iodine-131 and gold-198. The organizations taking part in these measurements and comparisons have been the United States National Bureau of Standards, Atomic Energy of Canada, Limited, and four British laboratories (the National Physical Laboratory, the Atomic Energy Research Establishment, Harwell, the Royal Cancer Hospital, London, and the Medical Research Council, London, co-ordinated through the National Physical Laboratory Advisory Committee on Radioactive Standards). Periodical meetings between representatives of the three countries have been arranged by the United States National Research Council Sub-committee on Beta- and Gamma-ray Measurements and Standards. Several papers on the work have already appeared (refs. 1–12).

The samples used for the comparisons were standard solutions prepared by the U.S. National Bureau of Standards, excepting the strontium-90 + yttrium-90 samples, which were prepared by the

Atomic Energy Research Establishment, Harwell. The solutions generally contained a few microcuries per gram. In the case of cobalt-60 and iodine-131, stronger solutions containing of the order of one millicurie per gram were provided. The disintegration-rates of the samples were determined at each of the laboratories by one or more of the following methods: total β-counting in a 4π solid angle, $4\pi\beta\gamma$- and $\beta\gamma$-coincidence counting, and $\gamma\gamma$-coincidence counting. The results of measurements under what are considered to be the best conditions attainable at present are in agreement to within about ± 2 per cent, except for 4π-counting of low-energy β-rays.

In measurements of sodium-24 and gold-198 by $4\pi\beta$-counting, the fractional losses of β-particles by absorption are small and the results agree within ± 2 per cent. They also agree within these limits with $4\pi\beta\gamma$- and $\beta\gamma$-coincidence results. The basic counting measurements for iodine-131 are in agreement within 1 per cent, but there is some uncertainty concerning the allowance to be made for self-absorption. No such allowance was applied by the British and Canadian laboratories; but it has been calculated by the National Bureau of Standards to be about 2 per cent. Owing to the complex disintegration scheme of iodine-131, there is unfortunately no ready means of providing a cross check. The apparent systematic difference of about 3 per cent between the National Bureau of Standards results for iodine-131 and the standard of this nuclide at present adopted in Great Britain and at Chalk River is thus attributable to the correction assumed for self-absorption.

Agreement to within ± 1 per cent was obtained in the measurements of cobalt-60 by $\beta\gamma$- and $\gamma\gamma$-coincidence counting. A wide range of values by $4\pi\beta$-counting was, however, reported by the British laboratories. Subsequent investigations at the National Bureau of Standards showed that, owing to the relatively low energies of the β-particles, the apparent disintegration-rates obtained by $4\pi\beta$-counting were critically dependent on the amount of solid material in the source and on its distribution. Consideration of the cobalt-60 results leads to the conclusion that, owing to the precautions necessary in the preparation of the source, and the uncertainties in the absorption corrections, the $4\pi\beta$-counting method of standardizing this nuclide is at present less reliable than the coincidence method. It is, however, considered that the disintegration-rate of the solution distributed was determined by the coincidence method to an accuracy approaching ± 1 per cent.

Ionization chamber equipment for preserving standards of the nuclides used for these comparisons has been set up at the National Bureau of Standards, and similar equipment is being calibrated at the National Physical Laboratory. The co-operation between the American, Canadian and British laboratories on all matters relating to the establishment and the maintenance of radioactivity standards is to be continued in order to check the agreement already attained, and to extend the comparisons to other nuclides. It is hoped that standardizing laboratories in other countries will participate in future comparisons; those interested should write to the most convenient of the authors of this communication.

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TURBULENCE IN THE ATMOSPHERE AND IN THE OCEAN

The study of atmospheric turbulence can reasonably be regarded as having been started some fifty years ago by the distinguished oceanographer, Ekman. Since then, it has progressed in the intermittent way of most branches of science, and at the present it appears to be in a state of flux.

Up to a few years ago, advances in atmospheric turbulence were usually achieved by exploiting the basic similarity between laws of flow on the laboratory and on the atmospheric scale, together with ingenious and painstaking confirmatory observations. These were, for technical reasons, usually made in the lowest 10 m. of the atmosphere, where the horizontal shearing stress can be taken as independent of height, although there were occasional explorations to the top of what was called the 'frictional boundary layer', at about 1 km., beyond which the eddy transfer of momentum was thought to be negligible. The turbulence was often regarded as fluctuations in the wind, temperature and humidity which were too rapid to be recorded by conventional meteorological instruments.

In 1949, however, Priestley made a pioneer statistical study[1] of the horizontal transfer of heat and momentum by motions of large scale, using wind and temperature observations made at daily intervals at all levels over Larkhill. His technique, which was perhaps influenced by the earlier work of Jeffreys and Defant, has since been used by others; it provides a convincing demonstration of the obvious fact that atmospheric turbulence cannot be identified with motions of any particular scale.

The close link between motions on all scales is well shown by the work of Sheppard, Charnock and Francis[2], who from observations made near the Scilly Isles suggested that over the ocean in the Westerlies the shearing stress did not vary with height up to the maximum height observed, about 1 km., and probably beyond. The implication was that the shearing stress was due to turbulent transfer of momentum down a gradient of mean momentum, the gradient being due not only to friction but also to a horizontal gradient of temperature, a thermal wind. The classical concept of a limited friction layer was not valid, at least over the ocean. This work, taken together with that of Priestley and others, fits well with recent models of the general circulation of the atmosphere in which the effects of motion on all scales play a part.

This broadening of the scope of atmospheric turbulence has raised new problems, not only of physics but also of nomenclature; in particular, since turbulence can no longer be regarded as the embroidery on the anemograph, some workers find it convenient to regard the word 'turbulence' as connoting a technique for determining, usually by statistical methods, the properties of any field of flow. This has the great virtue of bringing into the open the difficulties associated with the wide spectrum of atmospheric motions. When used as other than a technique, the word turbulence usually seems to be qualified in some way—by small-scale or large-scale, or by the ubiquitous medium-scale—the word turbulent being used only in such platitudes as "the atmosphere is turbulent on a broad range of scales". The result is that, at a meeting to discuss atmospheric turbulence, the papers may include almost any aspect of dynamical meteorology. This was certainly the case at a symposium held at the summer meeting of the Royal Meteorological Society held at Ashburne Hall, University of Manchester, during July 22–23. Of the four papers presented, one was concerned with motions through the whole atmosphere, two dealt with motions in the lowest 2 km. and one attempted to bridge the gap between small-scale near-surface flow and that at greater heights. A fifth paper, presented in a symposium on oceanographical topics, described eddying motion in tidal flow near the sea bed.

Prof. P. A. Sheppard presented a joint paper on medium-scale turbulence in trade-wind air, which described the results of an expedition to a small island in the West Indies to make observations similar to those made earlier at the Scilly Isles. On fifteen days out of a total of twenty-seven, balloons were released from the upwind shore at intervals of about 10 minutes and were observed every 20 seconds, using two theodolites. The particular interest of such observations in the trades is that the directions of the mean surface wind and the thermal wind are opposed (there was a maximum in the profile of mean wind-speed at a height of a few hundred metres) and that cumulus convection is almost always present. Fluctuations from the mean flow were analysed using averaging periods increasing from 3 hours up to the whole 27-day period. Over this period it was found that horizontal momentum was being transferred to the north by the larger-scale motions which were sampled, a smaller amount being transferred to the south by motions of smaller scale. On no scale was there equipartition of turbulent energy between the three velocity components, the root-mean-square energy in the vertical being one or two orders of magnitude less than that of the horizontal components. A complete account of the results of the expedition is to be published; they will add to our knowledge of the medium-scale turbulence and of the momentum transfer it brings about in this important region.

Mr. F. B. Smith then read his paper on geostrophic and ageostrophic wind analysis[3], in which he estimated the work done over the British Isles by the atmospheric pressure field set up by differential heating. He first reduced the equations of motion to an approximate but observable form which involved the geostrophic and ageostrophic components of the wind-velocity and the radius of curvature of the isobars. These he had obtained by drawing charts using British radio-sonde data at nine levels for every third day of 1953. The rate of production of kinetic energy was found to be of the same order as that found by Brunt by considering dissipation by small-scale turbulence, but it appeared to be differently distributed with height. The flow across the isobars was found to be about the same as would be predicted using the well-known Ekman distribution, again as used by Brunt; some check on this estimate was obtained by calculating the life of typical depressions, which was found to agree with observation. This paper is a good illustration of the close link between motions on the largest and smallest scales.

Turbulence of medium scale is being investigated by Dr. F. Pasquill, who presented a preliminary report of the diffusion of fluorescent dust over distances of some tens of miles and heights of some thousands of feet. The dust particles, of zinc cadmium sulphide, diameter 0·5–3μ, were sampled by the Meteorological Research Flight using an airborne sampler. Individual particles of dust can be counted later, since they fluoresce when irradiated with ultraviolet light. Results so far indicate that the distribution of the dust has the same form at all heights. The height of the cloud was much less than the width: the width did not increase uniformly with distance; the angle subtended at the release point by the cloud at forty miles distance was about half that subtended by the cloud at a mile or so.

Earlier diffusion experiments in Great Britain have been of a smaller scale and usually confined to the lowest 30 m., where the wind direction does not change appreciably with height. The interpretation of these observations of diffusion at greater heights is complicated by the variation of wind with height both in speed and direction.

The variation of wind with height has been studied by many workers since Ekman fifty years ago. It is now well known that in the lowest 10 m. or 100 m. the eddy viscosity increases linearly with height, and Dr. T. H. Ellison described the wind-field to be expected if this linear variation were maintained to greater heights. The solution he has derived has many points of interest and, of course, reduces to the familiar logarithmic distribution of wind with height near the ground. It is possible to allow for the effect of a thermal wind of simple form, and the resulting modification helps in the interpretation of observations such as those described by Prof. Sheppard, particularly over the ocean.

A paper presented by Prof. K. F. Bowden in an oceanographical symposium is also appropriate to this account. He has made measurements, in collaboration with Mr. L. A. Fairbairn, of fluctuations of the three components of current in tidal streams in the Irish Sea using an electrode flowmeter designed at the National Institute of Oceanography. The meter is complicated but seems quite suitable for recording fluctuations in current; the velocity of the mean current is not recorded. Prof. Bowden gave a good deal of information about the correlations of the fluctuating currents, and it was clear that much valuable work remains to be published.

H. Charnock

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[1] *Quart. J R. Met. Soc.*, 75, 28 (1949).

[2] *Quart. J.R. Met. Soc.*, 78, 563 (1952).

[3] *Quart. J R. Met. Soc.*, 31, 403 (1955).

NEWS and VIEWS

New Year Honours List

The following names of scientists and others associated with scientific work appear in the New Year Honours List:

Baronet: Sir Hubert Houldsworth, chairman of the National Coal Board.

K.C.B.: Sir Frederick Brundrett, chairman of the Defence Research Policy Committee and scientific adviser to the Minister of Defence.

K.B.E.: Alexander Glen, secretary, Department of Agriculture for Scotland.

D.B.E.: Prof. Kathleen Lonsdale, professor of chemistry and head of the Department of Crystallography, University College, London.

Knights: Dr. Eric Ashby, president and vice-chancellor of The Queen's University, Belfast; Dr. Ralph G. Hawtrey, president during 1946–48 of the Royal Economic Society, for services to the study of economics; Dr. Joseph Burtt Hutchinson, director of the Empire Cotton Growing Corporation's Cotton Research Station, Namulonge, Uganda; Dr. Eric J. F. James, high master, Manchester Grammar School; Walter Mercer, professor of orthopædic surgery, University of Edinburgh, president of the Royal College of Surgeons, Edinburgh; Prof. Alfred G. Pugsley, professor of civil engineering, University of Bristol; Prof. Samuel McM. Wadham, professor of agriculture, University of Melbourne, for public services; Prof. Solly Zuckerman, Sands Cox professor of anatomy, University of Birmingham, deputy chairman of the Advisory Council on Scientific Policy.

C.B.: Dr. W. Cawood, principal director of scientific research (air), Ministry of Supply; W. C. M. Couch, deputy director of electrical engineering, Admiralty; H. Hardman, deputy secretary, Ministry of Agriculture, Fisheries and Food; W. J. Richards, director of the Radar Research Establishment, Ministry of Supply.

C.M.G.: J. A. Beckett, assistant secretary, Ministry of Fuel and Power; F. S. Collier, forestry adviser to the Secretary of State for the Colonies; Prof. S. H. Roberts, vice-chancellor of the University of Sydney; Dr. J. A. Venn, president of Queens' College, Cambridge, lately chairman of the Colonial Studies Committee.

C.B.E.: Prof. C. E. H. Bawn, Grant-Brunner professor of inorganic and physical chemistry, University of Liverpool; W. H. Cashmore, director of the National Institute of Agricultural Engineering, Silsoe, Bedfordshire; S. H. Clarke, director of the Fire Research Station, Department of Scientific and Industrial Research; H. V. Disney, chief engineer, Industrial Group Headquarters, Risley, United Kingdom Atomic Energy Authority; Dr. A. T. Doodson, director of the Liverpool Observatory and Tidal Institute; Prof. W. P. Evans, professor of chemistry, Canterbury University College; R. Graham, director of aircraft research and development, Ministry of Supply; H. V. Hayes, director of air technical publications, Ministry of Supply; W. E. Hiley, director, Woodlands Research Department, Dartington Woodlands, Ltd.; C. E. Hudson, senior education and advisory officer, National Agricultural Advisory Service, Ministry of Agriculture, Fisheries and Food; H. D. Lewis, assistant secretary, Ministry of Agriculture, Fisheries and Food; Prof. J. R. Matthews, lately chairman of the Scottish Committee of the Nature Conservancy, and chairman of the council, Macaulay Institute for Soil Research; T. N. Mitchell, president of the Royal Agricultural Society, State of Victoria; Dr. A. S. Parkes, director of the Division of Experimental Biology, National Institute for Medical Research; Dr. H. Richardson, principal of the Bradford Technical College; H. D. Skinner, director of the Otago Museum and lecturer in anthropology in Otago University; H. C. Smith, secretary of agriculture, State of Tasmania; Dr. Kenneth M. Smith, director of the Virus Research Unit (Agricultural Research Council), Molteno Institute, University of Cambridge; R. S. Stafford, technical director, Handley Page, Ltd.; W. G. Rodway, for anti-locust work in East Africa; S. G. Wilson, director of veterinary services, Northern Region, Nigeria.

Archæology in the University of London: Prof. V. Gordon Childe

Prof. V. Gordon Childe is retiring from the chair of prehistoric European archæology in the University of London and the directorship of the Institute of Archæology in Regent's Park. We may hope that he will have a very happy period of retirement and that his increased leisure will enable him to give us the results of his mature conclusions. Childe is an Australian and was at Oxford when the First World War started; at the time his health was not good, but after the War he spent a long time in Central and Eastern Europe. It was here that his great knowledge of, and interest in, the early story of mankind in these areas developed. For a short time he acted as librarian at the Royal Anthropological Institute, but shortly after this the new Abercromby professorship of archæology at Edinburgh was founded and Gordon Childe was its first holder. Most of the students there only took archæology as a subsidiary subject, though there were a few honours candidates. Prof. Childe was very popular with his students and laid the foundation of what has become an important archæological school. He also did a considerable amount of archæological investigation in Scotland, and his work at Skara Brae is well known. Later Childe was offered and accepted a chair in the University of London, which carried with it the directorship of the Archæological Institute of the University. Here again with his colleagues he built up an important school, and one can only regret that his retirement occurs before the Institute moves into more official quarters in the new University building itself. It is to be hoped that, as is the case at Cambridge, the University of London may yet see its way to recognize archæology as an honours school for degree-giving purposes. It is well known that Childe holds strong ideological views not acceptable to everyone, but that must not be allowed to obscure the enormous amount of solid factual archæological work and teaching that he has accomplished; he is one of the leading prehistorians to-day.

Mr. W. F. Grimes, C.B.E.

The University of London Institute of Archæology, founded with a voluntary staff and director in 1937, has been directed since 1946 by the professor of prehistoric European archæology in the University, Prof. V. Gordon Childe; but since it has been receiving financial support from the University of London the Institute has extended so rapidly, and in particular the teaching work in prehistoric European archæology has increased so much, that on the resignation of Prof. Childe the Senate has decided to separate the posts, and has invited Mr. W. F. Grimes to accept the directorship. Prof. Gordon Childe's resignation from his double post takes effect on September 30, 1956.

Mr. Grimes, a graduate of the University of Wales, began his professional archæological career as assistant in the National Museum of Wales. While there he conducted many important excavations on prehistoric and Roman sites, undertook comprehensive field surveys of prehistoric monuments, and wrote a "Guide to the Collections illustrating the Prehistory of Wales". This was published in 1939, but republished in 1951 as "The Prehistory of Wales"; for it was, in fact, far more than a guide, but presented Welsh prehistory in its British and European setting. At the end of 1938 Mr. Grimes was appointed assistant to the Archæological Officer in the Ordnance Survey; but on the outbreak of war he was seconded to the Ministry of Works to conduct rescue excavations on archæological sites threatened by the construction of aerodromes or military works. These excavations resulted in many important discoveries, of which only a small part has yet been published, a full publication by H.M. Stationery Office being in preparation. At the end of the War, Mr. Grimes was appointed director of the London Museum when Mr. (now Sir Mortimer) Wheeler was appointed director-general of archæology in India. It thus fell to Mr. Grimes to find a new home for the Museum that was ejected from Lancaster House, and to install the collections in their new premises in Kensington Palace. At the same time Mr. Grimes had to organize and direct the excavations of the bombed sites in the City of London that have brought to light so many new details as to the topography and architecture of the Roman and medieval city, including the Temple of Mithras. Mr. Grimes is now president of the Council for British Archæology.

The Engineer

This week sees the centenary of *The Engineer* (see p. 10 of this issue), and a special issue has been prepared to mark the occasion. It is a remarkable and absorbing compilation, with its 124 pages of editorial matter and its 300 or so pages of advertisements. The Editor has assembled a notable collection of articles from leading authorities on the development and present situation in the main fields of engineering. These have been grouped into six sections, concluding with a fine series of coloured plates of modern manufacturing plant and products. The articles range from one by Sir Albert Pugsley on "Scientific Discovery" to others by Sir Christopher Hinton on "Nuclear Power", Dr. H. A. Thomas on "Electronics" and Dr. D. F. Galloway on "Production Methods"; between them these two give a good condensed picture of the present and future influence of automatic control in industry. Attention is also paid to engineering materials with articles on "Iron and Steel", "Non-ferrous Metals", "Concrete" and "Plastics". The publishers are to be congratulated on producing a volume, worthy of their high reputation, which will be of permanent value and interest.

Institute of Metals: Medal Awards

The Institute of Metals has awarded the following medals: *Institute of Metals Medal in Platinum* (1956), to Prof. G. L. Chaudron (professor at the Sorbonne and director of the Vitry Laboratory of the Centre National de la Recherche Scientifique), in recognition of his outstanding contributions to knowledge, particularly in the field of the light metals, which have greatly benefited the metal industries; *Rosenhain Medal* (1956), to Dr. D. McLean (principal scientific officer, Metallurgy Division, National Physical Laboratory, Teddington), in recognition of his outstanding contributions to knowledge in the field of physical metallurgy; *W. H. A. Robertson Medal* (1955) and premium of fifty guineas, to E. J. Thackwell (Northern Aluminium Co., Ltd., Rogerstone, Mon.), for a paper on the choice and construction of monolithic linings for twin-bath induction furnaces for melting aluminium alloys.

Staffing the United Kingdom Atomic Energy Authority

An adjournment debate on the staff of the Atomic Energy Authority, opened by Mr. A. Neave, was held in the House of Commons on December 21, and in replying for the Government the Minister of Works, Mr. N. Birch, said that, since the annual report of the Authority was issued, further measures have been taken to improve the pay and conditions; these should give the Authority greater flexibility and enable it to compete successfully with outside industry. As regards the transfer of staff from the Civil Service, 78·5 per cent of the Civil servants now with the Authority have accepted the offers; 10·5 per cent have rejected them and 11 per cent have not yet notified the Authority of their wishes. Only 8 per cent of the professional and scientific staff have decided not to avail themselves of the offer, whereas 15 per cent of the executive and clerical staff have rejected them. Many of these latter are of considerable seniority, but the numbers are not large and most of the wastage has been made good without much difficulty. As regards training, there are comprehensive schemes for craft and student apprenticeships, and practical training is sometimes provided for students before they enter the university or after graduation. Very special consideration has been given to 'sandwich' courses, and the Authority also runs a large number of advanced courses in nuclear technology within its own organization. Sympathetic consideration has been given to the difficulties experienced in getting technical training by staff at such places as Dounreay and Calder Hall, but Mr. Birch was unable to say anything more in reply to Mr. Neave's suggestion for a large central institution for nuclear physics or nuclear technology. The Minister thought that any real danger of widespread redundancy is remote whatever the future of nuclear weapons; the Authority would be only too glad to utilize any skilled personnel released from the weapons group. Mr. Birch could say nothing definite about the future pattern of the Authority. It is a pioneering organization, he said, which must keep abreast of advances in scientific thought and of new knowledge. Both scientific and administrative skill are needed, and the Authority will continue to require to recruit good men for its expanding field. Mr. H. Usborne suggested that the Authority is recruiting an excessive proportion of young engineers.

International Control of Nuclear Weapons

Replying to questions in the House of Commons on December 19, the Minister of State for Foreign Affairs, Mr. A. Nutting, said that no specific action has yet been taken on the proposal he made in the United Nations Disarmament Sub-Committee on October 7 for a conference of scientists representing each member country of the Sub-Committee to report on the possibilities of controlling nuclear weapons. A variant of this proposal was contained in a resolution passed by the United Nations Assembly the previous week, but was opposed by the U.S.S.R. Nevertheless, said Mr. Nutting, the Government is still seeking to get agreement to some scheme of this kind and has not abandoned hope of a disarmament agreement on conventional weapons, although it also hopes ultimately to achieve a comprehensive agreement embracing nuclear weapons when means of control have been discovered.

Journal of Analytical Psychology

Although the followers of Freud have been well supplied with literature, the disciples of Jung have not been so fortunate. It is therefore gratifying to find that the Society of Analytical Psychology, London, has decided to produce its own journal, called the *Journal of Analytical Psychology* (1, No. 1 (1955); published by the Tavistock Publications, Ltd., 2 Beaumont Street, W.1; 12*s*. 6*d*. per issue or 21*s*. per vol. of two issues). In this first issue it is stated that "the decision to launch a Journal of the Society did not spring only from the publicly expressed observation that we produce no journal, but also, indeed one could say mainly, from the internal vitality of its members, now over forty in number". In the past the writings of the Jungian school have tended towards theorization rather than a clinical approach, and it is a good thing that most of the papers here are concerned with patients rather than myths. Nevertheless, since mythology and anthropology play such a large part in the Jungian approach, a great deal of space is devoted to the relationship of dreams to primitive thought. The most important paper in this issue is that of J. Layard, on boar-sacrifice, in which the dream of a patient about cooking ham and being chased by a pig is related to the ritual sacrifice of pigs in Malekula. Another long paper is by Robert F. Hobson, on archetypal themes in depression, and Robert Moody writes on the function of counter transference. L. Stein writes on loathsome women and Amy Allenby on the father archetype in feminine psychology. Anthony Storr contributes a note on cybernetics and analytical psychology. There is also a long critical notice on the collected works of C. G. Jung and on Jung's "Answer to Job". It is difficult for anyone who has not been educated in the Jungian discipline to evaluate these papers. Those used to analysing dreams by free association, using the patient's interpretation, are likely to feel that they might have been interpreted otherwise, but in any event such clinical work is always of interest. It is to be hoped that this journal prospers, if only for the fact that it allows one to see how others are thinking.

University of Sheffield

The following have been appointed to lectureships in the University of Sheffield: Miss S. K. R. Clarke (bacteriology and virus diseases) and R. G. Siddall (fuel technology and chemical engineering). The present chair of fuel technology and chemical engineering in the University is to be called the Newton Drew chair in memory of the late Mr. and Mrs. W. Newton Drew. Mr. Newton Drew served on the University Council (1924–34), and was also treasurer of the University (1926–32) and a pro-chancellor (1932–34); Mrs. Newton Drew served on committees of the University for many years, and both were generous donors to the University. The present occupant of the chair is Prof. M. W. Thring.

Announcements

The Charles Mayer Prize of the Société de Chimie Biologique has been awarded for 1955 to Prof. S. Ochoa (University of Chicago) and Mme. M. Grunberg-Manago (of the Centre National de la Recherche Scientifique, France). The Prize, which is worth 500,000 francs, has only recently been created and is to be awarded annually, provisionally until 1960, for distinguished work on nucleoproteins.

Mr. G. F. Adams, scientific adviser to A. Gallenkamp and Co., Ltd., and Mr. H. B. Toft, formerly principal of Bath Technical College and recently a sales executive of the Company, have been elected to the board of directors of A. Gallenkamp and Co., Ltd.

The Royal Agricultural Society of England is offering its annual Research Medal, together with an award of a hundred guineas, for work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. Recommendations for the award can only be made by the head of the university department or research organization concerned. Such recommendations, with nine copies of the candidate's relevant papers, should be sent before January 31 to the Secretary of the Society at 16 Bedford Square, London, W.C.1.

The Education Panel of the Corrosion Group of the Society of Chemical Industry has established a prize of 25 guineas, to be awarded annually, for an essay or paper on any aspect (not necessarily research) of the corrosion of metals and its prevention. Competitors must not be more than twenty-seven years old, and their contributions, which may contain diagrams and photographs, should be about three thousand words in length. Entries must be submitted before March 31 to the Corrosion Group Essay Competition, c/o Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

SCIENCE AND DEFENCE IN GREAT BRITAIN

THE statement made by the Prime Minister, Sir Anthony Eden, in the House of Commons on October 25, on the administrative responsibilities of the Minister of Defence made no specific reference to the position of the Defence Research Policy Committee. Sir Anthony stated that arrangements have been made to co-ordinate, under the Minister of Defence, planning and training for the joint action of civil and military forces in home defence. The Minister of Supply has become a fourth Defence Department within the co-ordinating powers of the Ministry of Defence, and the Minister is now responsible for seeing that the composition and balance of forces within individual Armed Services meet the strategic policy laid down by the Defence Committee. A new post of chairman of the Chiefs of Staff Committee, to which Sir William Dickson has been appointed, has been created, and this officer will normally be the United Kingdom representative on the Military Committee of the North Atlantic Treaty Organization and on other international defence organizations.

These arrangements were discussed in a debate on the Armed Services in the House of Lords on November 8 and 9, in which the importance of research and of the scientist in defence was repeatedly stressed. In reply to Lord Swinton, who had urged that the Minister of Defence should also be responsible for deciding what research programmes should be undertaken and their priority, the Lord President of the Council, Lord Salisbury, said that the Minister of Defence has already been given responsibility for framing general policy governing research and development. Lord Rea suggested that the immensely accelerating rate of scientific discovery imposes on the Government a great responsibility to assess the future in terms which no individual past training and no previous experience can fulfil. Lord Hore-Belisha, too, was concerned as to the extent to which the scientist exerts an effective influence on policy, and Lord Freyberg also urged that a forecast of the effect of scientific invention upon the conduct of future wars should precede any reorganization or amalgamation of the Services. No one outside those responsible for the conduct of research knows either the aim of scientific invention or what has already been accomplished. Lord Balfour, in particular, emphasized the need for scientifically trained personnel in the Services, and doubts were freely expressed as to the extent to which amalgamation is possible and the level at which integration is desirable.

The Parliamentary Secretary to the Ministry of Defence, Lord Carrington, replying to the debate, assured the House that the Government attaches the greatest importance to scientists playing a sufficient part in the central organization for defence. The chairman of the Defence Research Policy Committee attends meetings of the Chiefs of Staff Committee whenever he wishes, and Lord Carrington doubted whether a week passes without him discussing some matters personally with the Chiefs of Staff. Although he is not a member of the Defence Committee, his views are invariably known to, and expressed by, the Minister of Defence, and the Defence Committee on occasion invites him to attend. The Chiefs of Staff have also asked the Scientific Adviser to the Minister of Defence to be the chairman of sub-committees to consider long-term problems. Lord Carrington emphasized that there is always a strong representation of scientists at the major exercises held by the Service Departments and the North Atlantic Treaty Organization; scientists are encouraged to put forward their ideas, and they are warmly welcomed by members of all three Armed Services.

THE BRITISH FLORA DURING 1955

STUDY of the British flora during 1955 has led to no outstanding additions to the list; but collectively the results represent important progress. This includes interesting extensions of the known range of some of the less-common species, a clearer understanding of the taxonomic value of various units, and the recognition of new ones. These, and other aspects, were illustrated by the exhibits at the annual exhibition meeting of the Botanical Society of the British Isles, arranged in the lecture room of the British Museum (Natural History) on November 28.

The meeting was attended by some three hundred members and guests, and a full account of the exhibits will appear in the *Proceedings* of the Society.

During the year many field botanists have been concentrating on work in connexion with the Distribution Maps Scheme[1] organized by the Society. The direct results of this were shown in an exhibit prepared by the Cambridge headquarters of the Scheme, which included a map showing the 10-km. squares of the National Grid for which lists of more than 50, 150 and 250 species, respectively, have been received. Although considerable gaps still remain, the progress of the work, which is still only in its second year, is well up to expectations. Mr. F. Perring and Dr. S. M. Walters (Cambridge) also showed examples of distribution-patterns revealed in the course of local surveys for the Scheme around Newton Stewart (Galloway) and Llanrhaiadr (Denbigh and Montgomery).

A by-product of the Scheme was the discovery of *Orchis militaris* in Suffolk, where a colony of more than five hundred plants was found by a worker listing the species of a 10-km. grid-square. This very rare plant, of which photographs were shown, is new to East Anglia. As in the only other known British colony (in Buckinghamshire), a large number of flower heads were found eaten off; but some seed capsules mature. An equally important, and perhaps more surprising, extension of range was the discovery of *Trientalis europaea* in a boggy alder-birch coppice, also in Suffolk. This was shown by Dr. F. Rose (Bedford College, London), with a map of the distribution of the species in Britain showing that the new locality is some hundred and fifty miles south of the nearest previously known station for this northern plant.

The flora of Rockall, which is about three hundred miles off the north-west coast of Scotland, was the subject of an exhibit by Miss Y. Chamberlain (British Museum (Natural History)). As a result of collections made from near the base of the rock by Charcot in 1921, and from the upper parts by James Fisher on September 18 last, twenty-one plant species are now known. These include one lichen (*Verrucaria* sp.), the remainder being algae. No flowering plants are to be found on this sea-swept and isolated rock.

Miss M. E. Bradshaw (Durham College) showed large-scale distribution maps of some *Alchemilla* microspecies in Teesdale and other valleys. These were plotted on a grid of 0·2 km. and showed interesting correlation with roadsides and fields used by grazing animals. A. C. Jermy (University College, Leicester) illustrated the distribution of *Luronium natans*. This was recorded from Ellesmere, in Shropshire, early in the nineteenth century and spread from Blake's Mere to the Shropshire Union Canal. It is still spreading in the Manchester, Stafford and Montgomery areas along the canals. Other localities are lakes, some of which are isolated in mountain districts, and it is suggested that water-birds as well as water-carriage may be agents in its dispersal. Another aquatic was shown by Miss E. J. Gibbons and J. E. Lousley, who exhibited *Alisma gramineum*. This is already known from a lake in Worcestershire where it grows in shallow water with flowers, fruits and leaves usually above the surface. In September, Miss Gibbons discovered the species near Spalding in Lincolnshire, and subsequent investigation showed that it occurs in four rivers and drains. The plant there is completely submerged—even the fruits being well below the surface of the water—and very different superficially from the Worcestershire form. The occurrence of the species in Lincolnshire fits in well with the known Continental distribution and establishes it as an undoubted native in Britain.

Dr. C. D. Pigott (Sheffield) illustrated the distribution of the native race of *Polemonium coeruleum* on black humus-rich soils on ledges of limestone cliffs or screes in the Pennines and Cheviots. Transplant experiments suggest that the moisture content of the soil is critical. Its presence in widespread localities during late-glacial times has been confirmed repeatedly, and it is now known to have persisted through the post-glacial. Dr. E. M. Evans (Nature Conservancy) provided an exhibit on the distribution and ecology of *Primula farinosa*. It is found in short turf grassland of dry soils, in *parvocaricetum* of flushed soils, and in fen, and its tolerance of this wide range of habitats can be explained by the theory that a high water-table is required for maximum development. An interesting study of the changes which have taken place in the flora of a small area in the course of a century was provided by O. Polunin (Charterhouse). He compared the 702 species recorded by J. D. Salmon for the Godalming district in 1849 with the 1,016 species known in 1955. During this period there has been a great decline in arable land and big increase in built-up areas, roads and paths. Alien plants form a larger proportion of the present flora, and a few species have become extinct during the period. Comparisons of this kind can make a valuable contribution to our knowledge of the changes which are taking place in the British flora generally.

Several exhibitors showed plants which are likely to prove of importance as additions to the list of British species. One of the most interesting of these is a *Sparganium*, noticed in substantial numbers this autumn along two to three miles of the banks of the Thames near Oxford; this was exhibited by M. D. Gwynne (Oxford). It has large fruits, of which a big proportion are two-seeded, and was at first thought to be a polyploid form of *Sparganium ramosum* ($2n=30$); but it has been found to have about the same chromosome number. Of species already described, it seems to be near the North American *S. eurycarpum* Engelm., but further study is required before it can be named. W. M. Baron and R. Kemp (Oxford) showed the grass *Nardurus maritimus* from recent collections in Berkshire, Oxfordshire and Hampshire and gave some of the previous records with maps showing the British and Continental distribution. From the time it was first noticed in Lincolnshire in 1903[2], its status has been in dispute; but our increased knowledge of the species suggests that in calcareous grassland it may well be native. The inland *Armeria* exhibited by Miss E. J. Gibbons and J. E. Lousley was first recorded from near Grantham in 1726[3], and there are many eighteenth-, nineteenth- and twentieth-century notices over a wide area of the old 'Lincoln Heath' in Lincolnshire and Leicestershire. In spite of the existence of supporting specimens, some botanists have regarded the inland occurrence of the usually maritime thrift as so improbable that the records have been dismissed as errors or introductions. In fact, there seems no real reason to doubt that the plants are native, and it was suggested that specimens gathered at Ancaster this year (and probably those at the other places) are *A. elongata* (Hoffm.) Koch, which occurs inland on sandy heaths over much of northern central Europe. The taxonomic rank of this plant is uncertain, and for the time being it should perhaps be treated as a variety of the 'Atlantic' *A. maritima*, which is a common coastal plant. An exhibit provided by the Department of Botany of the British Museum (Natural History) included specimens of plants of which accounts had appeared in *Watsonia* or the *Proceedings* of the Society during the past year.

One of the most interesting exhibits showing the important contribution which breeding experiments can make to taxonomic research was provided by M. Cole (Southampton). *Chenopodium album* and *C. reticulatum* are easily distinguished by the markings on their seed-coats, and they have been treated as separate species; but Mr. Cole has shown that the seed-coat markings on any particular plant are determined by the male pollen parent (xenia) and are therefore not a reliable guide to taxonomic status. J. P. Savidge (Liverpool) exhibited *Callitriche platycarpa* as a distinct species in Britain. His observations confirm recent work in the Netherlands[4] that this is quite distinct from *C. stagnalis* in both chromosome and morphological characters. He has noticed at least nine ecological forms, varying mainly in the form of the leaves, and the majority of old records and herbarium sheets of *C. palustris* (*C. verna*) and *C. polymorpha* in Britain can be referred to this species. J. A. Ratter (Liverpool) demonstrated morphological criteria in the *Dryopteris spinulosa* complex. He showed that epidermal and spore characters readily separate *D. spinulosa* and *D. dilatata*. N. M. Pritchard (Oxford) exhibited forms of *Gentianella campestris* in connexion with biometric analysis and cultural experiments being undertaken to ascertain if *G. baltica* is distinct from *G. campestris*, and if so, whether *G. campestris* forms a uniform group. Dr. E. F. Warburg (Oxford) showed forms of *Sedum forsterianum* and its allies which he has under cultivation, while B. N. Bowden (also of Oxford) illustrated the differences in the stomata between *Sesleria coerulea* and the British *S. varia* with a map showing doubtful as well as the accepted records of the latter in Britain. J. G. Packer (University College, Leicester) had a critical review of the criteria used for distinguishing the genus *Sieglingia*, in which he concluded that the relationship between *Danthonia calycina* and *Sieglingia decumbens* is one of species and not of genus. J. Rossiter (Oxford) showed specimens of *Ranunculus acris* and *R. bulbosus* which he had had in cultivation from Teesdale and Durham, and suggested that they included two ecotypes in each case. P. M. Benoit showed two forms of *Spartina townsendii* that he had found on mudflats near Barmouth Junction station, one of which had anthers only 5–7 mm. long, incompletely exserted, or exserted on short filaments, with small imperfect pollen grains and the styles small. This more slender plant is perhaps male-sterile, and was compared with a stouter form with anthers 8–11 mm. long exserted on long filaments with the pollen fully formed. P. D. Sell (Cambridge) and Dr. C. West exhibited a series of critical *Hieracia* and suggested that a long list of names in current use are synonyms of a single species.

It has already been shown that two species have been confused as greater bindweed—the native *Calystegia sepium* and the introduced *C. sylvestris*[5], which is more common in many districts. To these, an exhibit by Dr. S. M. Walters (Cambridge) and Prof. D. A. Webb (Trinity College, Dublin) added a third, the pink-flowered *C. dahuricus* Herbert apud Sims, which can be distinguished by the narrow leaf-shape and hairy winged petioles, and is widespread. G. Halliday (Cambridge) showed how another alien, *Arenaria balearica*, has been recorded from numerous widespread localities in Britain. As long ago as 1861 observations of this plant in Scotland aroused heated argument[6], and in 1908 it was remarked that it was "gradually making its way into our flora"[7]. To describe *Hieracium spraguei* as an 'endemic alien' would appear to be a contradiction in words, but, so far as our knowledge goes, this is a true statement of the position. Pugsley in 1948[8] described the species as new to science based on a plant found by Dr. T. A. Sprague in Buckinghamshire near Chorley Wood in 1923 and 1925. Despite careful search by several botanists, it could not be refound until R. F. Turney, who showed it at the exhibition, sent to Kew specimens collected by Mrs. A. T. Peppercorn in 1951. They have now found it in five localities in Buckinghamshire and one in Hertfordshire, but although the species is undoubtedly an alien in Britain, its native country is still unknown.

Mrs. B. H. S. Russell exhibited herbarium specimens and a drawing of *Dichondra repens*, a plant widespread both in the tropics and some temperate countries, which she had found established on dunes near Hayle, Cornwall. Miss C. M. Goodman showed a most interesting series of alien grasses found in fields in Worcestershire where their seeds had been introduced in wool 'shoddy'.

From the library of the Department of Botany of the British Museum (Natural History) was an exhibit of original drawings for Sowerby's "English Botany" for comparison with the copper-plate engravings of the first edition and lithographs of the third. From the same library came manuscripts of Wolley-Dod's "Flora of Sussex", Rea's "Botany of Worcestershire" (with the published works for comparison), Benbow's "Floras of Uxbridge and District and of Middlesex", and Trimen's annotated copy of Brewer's "Flora of Surrey". Mrs. H. N. Clokie (Oxford) showed specimens and manuscripts throwing new light on Dillenius and John Sibthorp. It seems that the types for Dillenius's new species in the third edition of Ray's "Synopsis" are likely to be found among Sherard's specimens rather than in the Dillenian Herbarium, most of the material of which was evidently collected after publication of the "Synopsis"[9].

Other exhibits included coloured photographs of some British plants by K. Le Sueur, an interesting photograph of *Ophrys fuciflora* believed to have been found in the Cotswolds, with an account of the circumstances by C. Thomas, records from the Lleyn Peninsula by Dr. A. P. Conolly, the stolon system of *Glaux maritima* by F. N. Hepper and Euphrasias in southern England by P. F. Yeo.

J. E. LOUSLEY

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INTERNATIONAL ANALOGY COMPUTATION MEETING

THE Société Belge des Ingénieurs des Télécommunications et d'Électronique organized last year a series of lectures and colloquia on the various aspects of analogy computation. These meetings, held on a local basis, aroused so much interest and seemed to lead to such fruitful discussions that the Society decided, in collaboration with the Société Belge des Électriciens and the Société Belge des Mécaniciens, to organize a larger international conference on this subject. This meeting was arranged for the period September 26–October 2 in Brussels, and was attended by four hundred scientists and engineers from seventeen countries. Apart from many Belgian participants, strong delegations went from the United States, France and Great Britain, and among the foreign guests were several scientists from the U.S.S.R. and from Poland. In conjunction with the scientific sessions, an exhibition of analogue computing equipment and of many interesting and novel applications was held.

The great number of papers submitted for reading (one hundred and one) made it necessary to conduct two parallel sessions, and several additional discussion meetings in smaller circles took place. To preserve the unity of the conference, the following invited survey papers were given before the whole audience on succeeding days, before splitting up for the specialist parallel sessions: "Les analyseurs différentiels électroniques", by M. F. H. Raymond; "Electrical network analysers", by Mr. E. L. Harder; "La méthode d'analogie rhéoélectrique, ses possibilités et ses tendances", by Prof. L. Malavard; "The mechanical differential analyser, recent developments and applications", by Mr. J. G. L. Michel; "Resistance-network analogues", by Dr. G. Liebmann; "Pédagogie concrète du calcul fonctionnel linéaire", by Prof. J. Brodin; and "Special computers", by Prof. H. Wallman. About 50 per cent of all contributions dealt with various aspects of electronic analogue computers, including differential analysers, simulators, etc., about 30 per cent with electrical analogues, such as electrolytic tanks and resistance-networks and their recent applications, and the remaining 20 per cent with mechanical differential analysers and various special-purpose computers. The review papers and the original communications, together with the discussions on these papers, will be published in full as Proceedings of the International Analogy Computation Meeting, Brussels, 1955, and its editors hope that the volume will be available at an early date.

It was decided during the meeting to form an International Association for Analogy Computation (Association Internationale pour le Calcul Analogique), and the chairmen of the various sessions, representing a good international cross-section, were asked to act as members of the organizing committee. The purpose of the new International Association for Analogy Computation is the furthering of this field by the organization of national and international scientific meetings, and the publication of a multi-language bulletin or periodical devoted to the scientific and engineering basis of analogue computers and to their steadily growing applications. Collaboration will be sought with existing organizations in the fields of electrical and mechanical engineering, and with those working with other computing techniques. The basic organization of the new Association will be in the hands of its first elected president, Prof. J. Hoffmann, and his colleagues at the Université Libre, Brussels.

This first international analogy computation meeting, bringing together people from many countries, was considered by all participants a very stimulating event, and the excellent organization of the meeting by the Société Belge des Ingénieurs des Télécommunications et d'Électronique and the great hospitality enjoyed will be remembered by all.

G. Liebmann

CHEMISTRY AND PHYSIOLOGY OF PHOSPHOLIPIDS

SYMPOSIUM IN ONTARIO

During October 12–13, some hundred and twenty scientific workers gathered at the University of Western Ontario, London, Ontario, to attend a symposium on phospholipids sponsored by the Biochemistry Division of the Chemical Institute of Canada. The success of the meetings, planned by Prof. R. J. Rossiter and members of the local committee of the Institute, was attested by the enthusiastic response of all participants. The papers and succeeding discussions will be published in full in the *Canadian Journal of Biochemistry and Physiology*.

The first part of the symposium, with Dr. A. M. Wynne (University of Toronto) in the chair, was entitled "Chemistry of Phospholipids" and dealt with current advances in knowledge of the structure and properties of the phospholipids. Dr. Erich Baer (Toronto) outlined the elegant synthetic methods used by his group for preparing optically pure α- or β-isomers of glycerophosphoric acid, glycerylphosphorylcholine, phosphatidic acids, lecithins, glycerylphosphorylethanolamine, glycerylphosphorylserine, and phosphatidyl serine. He also described the 22-step preparation of the first synthetic lipopeptide, L-α-(distearoyl)-phosphatidyl-L-serylglycylglycine. Finally, he reported on the first synthetic preparation of a fully unsaturated lecithin, L-α-dioleyllecithin. Of particular interest is the ability of this substance to render a number of polar compounds soluble in organic solvents, and its property of high stability to atmospheric oxidation. Dr. Baer emphasized the consistency with which the L-configuration and α-structure appear in natural glycerolphosphatides. In discussing Dr. Baer's paper, Dr. C. S. McArthur (University of Saskatchewan) commented on the attempts to prepare lecithins from L-α-glycerylphosphorylcholine by other methods. He also pointed out the possibilities of appreciable phospholipid losses during the dehydration of tissue with acetone prior to lipid extraction.

Drs. J. Folch and F. N. LeBaron (Harvard Medical School) critically reviewed the current state of knowledge of the chemistry of phosphoinositides. It was pointed out that the common feature of this class of lipids is the presence of meso-inositol, phosphoric acid and fatty acids. In some cases carbohydrates or amines are present and often glycerol. The five phosphoinositide preparations discussed include soybean lipositol, brain diphosphoinositide (the only member of the group from which inositol diphosphate has been obtained rather than the usual monophosphoric acid ester), peanut glyceroinositophosphatide, and wheat germ and cardiac muscle glyceroinositophosphatidic acids. Dr. Folch reported on the hydrolysis studies which have been carried out, the difficulties of obtaining uncontaminated preparations, and the appearance of inositol in other lipid complexes, and he emphasized the need for further structural studies. Dr. C. C. Lucas (Toronto) pointed out that the ubiquitous occurrence of inositol in biological material suggests a role as an essential component, and this is strengthened further by the observed lipotropic action of inositol.

The recent progress in the chemistry of sphingolipids was comprehensively reviewed by Dr. H. E. Carter (University of Illinois). He outlined the classical evidence for relative positions of functional groups on sphingosine and described his synthesis of tribenzoyl-D-*erythro*-dihydrosphingosine, which has properties conforming to those of the tribenzoyl derivative of the naturally occurring material. The application of infra-red techniques to establish the *trans*-structure of the double bond was mentioned, and the structure of sphingosine has finally been proved to be D *erythro*-1, 3-dihydroxy-2-amino-4-*trans*-octadecene. This would appear to be confirmed by the recent reports of the synthesis of sphingosine. Dr. Carter pointed out the difficulties encountered in establishing the *erythro*-configuration of sphingosine as it occurs in cerebrosides due to possibilities of inversion during hydrolysis. However, he showed that the analogous compound, phrenosine, contains sphingosine bearing the *erythro*-configuration, and he gave further information regarding cerebrosides and cerebroside sulphuric ester, although the configuration of the galactosidic bond remains unsolved. The steps which have led to the elucidation of the structure

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of sphingomyelin were then described, and mention was made of the complex glycosides of sphingosine, including gangliosides, hæmatosides, globosides, strandin, and polycerebrosides. Most of these glycolipids contain hexosamine or neuraminic acid. Finally, Dr. Carter reported the finding of phytosphingosine in corn phosphatides and preliminary evidence favouring the view that corn phosphatides contain phytosphingosine as phytosphingolipids rather than as simple phytocerebrosides.

Dr. J. F. Berry (Western Ontario) re-emphasized the importance of the techniques presented by Dr. Carter for approaching the characterization of sphingolipids and the nature of the complex bonds in proteolipids and lipopeptides. He described preliminary studies on the successful paper-chromatographic separation of intact tissue phospholipids, and stressed the importance of these techniques in identifying and purifying new phospholipids.

The second part of the symposium, with Dr. W. R. Bloor (University of Rochester, New York State) in the chair, was devoted to "Metabolism and Function of Phospholipids". Dr. E. P. Kennedy (University of Chicago) introduced his account of the biological synthesis of phospholipids by emphasizing the contribution made by the advent of isotope tracer techniques and their application to studies in cell-free enzyme preparations. He reviewed the evidence pointing to L-α-glycerophosphate as a precursor to phospholipids, a point demonstrated by the incorporation into phospholipids of glycerophosphate labelled with phosphorus-32. Dr. Kennedy's group provided the next logical step by the isolation and partial purification of a rat liver enzyme, glycerokinase, which synthesizes L-α-glycerophosphate from adenosine triphosphate and glycerol. Dr. Baer's suggestion that natural glycerophosphatides are of the L-α-configuration was given support by this finding and by the observation that only the L-α-glycerophosphate can be incorporated into phospholipids. Kornberg's earlier work was reviewed, which demonstrated the activation of fatty acids to acyl-coenzyme A derivatives with adenosine triphosphate, and the attachment of these acyl-coenzyme A esters to L-α-glycerophosphate to form phosphatidic acid, the function of which was the subject of much discussion during the remainder of the symposium. Kornberg had earlier suggested that phosphorylcholine could be incorporated into lecithin by condensation with phosphatidic acid, inasmuch as the incorporation of a phosphorylcholine unit into lecithin was demonstrated. Dr. Kennedy's group has found that large amounts of adenosine triphosphate are necessary to accomplish this reaction in mitochondria. Further scrutiny reveals that the active co-factor is a cytidine triphosphate contaminant of the adenosine triphosphate preparation. Dr. Kennedy and his co-workers have demonstrated a condensation between cytidine triphosphate and the phosphorylcholine unit with the formation of cytidine-diphosphorylcholine, which was isolated chromatographically, estimated in tissues by isotope dilution techniques, and chemically synthesized. Labelled synthetic cytidine-diphosphorylcholine, as well as cytidine-diphosphorylethanolamine, have been shown to act as precursors for the isotope in phosphatidyl choline and phosphatidyl ethanolamine, respectively. Furthermore, tissue enzymes have been found that are able to synthesize the cytidine diphosphate bases. This reaction is reversible and is also completely specific for cytidine triphosphate and represents the first co-enzymatic rôle found for this nucleotide. Enzymes have previously been described that are able to phosphorylate choline or ethanolamine from adenosine triphosphate. Dr. Kennedy pointed out the bearing such metabolic pathways might have upon the biosynthesis of other phospholipids and on the lipotropic effect of choline.

Dr. G. C. Butler (Toronto), in discussing Dr. Kennedy's paper, raised the pressing point of the nature of the acceptor for phosphorylcholine. Phosphatidic acid, triglycerides and diglycerides are prominent among the suspected compounds. However, attempts to demonstrate any of these compounds as intermediates have met with failure.

Dr. L. E. Hokin (McGill University) presented the results of his studies on the metabolism of phospholipids *in vitro*, in which he has found that cholinergic drugs and pancreozymin in the pancreas, and acetylcholine and adrenalin in the salivary glands, all stimulate the secretion of protein. In each case, the high secretion of protein is accompanied by an increased incorporation of phosphorus-32 into the phospholipids. These studies were carried out with actively respiring tissue slices. The observed effects were only slight in homogenate preparations, and were not accompanied by changes in respiration or labelling of acid-soluble phosphorus compounds. Dr. Hokin has extended these studies to include guinea pig brain-cortex slices, where a similar stimulation of the incorporation of phosphorus-32 into phospholipids was obtained with acetylcholine. This was abolished in the presence of atropine. In both pancreas and brain slices, incubated with phosphorus-32 and glycerol labelled with carbon-14, acetylcholine stimulated primarily the incorporation of phosphorus-32 with little effect on the incorporation of carbon-14. This was taken to indicate an increased turnover of a phosphorus-containing portion rather than increased total synthesis of phospholipid. By mild alkaline hydrolysis of the lipid extracts and paper-chromatographic separation of the products according to the technique of Dawson, Dr. Hokin has demonstrated that acetylcholine maximally stimulates the incorporation of phosphorus-32 into phosphatidic acid and phosphoinositide in brain and pancreas. Appreciable effects were noted on phosphatidylcholine in brain and on phosphatidylethanolamine in pancreas.

Dr. R. J. Rossiter (Western Ontario) pointed out two additional physiological conditions, namely, starvation and cold stress, which produce changes in lipid labelling from one substrate and not from another. In these cases, phospholipid labelling from acetate-1-^{14}C is decreased, with no change in labelling from glycerol-1-^{14}C, glycine-2-^{14}C, or inorganic phosphorus-32. In addition, Dr. Rossiter gave details showing a greater incorporation of glycerol-1-^{14}C into the glycerol portion of phosphoglycerides than into the glycerol portion of phosphatidic acid. This supplies further evidence tending to negate the suggestion that phosphatidic acid might function as an acceptor of phosphorylated base.

Dr. J. M. R. Beveridge (Queen's University, Kingston, Ontario) reviewed the current views on the function of phospholipids and, among other functions, discussed their role as a structural element. Although there is little to support the notion that phospholipids act as intermediates in the resynthesis of triglycerides during fat absorption, it is considered that they are involved in this process in some manner.

Dr. Beveridge gave evidence contrary to the belief that phospholipids comprise a vehicle for the transportation of fatty acids, although he pointed out that the phospholipids as β-lipoproteins may play a part in the transport of neutral fat. Finally, he quoted from the literature in support of the theory that choline-containing phospholipids facilitate the oxidation of fatty acids. He emphasized that no single function of the phospholipids could be stated in a positive manner. Dr. O. F. Denstedt (McGill University) commented on the physico-chemical function of phospholipids at biological interfaces.

JAMES F. BERRY

MELTING OF SOLIDS

SYMPOSIUM IN OTTAWA

A SYMPOSIUM on melting, diffusion and related topics was held during October 24–25 at the National Research Council Laboratories, Sussex Drive, Ottawa, under the chairmanship of Dr. D. K. C. MacDonald. The meeting was held at the invitation of the Low Temperature and Solid State Physics Group of the Division of Pure Physics, National Research Council of Canada, for the purpose of bringing together scientists within easy reach of Ottawa interested in melting from the different points of view of chemist, geophysicist, metallurgist and physicist. Twelve lectures were given; fifty minutes was allotted to each, of which about twenty was reserved for questions and discussion. It was found that this schedule allowed each speaker time for an adequate exposition of his subject, while preserving the balance of lecture and discussion.

A contrast soon became apparent between the working concepts of the physicists and chemists and those of the metallurgists. The physicists and chemists tended to regard both solid and liquid as homogeneous down to atomic dimensions, and thought in terms of thermodynamics and statistical mechanics. Thus, in his introductory lecture, Dr. MacDonald discussed self-diffusion and melting, using the model of 'hole' formation in the crystal lattice, and outlined the evidence which suggests that melting occurs when the hole concentration has risen to the order of 10^{-3}. J. S. Dugdale (National Research Council) gave a comprehensive review of both experimental and theoretical work on the behaviour of the melting curve at high pressures. Two papers from Chalk River described investigations of structure and diffusion in liquids using slow-neutron diffraction: D. G. Henshaw and D. G. Hurst have determined radial distribution functions in liquid helium, which show marked increase in short-range order with increase of pressure; and B. N. Brockhouse has made some preliminary measurements of the energy distribution in neutrons scattered from liquids, data which, after suitable analysis, can give information about self-diffusion and time-dependent pair distribution functions in the liquid. J. A. Morrison (National Research Council) described experiments on surface melting in adsorbed layers of argon and nitrogen on substrates of titanium oxide, with an anomaly in specific heat becoming rapidly sharper as the thickness of the layer increased. The interpretation of these results was discussed by D. C. Patterson (University of Montreal), using an order–disorder model for melting, and later by the meeting at large.

W. B. Pearson (National Research Council) described experiments on dilute alloys illustrating the effects of lattice distortion upon melting temperatures. The other metallurgists were concerned to make plain the inhomogeneous nature of the melting process, making use of photographs of the melting and freezing interfaces in metals. A. Rosenberg (University of Toronto) showed that freezing in 'pure' lead takes place by lamellar growth, and that melting appears to be the same process in reverse; this was effectively illustrated in a film using suitable space and time magnification. J. W. Rutter (University of Toronto) described the freezing of impure metals and showed how the formation of impurity substructures depends upon the concentration of impurity, rate of freezing, and temperature gradient in the liquid. E H. McLaren (National Research Council) has used precision (10^{-4} deg. C.) resistance thermometry for investigating the freezing and melting temperatures of zinc and tin, and has found that differences of freezing technique and thermal history can cause changes up to about 10^{-2} deg. C. In a brief, provocative talk, W. C. Winegard (University of Toronto) emphasized the difference of outlook of physicist and metallurgist and criticized the theories of the former for taking no account of the impurities and dislocations which are known to play an important part in melting. A lively discussion followed, profitable because the participants had already listened to uninterrupted expositions of each other's work.

Any doubts of the usefulness of even the crudest of fundamental theories was dispelled by R. J. Uffen (University of Western Ontario), who described how knowledge of the physics of condensed phases is used in attempts to deduce the composition and state of the Earth's mantle and core. For this purpose not nearly enough is yet known about the physics of high pressures, and bold extrapolations from laboratory pressures have to be made. The success of the symposium makes it probable that similar meetings will be arranged for the discussion of other subjects related to work in low-temperature and solid-state physics.

T. H. K. BARRON

CHEMICAL COMPOSITION OF PARTHIAN COINS

AN outstanding example of the value of accurate and complete chemical analyses in the investigation of ancient metals, when these are afterwards interpreted by an ingenious mind, is given in a monograph on the "Chemical Composition of Parthian Coins", by Earle R Caley, published by the American Numismatic Society, New York (Numismatic Notes and Monographs, No. 129; 1955). The author has made a large number of analyses of Parthian silver and bronze coins not only for the major constituents but also for minor impurities. There is internal evidence that these are reliable, and much new light is thrown on a field of historical metallurgy concerning which knowledge has hitherto been most meagre.

An elegant piece of detective research has revealed, practically beyond doubt, the materials from which the debased silver coins of the King Orodes I (57–38/37 B.C.) were made. From analyses of silver coins of the highest fineness for the time, it is shown that the 'pure' silver available might contain just over 99 per cent of silver and gold together (the presence of traces of gold in the silver was not recognized by early metallurgists) and perhaps 0·4 per cent of lead. Accepting this composition for the basis metal, the other impurities—tin, part or all of the lead, iron, nickel and, in one case, zinc—will, in the main, have come in with the copper when this and the silver were melted together. It is possible, therefore, to calculate the composition of the copper alloy used.

From such calculations it is clear that two different materials have been employed at different times, for the drachm and for the tetradrachm, and presumably at different mints. In one case the alloy appears to have been prepared from the 'pure' silver and very impure, but virgin, copper, the average analysis of that used in the manufacture of the drachms being: copper, 95; tin, 1·7; lead, 2·8; iron, 0·1; and nickel, 0·1. The copper used for the tetradrachms was of much better quality, being approximately: copper, 99; tin, 0·3; lead, 0·5; iron, 0·1; and nickel, 0·1; which in all probability was of the highest purity then available to the mint. The marked difference in these two analyses would suggest that the drachms and the tetradrachms were struck at different mints, which were possibly a considerable distance apart.

In the other case, there is consistent evidence that a bronze was employed the composition of which was very approximately: copper, 91; tin, 5·5; lead, 3; iron, 0·1; and nickel, 0·1. Comparison of this result with analyses of the earlier Parthian bronze coins shows that the two compositions are in many cases not greatly different either in the major elements present or in the content of impurities. It is suggested, therefore, that the bronze used for preparing the debased alloys was obtained by melting down bronze coins of the earlier Parthian kings. In some cases the amount of lead present is in excess of that likely to be present in the silver and that introduced by the bronze, and it may be, therefore, that in such coins a relatively small amount of lead was deliberately added as such.

F. C. Thompson

NATIONAL RESEARCH COUNCIL OF CANADA

REPORT FOR 1954–55

THE thirty-eighth annual report* of the National Research Council of Canada covers the year ended March 1955, and comprises, besides the president's report, the financial statement and the balance sheet and annual statement of Canadian Patents and Developments, Ltd. The president's report notes that in 1954 the National Research Council provided 2·5 million dollars in 410 awards and 263 scholarships for fundamental research at the universities, and that since the end of the Second World War the Council's support to the universities has increased five-fold. The Council's own scientific staff numbered 548, with 711 technicians and 775 engaged in general service and administrative, as well as about a hundred postdoctorate Fellows. Technical inquiries from Canadian industries numbered about seven thousand five hundred, and the president stresses the value of the work of the twenty-eight associate committees in dealing with scientific and technical problems of national scope.

In an effort to reduce the surface drying of foodstuffs, the Division of Applied Biology has obtained relative humidities approaching saturation by cooling an experimental room indirectly through a jacket of cold air, and recent studies by the Division have shown that the grey discoloration of processed pork occurs much more rapidly in the muscle pigment, myoglobin, than in the blood pigment, hæmoglobin. Investigations of the frozen storage of living cells and small organisms have shown that glycerol reduces freezing damage by changing the pattern of ice-formation. Studies of the carbohydrate composition of various grains, woods and marine algæ have shown that in most plant tissues large quantities of hemicellulose and other complex sugars are associated with cellulose.

The scientific interests of the Maritime Regional Laboratory have been broadened considerably, and a dryer capable of operating on half-ton batches has been designed and constructed for studies of the drying of seaweeds and similar material. Nutritional tests on dried dulse and rockweed meals indicated that the meals compared favourably with casein and were superior to gelatin or soybean in regeneration of liver protein. A method has been developed for determining the presence of carrageenin in seaweeds, and a study of the cause of the flakiness of cod fillets was commenced. At the Prairie Regional Laboratory, Saskatoon, work was continued on the utilization of agricultural materials, including the utilization of straw for pulp, and an investigation on the production of lysine by fermentation. A new fermentation has been developed for *d*-arabitol, glycerol and erythritol. A study of contributory factors in elevator dust explosions points to particle size as the most important factor, only those fractions which pass through a 150-mesh screen being potentially dangerous in initiating explosions.

In the Division of Applied Chemistry, special attention was given to the corrosion in automotive cooling systems by ethylene glycol and the corrosion of iron in aqueous solutions, while studies of the adsorption and desorption of detergents by textiles, using radioactive tracer techniques, have led to a better understanding of detergent action and indicated possibilities for obtaining higher efficiencies in laundering. Work on the direct oxidation of ethylene to ethylene oxide has led to basic studies on the phase behaviour and magnetic susceptibilities of oxidation catalysts, the kinetics of the photochemical oxidation of hydrocarbons, the catalytic polymerization of ethylene and physical adsorption at gas–solid interfaces. Promising results were obtained in a new drying technique for contacting solids and fluids.

The Division of Pure Chemistry continued its investigations of alkaloids and also work on the quantitative description of solvolytic reactions of aromatic and aliphatic sulphonic acids in water and alcohols. Studies of infra-red spectra have been applied to the identification of small amounts of steroid hormones and metabolites isolated from natural sources, and work on free radicals has been extended to the liquid and solid states. A method has been developed in the Molecular Spectroscopy Section for obtaining standard Raman intensities, the sum of which is useful in determining the structure of petroleum hydrocarbons; and in a study of the extent to which the properties of very small solid particles differ from those of bulk solids, besides effects due to the small dimensions, effects attributable to the structure of solid surfaces have been found.

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* Thirty-eighth Annual Report of the National Research Council of Canada, 1954–55, including the Annual Report of the Canadian Patents and Development, Ltd. Pp. 44. (N.R.C. No. 3607.) (Ottawa: National Research Council, 1955.)

In the Division of Physics, the Applied Physics Branch has provided a common dosage standard for X-radiation at cancer clinics throughout Canada, has made a significant contribution to Canadian mapping methods, and has completed a mutual inductance on which the Canadian ohm will be based, a highly precise temperature scale extending over most of the international scale, and the reproduction of the standard of brightness through the brightness of melting platinum. A major effort in the Interferometry Section was the study of new wave-length standards with the view of basing the international metre, and hence the Canadian yard, on a wave-length. Good progress was made on an analytical method of bridging, and the usefulness of a radar altimeter and of combined vertical and oblique aerial photographs was also demonstrated. The Pure Physics Branch reports a considerable advance in the knowledge of the relative ionizing effects of particles of different energies, in the energy-range of billions of electron volts, and the same photographic plate technique has been used to study and identify rare types of mesons produced by cosmic rays. The outstanding developments in the Solid State Physics Group have been in studying 'anomalous' electron behaviour in metals at low temperatures, and the resistance minimum in copper was studied in greater detail in an attempt to understand its origin. Well-resolved absorption and emission spectra of the molecules O_2, NO, NO^+, HCN, CO and CN in the vacuum ultra-violet have been obtained with the 3-m. vacuum spectrograph, and using the same instrument the absolute wave-length of the Lyman alpha-line of deuterium has been determined with considerable precision. The structures of pyrobelonite and brackebuschite (vanadium minerals), codeine hydrobromide dihydrate, lindgrenite (a copper molybdate mineral) and potassium dithionate have been determined in the X-Ray Diffraction Laboratory.

The Division of Building Research continued to develop steadily, and, in co-operation with the Central Mortgage and Housing Corporation, steady progress was made in the improvement of technical housing standards and designs, consistent with every practicable reduction in true costs. A completely revised National Building Code of Canada was issued in June 1954, and the research into fire fatalities is already yielding significant results. Jointly with the Meteorological Division of the Department of Transport, the Division also published the first Climatological Atlas of Canada, the result of two years work by its own climatologist.

Much of the work of the Division of Mechanical Engineering continued to be devoted to defence, but in the Hydraulics Laboratory activity was concentrated on projects related to the St. Lawrence Seaway development. Extended work was carried out on the suitability of Western Canadian fuel oils for industrial gas turbines, and the facilities of the Fuels and Lubricants Laboratory were being extended to permit qualification tests of heavy-duty automotive and marine oils, hypoid gear lubricants, lubricating greases, and hydraulic and brake fluids. The investigation of aircraft icing in flight was terminated, but the icing project is continuing with an investigation of the icing of helicopters, while icing protection studies have also been made on radar components; gas turbine components, radomes and icing instruments.

About half the work of the Radio and Electrical Engineering Division has continued to be concerned with defence; but besides the microwave position-fixing system for inshore survey operations, the Division has designed a microwave system to operate combined automatic-light and fog-alarm stations which cannot be easily or economically controlled by submarine cable, and two installations have been completed. Considerable progress has been made in developing an instrument making an electronic inspection for flaws of high-quality paper while it is being manufactured. The use of silica in place of germanium as the active element in transistors was being investigated, and theoretical studies of electron-tube physics have led to the development of a new detector for microwave energy and to a new laboratory method of measuring the maximum electron emission from cathodes. An experimental microwave radio link has been established between Ottawa and Toronto to study the scattering of microwave signals beyond the horizon, caused by turbulence in the atmosphere, and, besides daily observations of radio emission from the Sun on a wave-length of 10·7 cm., three electronic musical instruments were being developed.

The Division of Medical Research made 151 grants during the year and granted eight senior and sixteen ordinary research fellowships. About two-thirds of the grants were for a continuation of researches.

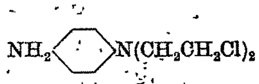
SELECTIVITY OF ENZYME-ACTIVATED NITROGEN MUSTARDS

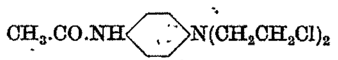
By P. HEBBORN and PROF. J. F. DANIELLI

Zoology Department, King's College, London, W.C.2

IN chemotherapy, in general one of the outstanding problems is to obtain drugs which will have a much greater effect upon the cells which are intended to be the target for the drug than upon other cells. In the chemotherapy of tumours, this problem is particularly difficult to solve because tumour cells closely resemble many normal cells, to which extensive damage cannot be tolerated. In theory, the selectivity of a drug can be increased by administering it as a derivative, the action of which is contingent upon one or more cellular variables[1]. The more variables involved in eliciting the action of a drug, the greater will be its selectivity.

We have made a preliminary investigation of this theory, starting from the aromatic nitrogen mustards, such as (I), which have been developed at the Chester


(I)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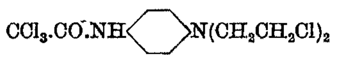
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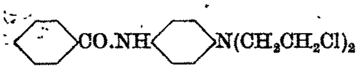
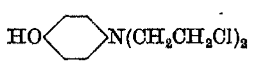

(IV)


(V)

Beatty Research Institute. The action of this compound, and a number of its derivatives, has been examined by intramuscular injection into Wistar albino rats bearing the Walker rat sarcoma 256. The derivatives were compounds (II), (III) and (IV). The cytotoxic action of nitrogen mustards is believed to be caused by ionization of a chlorine atom from a β-chloroethyl group to give a highly reactive carbonium ion, $R.CH_2CH_2^+$. It has been shown, particularly by the work of Haddow, Kon and Ross[2] and Ross[3], that in the derivatives of phenyl di-(β-chloroethyl) amine the rate of formation of carbonium ions is modified by substitution in the benzene ring. The general conclusion has been that derivatives with a high rate of formation of carbonium ions have a pronounced inhibitory effect on tumour growth, whereas derivatives with a low rate of ionization have no effect. Compound (I) has a very high rate of ionization, whereas in (II), (III) and (IV) the rate of ionization is greatly reduced. Thus the general toxicity, and action upon tumours, of (II), (III) and (IV) should be much less than with (I), except in the case of cells which contain enzymes capable of liberating (I) from the derivatives: that is, the action of (II), (III) and (IV) should be restricted to those cells which contain enzymes capable of liberating (I) by hydrolysis of the CONH group. Thus in theory these compounds are provided with the equivalent of a selective proximity fuse.

To study this theory, we have investigated (*a*) the toxicity of the compounds to rats not bearing tumours, (*b*) the cause of death with the different compounds, (*c*) the action upon the Walker rat sarcoma 256, and (*d*) the enzyme content of the tumour and certain organs of the rat.

The results are summarized in Table 1. The rate of hydrolysis, in the second column, determined by Dr. W. C. J. Ross, gives a measure of the rate of formation of carbonium ions. The third column contains *LD*50 values, as a measure of toxicity. The detoxication caused by acylation is very striking. The trichloracetyl derivative had less than one two-hundredth of the toxicity of the parent compound. The decreases in toxicity are much greater than can be accounted for by the changes of rate of hydrolysis.

Table 1

Drug	Rate of hydrolysis per cent (Ross)	*LD*50 (mgm./100 gm. rat)	Action on tumour	Enzyme units/gm. tissue	
				Liver	Tumour
(I)	> 100	0·6	(+)		
(II)	42	4·8	++	1·8	0·29
(III)	13	> 100	++	40	0·36
(IV)	40	35	−	0·35	0·05

Despite the large variations in toxicity, the cause of death was probably the same for all four compounds. Before death the abnormalities were a progressive loss of weight (up to 30 per cent), diarrhœa which was occasionally hæmorrhagic, an erythematous condition of the nose, muzzle and eye regions, a general weakness of the rat associated with apathy, laboured breathing, coldness and, finally, coma.

Post-mortem observations indicated that the gut was affected to the greatest extent. Macroscopically, this was marked by a loss in tone and distension due to fluid and gaseous contents. The spleen and body-fat were reduced.

Cytological examination showed that there was an absence of mitosis in the gut and a drastic reduction in the size of the villi in rats subjected to drugs (I) and (II), whereas the gut of rats subjected to drug (IV) showed no histopathological symptoms.

The action of a cytotoxic agent upon a tumour may be to cause regression, to inhibit further growth, to slow the rate of growth, or negligible. The action of compounds (I)–(IV) was tested upon tumours which had grown to a volume of 5–10 ml. Each compound was given in a daily dosage of one-third to one-tenth of the *LD*50, for up to eight days. With the parent compound (I), the rate of growth of the tumour was reduced and there was a considerable fall in body-weight. With (II) and (III) regression occurred, and there was a fall in body-weight. Compound (IV) had no action upon either the tumour or body-weight. There is no correlation between either toxicity, or rate of hydrolysis, and action upon the tumour.

When tested for enzyme able to hydrolyse the amide linkage in compounds (II)–(IV), the different organs of the rat differed markedly. For example, with the acetylamino-group, muscle had little activity, whereas kidney, liver and intestine had marked activity. The tumour activity was marked towards the acetylamino- and trichloroacetylamino-groups, and negligible towards the benzoylamino-group. There is a correlation between ability to cause regression and presence of a significant amount of activating enzyme in the tumour.

The results obtained support the view that the selectivity of a cytotoxic compound can be increased by converting it to a derivative from which the parent compound can be released by enzyme activity. With the three derivatives used here, in two cases the selectivity for tumour cells was notably increased, and in the other case equally decreased: these differences were correlated with presence (or absence) of activating enzyme. A similar correlation has been obtained with the corresponding derivatives of the phenolic mustard (V). It is interesting that such considerable differences exist between derivatives obtained with such simple acylating agents: with more complex inactivating agents a higher degree of selectivity may be expected.

The nitrogen mustards act most strikingly upon cells in which growth and division are rapid. The selectivity of the derivatives studied here is based on at least two cellular variables—growth-rate and enzyme content. It seems probable that a further increase in selectivity could be introduced by using inactivating agents introducing dependence upon yet a third variable. For example, acylation of (I) with an amino-acid might be expected to add dependence upon active transport of amino-acids. Investigations of this nature are now being made, with assistance provided by the British Empire Cancer Campaign.

We are indebted to Boots Pure Drug Co., Ltd., for the gift of compounds (I), (II) and (III), to Dr. W. C. J. Ross, who synthesized compound (IV) for us, to Mr. J. A. Marsh for help and advice with the tumour tests, and to Prof. A. Haddow and Dr. L. N. Owen for advice on many points. One of us (P. H.) has held a studentship of the Medical Research Council while carrying out this work. [Oct. 10

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CORRELATION BETWEEN PHOTONS IN TWO COHERENT BEAMS OF LIGHT

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IN an earlier paper[1], we have described a new type of interferometer which has been used to measure the angular diameter of radio stars[2]. In this instrument the signals from two aerials A_1 and A_2 (Fig. 1*a*) are detected independently and the correlation between the low-frequency outputs of the detectors is recorded. The relative phases of the two radio signals are therefore lost, and only the correlation in their intensity fluctuations is measured; so that the principle differs radically from that of the familiar Michelson interferometer where the signals are combined before detection and where their relative phase must be preserved.

This new system was developed for use with very long base-lines, and experimentally it has proved to be largely free of the effects of ionospheric scintillation[2]. These advantages led us to suggest[1] that the principle might be applied to the measurement of the angular diameter of visual stars. Thus one could replace the two aerials by two mirrors M_1, M_2 (Fig. 1*b*) and the radio-frequency detectors by photo-electric cells C_1, C_2, and measure, as a function of the separation of the mirrors, the correlation between the fluctuations in the currents from the cells when illuminated by a star.

It is, of course, essential to the operation of such a system that the time of arrival of photons at the two photocathodes should be correlated when the light beams incident upon the two mirrors are coherent. However, so far as we know, this fundamental effect has never been directly observed with light, and indeed its very existence has been questioned. Furthermore, it was by no means certain that the correlation would be fully preserved in the process of photo-electric emission. For these reasons a laboratory experiment was carried out as described below.

The apparatus is shown in outline in Fig. 2. A light source was formed by a small rectangular aperture, 0·13 mm. × 0·15 mm. in cross-section, on which the image of a high-pressure mercury arc was focused. The 4358 A. line was isolated by a system of filters, and the beam was divided by the half-silvered mirror M to illuminate the cathodes of the photomultipliers C_1, C_2. The two cathodes were at a distance of 2·65 m. from the source and their areas were limited by identical rectangular apertures O_1, O_2, 9·0 mm. × 8·5 mm. in cross-section. (It can be shown that for this type of instrument the two cathodes need not be located at precisely equal distances from the source. In the present case their distances were adjusted to be roughly equal to an accuracy of about 1 cm.) In order that the degree of coherence of the two light beams might be varied at will, the photomultiplier C_1 was mounted on a horizontal slide which could be traversed normal to the incident light. The two cathode apertures, as viewed from the source, could thus be superimposed

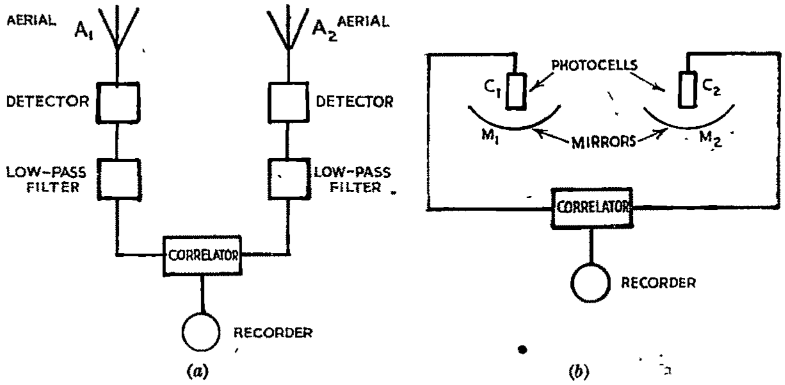

Fig. 1. A new type of radio interferometer (*a*), together with its analogue (*b*) at optical wave-lengths

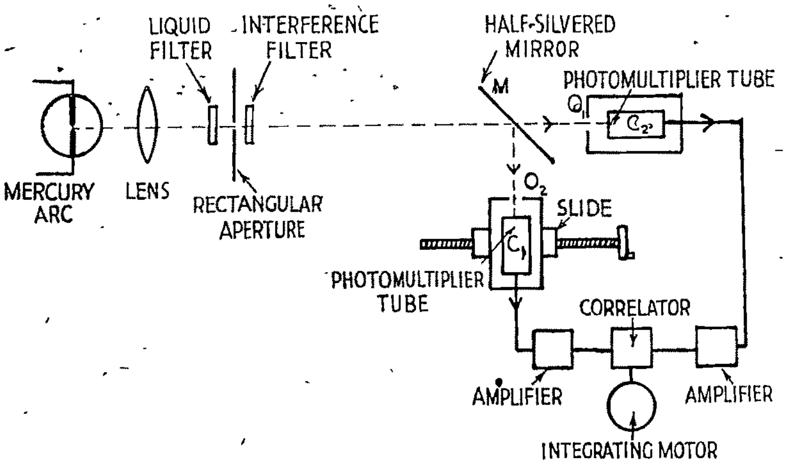

Fig. 2. Simplified diagram of the apparatus

or separated by any amount up to about three times their own width. The fluctuations in the output currents from the photomultipliers were amplified over the band 3–27 Mc./s. and multiplied together in a linear mixer. The average value of the product, which was recorded on the revolution counter of an integrating motor, gave a measure of the correlation in the fluctuations. To obtain a significant result it was necessary to integrate for periods of the order of one hour, so very great care had to be taken in the design of the electronic equipment to eliminate the effects of drift, of interference and of amplifier noise.

Assuming that the probability of emission of a photoelectron is proportional to the square of the amplitude of the incident light, one can use classical electromagnetic wave theory to calculate the correlation between the fluctuations in the current from the two cathodes. On this assumption it can be shown that, with the two cathodes superimposed, the correlation $S(0)$ is given by :

$$S(0) = A.T.b_v.\mathrm{f}\left(\frac{a_1\theta_1\pi}{\lambda_0}\right).\,\mathrm{f}\left(\frac{a_2\theta_2\pi}{\lambda_0}\right)\int \alpha^2(\nu).n_0{}^2(\nu).d\nu \qquad (1)$$

It can also be shown that the associated root-mean-square fluctuations N are given by :

$$N = A.T.\frac{2m}{m-1}.\,b_v\,(b_vT)^{-\frac{1}{2}}\int \alpha(\nu).n_0(\nu).d\nu \qquad (2)$$

where A is a constant of proportionality depending on the amplifier gain, etc. ; T is the time of observation ; $\alpha(\nu)$ is the quantum efficiency of the photocathodes at a frequency ν ; $n_0(\nu)$ is the number of quanta incident on a photocathode per second, per cycle bandwidth ; b_v is the bandwidth of the amplifiers ; $m/(m-1)$ is the familiar excess noise introduced by secondary multiplication ; a_1, a_2 are the horizontal and vertical dimensions of the photocathode apertures ; θ_1, θ_2 are the angular dimensions of the source as viewed from the photocathodes ; and λ_0 is the mean wave-length of the light. The integrals are taken over the complete optical spectrum and the phototubes are assumed to be identical. The factor $\mathrm{f}\left(\frac{a\theta\pi}{\lambda_0}\right)$ is determined by the dimensionless parameter η defined by

$$\eta = a\theta/\lambda_0 \qquad (3)$$

which is a measure of the degree to which the light is coherent over a photocathode. When $\eta \ll 1$, as for a point source, $\mathrm{f}(\eta)$ is effectively unity ; however, in the laboratory experiment it proved convenient to make η_1, η_2 of the order of unity in order to increase the light incident on the cathodes and thereby improve the ratio of signal to noise. The corresponding values of $\mathrm{f}(\eta_1)$, $\mathrm{f}(\eta_2)$ were 0·62 and 0·69 respectively.

When the centres of the cathodes, as viewed from the source, are displaced horizontally by a distance d, the theoretical value of the correlation decreases in a manner dependent upon the dimensionless parameters, η_1 and d/a_1. In the simple case where $\eta_1 \ll 1$, which would apply to an experiment on a visual star, it can be shown that $S(d)$, the correlation as a function of d, is proportional to the square of the Fourier transform of the intensity distribution across the equivalent line source. However, when $\eta \gg 1$, as in the present experiment, the correlation is determined effectively by the apparent overlap of the cathodes and does not depend critically on the actual width of the source. For this reason no attempt was made in the present experiment to measure the apparent angular size of the source.

The initial observations were taken with the photocathodes effectively superimposed ($d = 0$) and with varying intensities of illumination. In all cases a positive correlation was observed which completely disappeared, as expected, when the separation of the photocathodes was large. In these first experiments the quantum efficiency of the photocathodes was too low to give a satisfactory ratio of signal to noise. However, when an improved type of photomultiplier became available with an appreciably higher quantum efficiency, it was possible to make a quantitative test of the theory.

A set of four runs, each of 90 min. duration, was made with the cathodes superimposed ($d = 0$), the counter readings being recorded at 5-min. intervals. From these readings an estimate was made of N_e, the root mean square deviation in the final reading $S(0)$ of the counter, and the observed values of $S_e(0)/N_e$ are shown in column 2 of Table 1. The results are given as a ratio in order to eliminate the factor A in equations (1) and (2), which is affected by changes in the gain of the equipment. For each run the factor

$$\frac{m-1}{m}\int \alpha^2(\nu)n_0{}^2(\nu)d\nu \Big/ \int \alpha(\nu)n_0(\nu)d\nu$$

was determined from measurements of the spectrum of the incident light and of the d.c. current, gain and output noise of the photomultipliers ; the corresponding theoretical values of $S(0)/N$ are shown in the second column of Table 1. In a typical case, the photomultiplier gain was 3 × 10^5, the output current was 140 μamp., the quantum efficiency $\alpha(\nu_0)$ was of the order of 15 per cent and $n_0(\nu_0)$ was of the order of 3×10^{-3}. After each run a comparison run was taken with the centres of the photocathodes, as viewed from the source, separated by twice their width ($d = 2a$), in which position the theoretical

Table 1. COMPARISON BETWEEN THE THEORETICAL AND EXPERIMENTAL VALUES OF THE CORRELATION

	Cathodes superimposed ($d = 0$)		Cathodes separated ($d = 2a = 1{\cdot}8$ cm.)	
	Experimental ratio of correlation to r.m.s. deviation $S_e(0)/N_e$	Theoretical ratio of correlation to r.m.s. deviation $S(0)/N$	Experimental ratio of correlation to r.m.s. deviation $S_e(d)/N_e$	Theoretical ratio of correlation to r.m.s. deviation $S(d)/N$
1	+7·4	+8·4	−0·4	~ 0
2	+6·6	+8·0	+0·5	~ 0
3	+7·6	+8·4	+1·7	~ 0
4	+4·2	+5·2	−0·3	~ 0

correlation is virtually zero. The ratio of $S_e(d)$, the counter reading after 90 minutes, to N_e, the root mean square deviation, is shown in the third column of Table 1.

The results shown in Table 1 confirm that correlation is observed when the cathodes are superimposed but not when they are widely separated. However, it may be noted that the correlations observed with $d=0$ are consistently lower than those predicted theoretically. The discrepancy may not be significant but, if it is real, it was possibly caused by defects in the optical system. In particular, the image of the arc showed striations due to imperfections in the glass bulb of the lamp; this implies that unwanted differential phase-shifts were being introduced which would tend to reduce the observed correlation.

This experiment shows beyond question that the photons in two coherent beams of light are correlated, and that this correlation is preserved in the process of photoelectric emission. Furthermore, the quantitative results are in fair agreement with those predicted by classical electromagnetic wave theory and the correspondence principle. It follows that the fundamental principle of the interferometer represented in Fig. 1*b* is sound, and it is proposed to examine in further detail its application to visual astronomy. The basic mathematical theory together with a description of the electronic apparatus used in the laboratory experiment will be given later.

We thank the Director of Jodrell Bank for making available the necessary facilities, the Superintendent of the Services Electronics Research Laboratory for the loan of equipment, and Mr. J. Rodda, of the Ediswan Co., for the use of two experimental phototubes. One of us wishes to thank the Admiralty for permission to submit this communication for publication. [Oct. 5

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OBSERVATIONS OF WHISTLING ATMOSPHERICS AT GEOMAGNETICALLY CONJUGATE POINTS

WE have observed whistlers, most recently described comprehensively by L. R. O. Storey[1], to occur simultaneously at 55·1° and 50·2° N. geomagnetic latitude on the east coast of North America, and have found the individual whistlers to have essentially identical characteristics at the two stations for the particular period of activity studied. All individual whistlers observed at either station were accompanied by a simultaneous occurrence at the other station, but for each occurrence the stronger whistler did not always occur at the same station. Apart from intensity variations, other characteristics were essentially uniform throughout the observing period.

Tape recordings of whistlers simultaneously observed at the two locations, Hanover, N.H., and Washington, D.C., were analysed on a comb-filter type of sound spectrograph, and Figs. 1 and 2 show typical examples taken from more than a hundred occurrences on March 1, 1955, between 09.45 and 10.15, 75° W. standard time. The most probable source of storms for producing these whistlers appears from weather data to have been in the State of New York at a geomagnetic latitude of about 54° N.

The dotted curves plotted on the spectrograms are the function $f = (D/t)^2$, where t is measured from the initiating atmospheric. This formula, which is Storey's form of the frequency-dependence given by Eckersley[2], is seen to fit the data rather well for $D = 200$. The dispersion D as given by Storey's

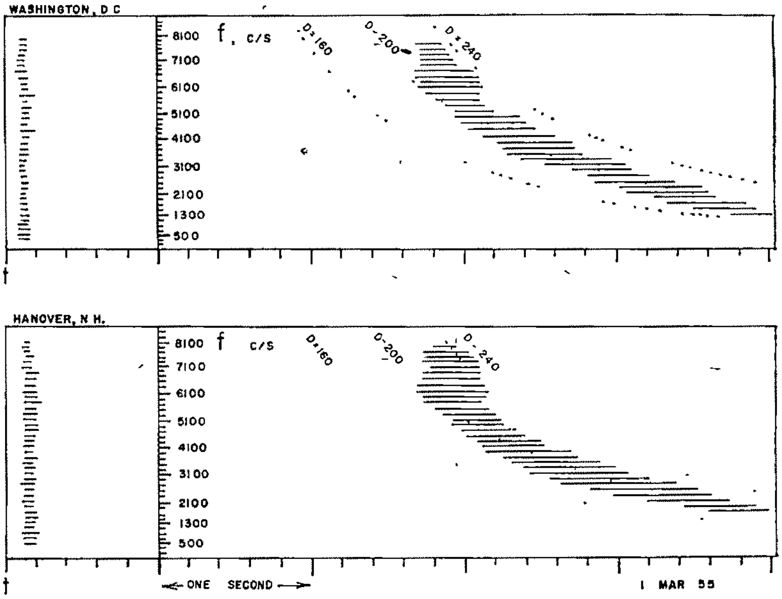

Fig. 1. An atmospheric followed about 2·5 sec. later by the commencement of a whistler. The atmospheric was observed to occur simultaneously at both stations within the limits of the timing method used (about ± 0·1 sec.) and, there being no others of comparable amplitude within a few seconds, is reasonably assumed to be the same atmospheric on both records

equation 15 is proportional to the expression $\sqrt{N}/B\,ds$ integrated over the propagation path, where N is the electron density, B the static magnetic field, and ds the differential path-length. Considering the effect of path-length only, and considering the path to be along the flux of the simple geomagnetic field, a difference of 35·6 per cent in D between the two points of observation is computed. (Inclusion of the field in the integral leads to $\int (1 + 3\cos^2\theta)^{1/4}\sin^3\theta d\theta$, which we have not succeeded in integrating directly.) This difference does not seem to appear in the observations, and we conclude tentatively that the observed dispersion does not necessarily depend upon the latitude of the observer but rather upon the latitude of the storm source. If this conclusion is correct, and if the ability to hear a whistler depends upon the proximity of the observer to the location, or the geomagnetically conjugate location, of the atmospheric generating it, then one would expect the distribution of the dispersions of all whistlers heard at a station to depend upon the latitude of that station. On the other hand, we have never observed whistlers to result from lightning which could be seen from the point of whistler observation.

(*Note added in proof, November* 25. A. G. Jean, of the National Bureau of Standards, Boulder, Colorado, has reported to us in recent conversations that he has on one occasion heard whistlers apparently associated with visible lightning flashes. It should also be recalled that E. T. Burton and E. M. Boardman reported in 1933 a direct correspondence with flashes of undetermined kind seen near the apparent end of an auroral arc[3].)

We have noted that atmospherics which produce whistlers usually have a characteristic sound. Continuing the onomatopœic vocabulary started by E. T. Burton[4], we have called these 'bonks'. There are many gradations between a 'whistler' (a term first used by Eckersley[5]) and a 'swish', a term first used by Burton. The former is a descending tone, whereas the latter is a descending frequency band of noise. We submit that the accompanying records are of bonks followed by swishlers.

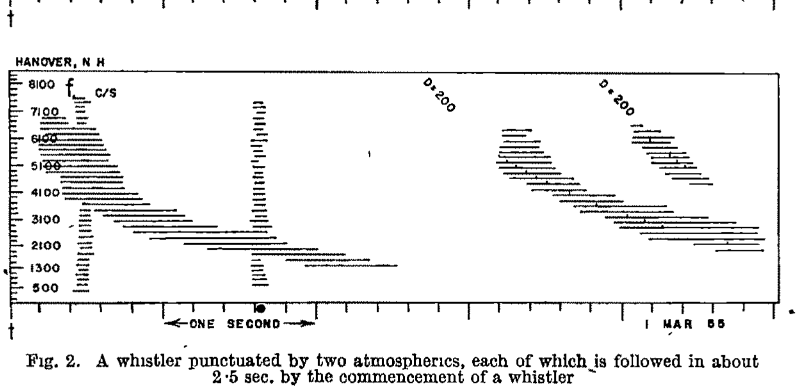

Fig. 2. A whistler punctuated by two atmospherics, each of which is followed in about 2·5 sec. by the commencement of a whistler

We wish to acknowledge the assistance of our colleagues at our respective institutions: H. W. Curtis, W. C. Johnson and B. Pratt at Dartmouth College; and J. E. Raudenbush and W. E. Garner at the Naval Research Laboratory.

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Aug. 30.

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[2] Eckersley, T. L., *Nature*, **135**, 104 (1935).

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[5] Eckersley, T. L., *Nature*, **122**, 768 (1928).

Observations which we have conducted near geomagnetically conjugate points at about 50° geomagnetic latitude in the Aleutian Islands and in New Zealand appear to confirm L. R. O. Storey's remarkable theory that the long, dispersive paths needed by T. L. Eckersley to explain the generation of 'whistlers' and 'swishes' from atmospherics are along the geomagnetic flux lines between the northern and southern hemispheres[1,2]. Simultaneous recording on magnetic tape on a schedule of 4 min./3 hr. was begun on August 23, 1955 Z (Z = zero meridian reference), at Unalaska and at sites near Wellington and Dunedin, N.Z. Unalaska and Wellington are within 250 miles of geomagnetically conjugate points, and Unalaska and Dunedin are within 75 miles of such points. Activity at all stations was very low until August 28 at 11.40 Z, when weak whistler activity commenced at all stations. The strength of the activity had increased somewhat by 14.40 Z, and further at 17.40 Z. During the latter schedule, four good examples of whistler trains[2] were observed at both the northern and southern stations. The low rate of occurrence, and the timing accuracy used, were such that there can be little doubt of the correspondence of the phenomena at the northern and southern stations. There were no other occurrences of comparable nature and magnitude at any of the stations during the schedule. Further activity occurred on the 14.40 Z and 17.40 Z schedules on September 1. On that day the occurrences were strong but less-frequent, and the background noise was particularly low.

In the accompanying spectrograms it is seen that the essential details of Storey's theory are amply borne out. The spectrograms are tracings of records

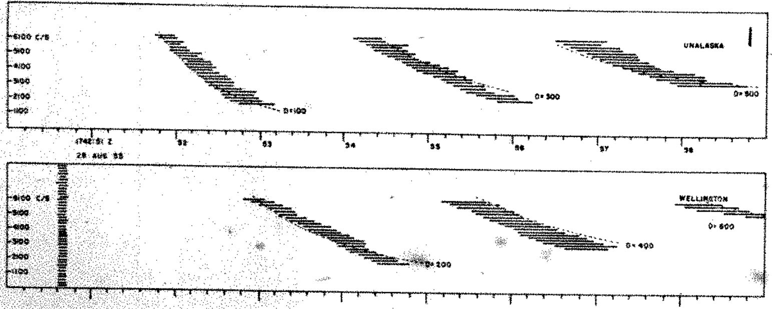

Fig. 1. Atmospheric heard in New Zealand which, according to the Storey theory, produced a whistler in Alaska after being smeared out by propagation over the long dispersive path along the geomagnetic flux lines connecting the two locations. The whistler then returned to New Zealand, further dispersed by another transit of the path, returned to Alaska still further dispersed, etc. The attenuation produced by a round trip is sometimes as low as 2 db.

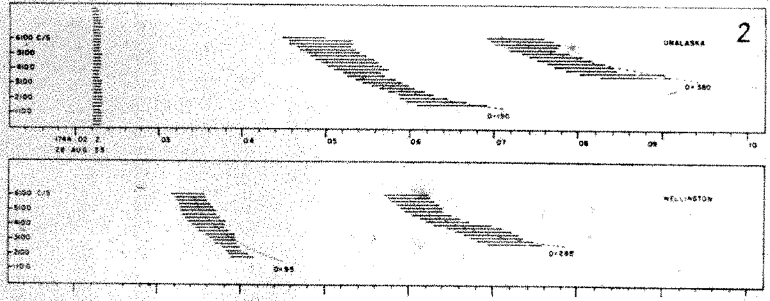

Fig. 2. Atmospheric heard in the Aleutians which produced a whistler in New Zealand, returned to Alaska, etc.

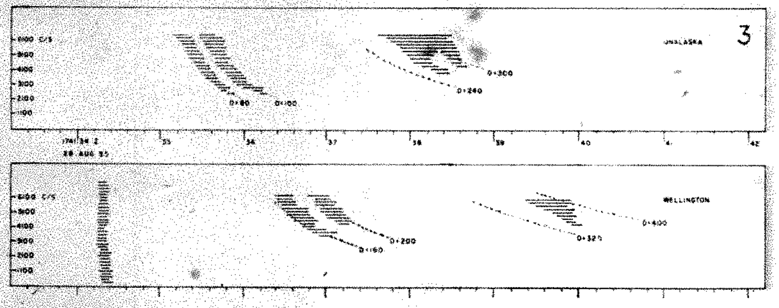

Fig. 3. A whistler pair produced by a single atmospheric. This type, reported by Storey, apparently results from independent propagation over two paths

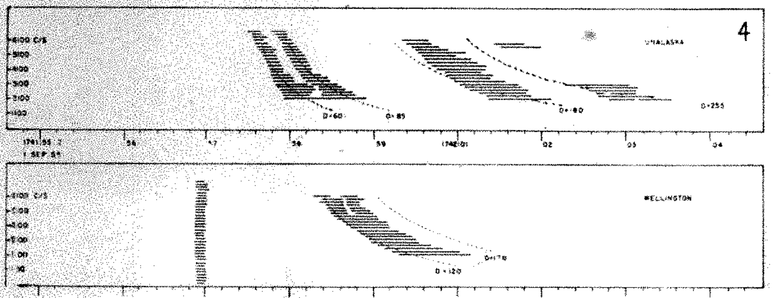

Fig. 4. Another whistler pair produced by a single atmospheric

made with a comb-filter with a stylus for each filter writing on electrically sensitive paper. The values of D shown are from the equation $t = D/\sqrt{f}$, which is Storey's form of the frequency dependence given by Eckersley. The origin of t is taken at the leading edge of the generating spheric in each example.

The estimated timing accuracy was ± 0·3s. at each station for the August 28 schedule at 17.40 Z and ± 0·5s. at each station for the September 1 schedule at 17.40 Z. The times shown on the spectrograms are those determined for the Alaska records. The New Zealand records have been registered as if the performance were according to Storey's theory. This required adjusting the New Zealand times by adding the following amounts: for August 28, 1741.34, 0·2s.; for 1742.51, 0·4s.; and for 1744.02, 0·4s. For September 1, 1741.55, 0·1s. was added.

The Dunedin records have been found to be closely identical with the Wellington records. This is as we would expect from experience in North America, in which simultaneous observations at Washington, D.C., and Hanover, N.H., were compared[3].

The consistence of these results with Storey's theory permits the planning of a synoptic programme of observation during the coming International Geophysical Year with much greater confidence and insight. We are grateful to the U.S. National Academy of Sciences for sponsoring this international scientific experiment and for assisting us with funds obtained from the U.S. National Science Foundation for costs other than salaries. We hope that the successful outcome of the experiment on an informal basis is but a precursor of many others planned for the International Geophysical Year.

We are especially indebted to H. W. Curtis, of Dartmouth College, who established the station and made the observations at Unalaska, to the U.S. Navy's Bureau of Ships for making his time available, to the U.S. Military Air Transport System for his return transportation, and to the Alaska Communication System of the U.S. Army Signal Corps for assistance and hospitality to him at Unalaska. We are also very much indebted to L. H. Martin, of the New Zealand Broadcasting Service, who established the station and made the observations near Dunedin. Lastly, we thank H. E. Dinger, of the U.S. Naval Research Laboratory, for preparation of the original spectrograms, and W. C. Johnson, of Dartmouth College, for their reproduction.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Cosmic Spherules in Deep-Sea Sediments

IN 1876, Sir John Murray[1] published observations on magnetic spherules extracted from deep-sea sediments collected by the *Challenger* Expedition. Together with Renard[2], he later described them more fully and gave strong reasons for assuming them to have a cosmic origin. Very few observations have since then been published on these spherules. The two most recent publications are by Bruun, Langer and Pauly[3] describing magnetic particles collected from the sediment surface by the *Galathea* Expedition, and by Laevastu and Mellis[4], working in Göteborg, who extracted, counted and measured black spherules from one ordinary long core from the Swedish Deep-Sea Expedition.

During the Swedish Deep-Sea Expedition with the *Albatross* a number of thick cores, up to 5½ metres long, were collected from different localities and depths in order to obtain more exact observations on the supply to the Earth of cosmic particles during the past few million years[5]. Some of these cores have, in the Institute of Oceanography in Göteborg, been subjected to magnetic extraction and have yielded, per kilogram of sediment, several hundred black spherules, greater than 35µ in diameter, from different layers in the cores[6].

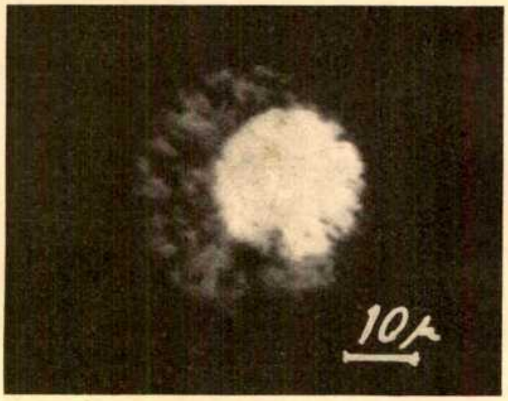

Fig. 1. Spherule from *Albatross* Core 71 (lat. 07° 38′ S., long. 152° 53′ W., depth 4,990 m.). Sample 93, 160 cm. below the sediment surface. Magnetite, grey; metallic nucleus, white

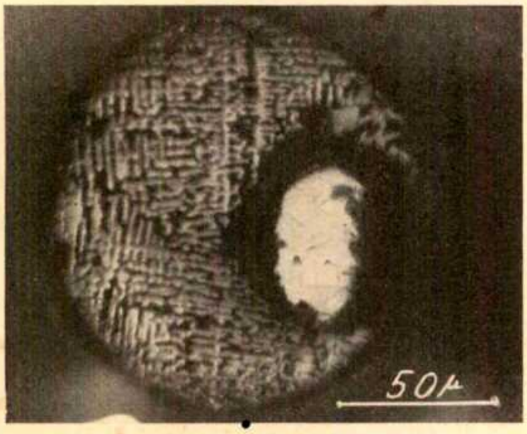

Fig. 2. Spherule from the same sample as Fig. 1. Dendritic magnetite, grey, probably in silicate, and metallic nucleus, white. The black area around the nucleus is void

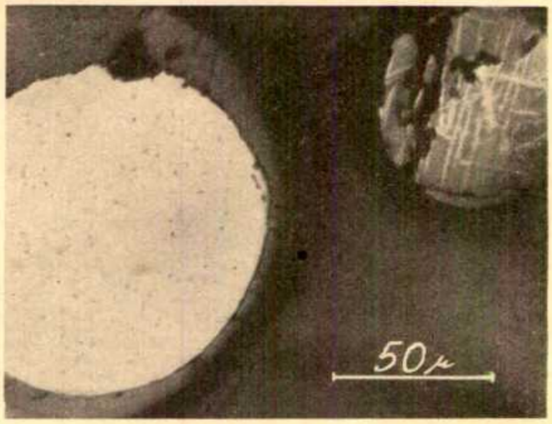

Fig. 3. Artificial spherules. Magnetite, grey; hæmatite lamellæ, light grey; and metallic nucleus, white

Doubts have been expressed about the cosmic origin of these spherules. In the course of our experiments, several of the spherules found have been mounted in plastic and polished, in many cases displaying a metallic nucleus inside a superficial layer of magnetite (Fig. 1), presumably due to oxidation during the flight through the atmosphere. In most of the spherules with a metallic nucleus the metal reduces acid copper sulphate solution, indicating metallic iron. In a few cases a structure, probably due to a consolidation from the molten state, has been observed (Fig. 2). Since a volcanic origin is not likely, this also supports the cosmic origin of the black spherules on which the investigation has hitherto been concentrated.

The possibility that the spherules may in part be of artificial origin cannot *a priori* be excluded for spherules found in the uppermost sediment surface. But for spherules found a few centimetres or more below the surface layer in deep-sea sediments, this origin can be ruled out. In fact, we have found spherules in sediment layers the age of which is of the order of several million years, proving that already in Tertiary time cosmic spherules were being deposited on the Earth.

In interpreting magnetic spherules collected on the continents by, among others, Buddhue and Thomsen[7], great caution is necessary. Hoppe and Zimmermann[8] have published results from attempts to collect magnetic fragments from the air in Jena and other localities, which prove that magnetic spherules found there are largely products from industries in the vicinity. This they assume to have been the case, at least with some of the magnetic spherules described by Thomsen. Similar experiments made in Göteborg confirm this view. We have also found that black magnetic spherules, obtained by means of an oxygen flame from an iron wire, consist of magnetite with or without a metallic nucleus, and that they are very similar to the true cosmic spherules (Fig. 3).

Prof. H. Pettersson has proposed that a collection of meteoritic dust and fragments should be undertaken during the International Geophysical Year, preferably on islands in the Pacific Ocean. Preliminary experiments for this purpose have already been started near Bornö Station in the Gullmar Fjord.

A detailed report on our finds is in preparation.

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Enhanced Initiating Effect of Multiple Shock Intersections

PREVIOUS work has shown that underwater shock-wave initiation of cast pentolite can be photographed advantageously by a simple argon flash-lamp method in which a common mechanical-shutter camera is used[1]. Very minute scintillations were usually evident on the detonating pentolite charges, presumably because of the presence of minute air pockets between the particles situated near the surface of the charges. These air pockets probably provided a multitude of initiation centres. Bowden and co-workers have obtained photographic evidence that bubbles in nitroglycerin and air pockets in solid explosives enhance initiation and that initiation occurs at these bubbles or gas pockets[2].

When these results were discussed with Dr. F. P. Bowden, of Cambridge, he suggested to us that initiation of a receptor also might be enhanced by multiple or reinforced shock waves acting simultaneously on the explosive receptor. The arrangement to be described here was used to obtain photographic evidence of such an effect. Commercial nitroglycerin (a mixture of glycerin trinitrate and glycol dinitrate) was selected for the investigation because of uniformity in properties and the normal absence of air bubbles.

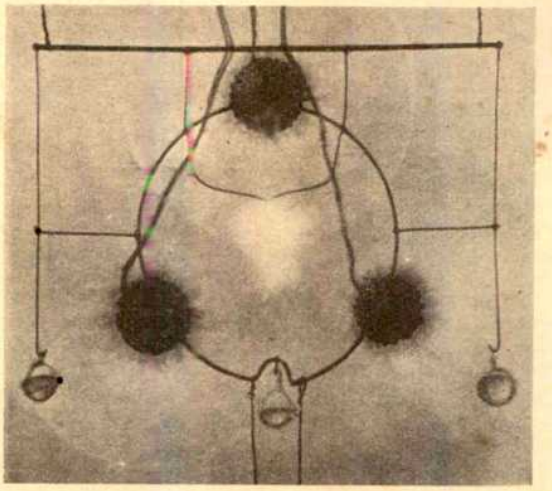

Fig. 2

The arrangement shown in Fig. 1 consisted of four nitroglycerin receptors (A) spaced uniformly about three evenly separated blasting caps (B). About 1·5–2·0 gm. of nitroglycerin was contained in each thin glass bulb, which weighed about 0·2 gm. Two individual receptors, A_2, A_4, were exposed simultaneously to a single shock; one, A_3, to a double intersecting shock; and a third, A_1, to a triple intersecting shock from the three blasting caps fired simultaneously. The location of the individual receptors with respect to the caps determined whether the exposure was to a single, double-intersecting, or triple-intersecting shock. Simultaneous firing of caps in series connexion was obtained by using a special arc-fired cap rather than the usual bridge-wire type. The caps were mounted at equal distances from each other on the central wire ring. The base charge was 5 grains of PETN.

Fig. 2 is an argon flash-lamp picture[3] (back lighted; about 0·5 μsec. exposure; 1/200 sec. shutter) that shows the underwater shock waves when in contact with all receptors, the centres of which were essentially 2½ in. from the nearest caps. Only the central receptor that was exposed to a triple shock intersection was initiated. None of the other receptors was initiated.

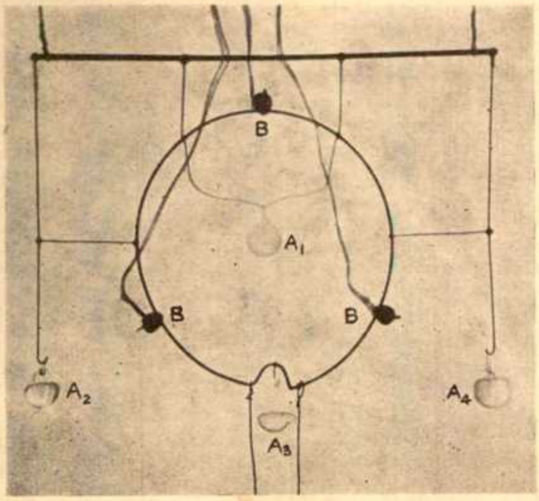

Fig. 1

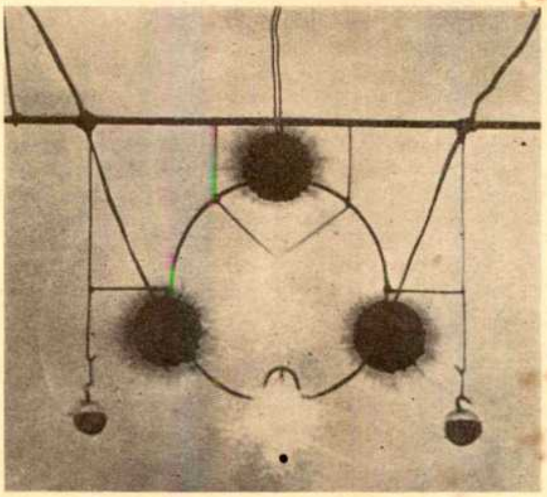

Fig. 3

The arrangement of Fig. 3 was like that of Fig. 2 except that the distance between the caps and the adjacent nitroglycerin receptors was reduced by ½ in., and that the picture was taken sooner to show again the simultaneous shock influence. In this case the receptors that were exposed to triple- and double-intersecting shocks were initiated. The receptors that were exposed to the singly arriving shocks from the caps did not explode.

When explosion of the receptor is accompanied by a brilliant flash, it is not possible to determine the instant of initiation, because the brilliant flash obscures the state of gas expansion and the location of the shock wave about the receptor. With less luminous receptors the simple flash method provides much information about underwater shock-wave initiation. When nitroglycerin is used, some detailed information is lost, and accordingly future work is planned with a Kerr-cell, rapid-shutter camera. It is clear, however, that weak shock waves which are unable singly to initiate explosion can do so when they meet and reinforce one another.

I greatly appreciate the suggestions kindly given by Dr. F. P. Bowden.

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Microwave Observation of Detonation

THE usual methods for the measurement of the detonation velocity of explosives either do not permit the free selection of conditions of confinement or do not permit the observation of velocity with a high degree of continuity[1].

We have recently developed a technique for measuring the velocity of detonation of various high explosives under contained conditions by means of the reflexion of microwaves from a region travelling with the detonation front. The technique differs substantially from that of Koch[2] and the recent development of his technique by Cook, Doran and Morris[3], in both of which the explosive is unconfined and reflexion occurs in part from the detonation front and in part from the detonation products.

Our experimental method employs the principles of microwave interferometry[4], together with continuous recording of the intensity of the interference field at a point as the detonation moves along the containing tube. In the primitive form of apparatus, a standard brass mould stemmed with explosive is connected, through a polytetrafluorethylene window, to the end section of a rectangular *Q*-band wave-guide, thus forming the variable arm of the interferometer. The wave is guided over the whole forward and return path. The explosive is initiated from the distant end of the stemming, and the interference pattern is recorded together with time markers.

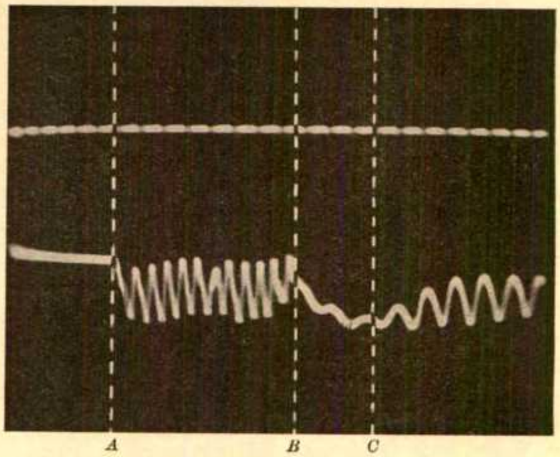

Fig. 1. An oscillogram showing complete detonation in tetryl, the penetration of a polytetrafluorethylene window and the subsequent event in the rectangular wave-guide

A typical oscillograph record of the pattern is shown in Fig. 1. This is for a stable detonation in a 0·6 in. external diameter brass mould of a 2 in. × 0·152 in. diameter stemming of 1·39 gm.cm.$^{-3}$ tetryl. The trace from *A* to *B* corresponds to the progress of the detonation in the explosive stemming; *B* to *C* represents the bursting of the polytetrafluorethylene window and the reforming of an adequate reflexion front in the rectangular wave-guide. The remaining portion of the trace is due to reflexion occurring in the rectangular wave-guide from the shock front, or perhaps from the detonation products travelling with a considerably reduced velocity. The time base shows microsecond marker intervals. For this particular case the detonation velocity derived from the oscillogram is about 6,600 m.sec.$^{-1}$ and the velocity of the front in the wave-guide after detonation is about 3,600 m.sec.$^{-1}$.

To derive the velocities from the oscillogram, all that is required is a knowledge of the guide wavelength appropriate to the region. For the case of the detonation velocity determination, in addition to the microwave frequency, the dielectric properties (permittivity and loss factor) of the explosive must be known. Measurements of these properties have been made over a range of densities by the usual cavity techniques for a number of high explosives. In all cases the loss factors are sufficiently low to cause no appreciable attenuation. In the example given above the relative permittivity was 2·73, and the microwave frequency was 34·50 kMc.

While no extensive detonation velocity determinations have yet been made by us, an estimate of the likely error for the initial form of the equipment indicates that the detonation velocity determined should lie within ± 1½ per cent of the true value. This error is of much the same order as the errors in other methods. It will be clear, however, that since the reflexion arises entirely from the interior of the explosive, the main advantage of the new method does not derive so much from the ability to measure detonation velocities with great absolute accuracy, as from its other possibilities. These include the observation of relative variations due to density, diameter or confinement, the observation of contact transmission, instability and other effects under confined conditions, and the avoidance of external effects during detonation from luminosity, shock-waves or detonation products. Any degree of confinement may be used, from very thin metal foils upward, and other materials may be used with thin internal metal deposits.

In the oscillograms obtained it is easy to discriminate four phase points in each period, and thus a definite distance from some arbitrary fixed point in the explosive is located at about every millimetre in the example discussed. This distance defines the degree of continuity in the present observations, but developments in the recording system are immediately possible and a finer distance resolution will result.

Full details of the method and associated dielectric measurements will be given elsewhere. This communication is published by permission of the Chief Scientist, Australian Commonwealth Department of Supply.

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G. F. CAWSEY

Department of Supply,
Australia. July 25.

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Search for Point Source of Cosmic Rays

IN order to search for possible point sources of cosmic rays, an alt-azimuth Geiger–Müller counter telescope of narrow angular resolution (5° × 5°) was made, and kept nearly horizontal (zenith distance $Z = 80°$) so that the effective cosmic-ray particles were free from complicated geomagnetic deflexion. After scanning over the celestial sphere, especially large intensities were observed at two positions as noticed in our earlier paper[1].

In order to confirm one of them (declination $\delta = 0°$, right ascension $\alpha = 5$h. 30m., before entering into the geomagnetic field), observations of a small part of the celestial sphere including the position have been repeated since April 1954, with the telescope (No. 1) described above. Meanwhile, another telescope (No. 2) with higher accuracy was built, which can observe five adjacent declination bands at once with narrow angular resolution (4° × 5°). Observations with two telescopes have been repeated since July 13, 1955. Observations were carried out at the zenith distance $Z = 80°$, twice a day at two azimuths, $A = 85°$ and $A = 255°$, respectively. The following results were obtained from the observations up to August 18, 1955.

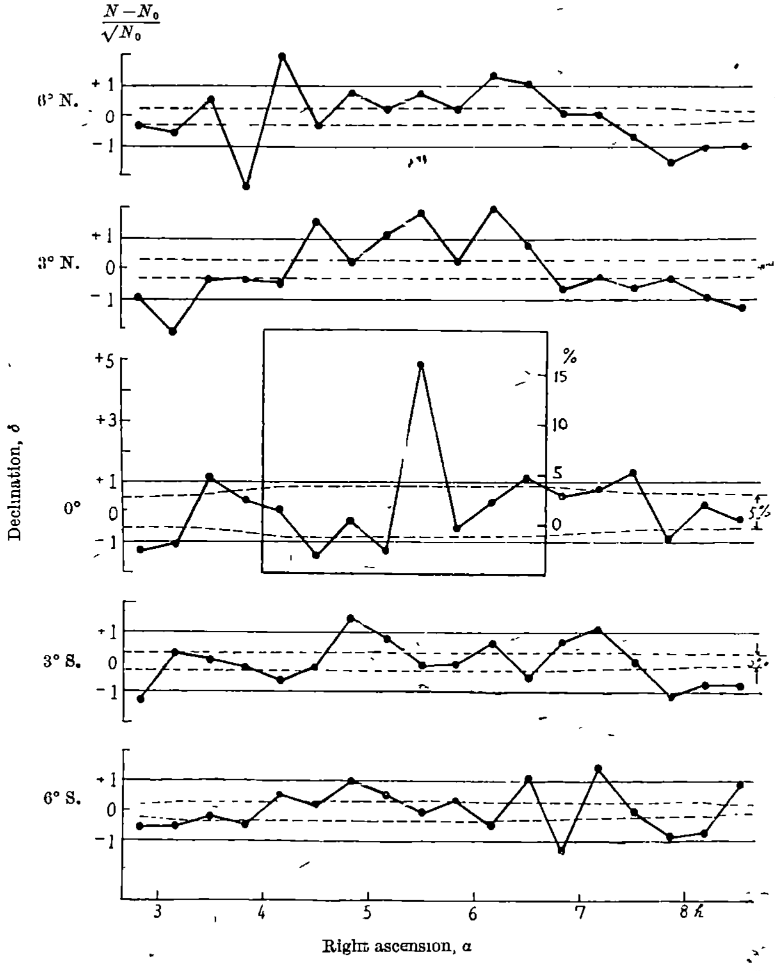
The relative intensities in the part of the celestial sphere ($\delta = 0°$, 4h. 10m. $< \alpha <$ 6h. 30m.) are shown in the central part of Fig. 1, where the eight points were observed with equal statistical accuracy. The count at the position marked by the previous scanning ($\alpha = 5$h. 30m.) is $N = 1{,}264$, while the average of the other seven positions is $N_0 = 1{,}091{\cdot}6$. Therefore,

$$N - N_0 = +0{\cdot}157\,N_0 = +5{\cdot}2\sqrt{N_0}$$

or the significance-level is about 10^{-6}. Thus, this position was confirmed to be a point source of cosmic rays. This is the first example of a particular point source, though the existence of point sources was presumed through the statistical arguments in our previous paper[1].

The results over a little larger part of the celestial sphere are shown in Fig. 1, where the statistical accuracies corresponding to the various points are not constant. Therefore, the ordinate is not the relative count $(N - N_0)/N_0$, but the count divided by the standard deviation corresponding to the observation of each point, $(N - N_0)/\sqrt{N_0}$, where N_0 is not constant. From the observations up to August 18, no point source except that described above was found in the part of the celestial sphere shown in the figure, provided that fluctuations less than 2·5 standard deviations are regarded as insignificant.

The increase at the point source was 20 ± 8 per cent by telescope No. 2, which includes no effect of side showers. It was 19 ± 4 per cent by telescope No. 1, after correction for the side showers. Thus, the intensity of cosmic rays from the point source is 20 ± 4 per cent of the background cosmic rays in the solid angle 5° × 5°, so the point source con-



Right ascension, α

Fig. 1. A part of the celestial sphere observed with alt-azimuth cosmic-ray telescopes Ordinates: $(N-N_0)/\sqrt{N_0}$. In the central part of the figure, where observations were made with high and uniform accuracy, the ordinate is scaled also by $(N-N_0)/N_0$ Horizontal lines: $N-N_0 = \pm\sqrt{N_0}$. Dotted curves: $(N-N_0)/N_0 = \pm 2{\cdot}5$ per cent

tributes 0·016 per cent of total cosmic rays in the same energy region. The angular width of the point source was estimated by various methods to be not more than 5°. Increase of cosmic rays at the position was observed at both azimuths. Positions observed at the two azimuths were identified through the correction for the geomagnetic deflexion, which depends on the charge and momentum of effective primary particles. They were presumed statistically to be positive and 2 Størmers ($P \doteqdot 240$ GeV./c.) respectively by the previous scanning, and were shown to be correct through the observation of this particular point source.

We thank Prof. Y. Hagihara and Prof. T. Hatanaka for their interest and discussions.

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The Near Ultra-Violet Bands of *para*-Dichlorobenzene

The bands in the near ultra-violet of *p*-dichlorobenzene were first studied in absorption by Wollman and reported by H. Sponer[1], who gave a general analysis and description of the bands. Recently, T. Anno and T. Matubara[2] have published a detailed analysis of these absorption bands obtained at different temperatures. Work on these bands, in absorption as well as in emission, has been in progress in this laboratory for some time past. Comparison of our results with those of earlier workers is thought worthy of advance publication, since the spectrum has also been obtained in emission and there are a few interesting points of difference in analysis.

The position of the zero band as measured by us is 35,755 cm.$^{-1}$ in absorption and 35,752 cm.$^{-1}$ in emission. The divergence is within experimental error. The value is again in agreement with that in absorption reported by Anno and Matubara, namely, 35,750 cm.$^{-1}$, but differs from that given by Sponer, namely, 35,743 cm.$^{-1}$.

The main progression, which consists of doublet bands, involves the upper-state frequencies near 1,061 and 1,051. Anno and Matubara correlate these frequencies with the ground-state frequencies 1,164 and 1,102 respectively, observed in absorption and Raman effect. But in the emission spectrum obtained by us, there is a broad band at 34,672 cm.$^{-1}$, which perhaps represents two unresolved bands involving the ground-state frequencies 1,084 and 1,071. The ground-state frequencies 1,164 and 1,102 do not seem to occur in the emission spectrum. Further, from the polarization measurements of the Raman lines, Saxena and Narain[3] suggest that perhaps 1,084 and 1,071 form a Fermi doublet. Thus the data of the emission spectrum and the intensity and polarization of the Raman lines appear to favour the correlation of the upper-state frequencies 1,061 and 1,051 to the ground-state frequencies 1,084 and 1,071 rather than to 1,164 and 1,102 respectively.

The ground-state frequency 248 observed by us and also by Anno and Matubara does not seem to have a corresponding Raman line, unless it is a very faint line at 232 cm.$^{-1}$ reported by Kohlrausch and Paulsen[4] (and referred to by Sponer and Nordheim[5]). In emission, there is a band of medium intensity on the longer wave-length side of the zero band at a separation of 251 cm.$^{-1}$. This band probably corresponds to the ground-state frequency 248 observed in absorption.

The totally symmetric ground-state frequency 331 is correlated with 244 in the excited state by Anno and Matubara. But the intensity of the band involving the frequency 244 is low, and although this is not, by itself, an argument against its being totally symmetric, we prefer to regard it as a satellite of the band involving the upper-state frequency 329. This assignment has also been suggested as an alternative one by Anno and Matubara.

The prominent difference-frequencies of about 25 and 85 are observed by all workers. Of the other difference-frequencies 9 and 16 reported by Anno and Matubara, only the first occurs in association with weak bands on our plates, while there is no trace of the bands involving the difference-frequency 16. This is no doubt due to the fact that we restricted our studies to room temperature, about 30° C., where this difference-frequency is either absent or very weak[2].

The occurrence of the ground-state frequencies 302 and 486 is regarded as rather uncertain by us, as the bands involving these frequencies can have alternative assignments.

A detailed treatment of the bands obtained in absorption and emission is to be published elsewhere.

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Correlation of Nuclear Quadrupole Interaction Frequencies with Polarographic Half-Wave Potentials

When the nuclear quadrupole interaction frequencies of some aryl iodo-compounds are plotted against the corresponding half-wave potentials of these compounds at *p*H 7 (Fig. 1) a general linear

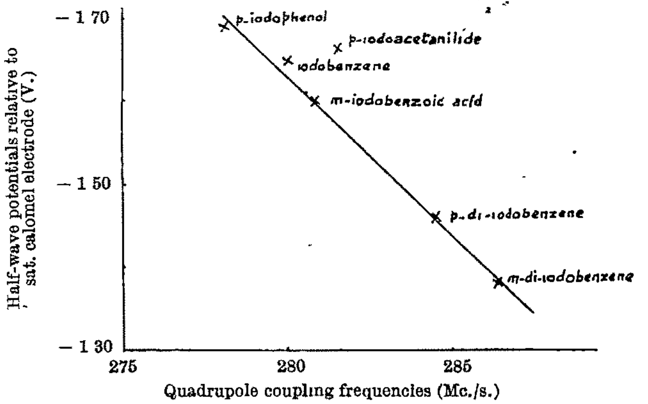

Fig. 1

trend is obvious; but the departure from linearity in the case of the iodoanilines is more serious (points not shown on graph). The data are taken from results obtained by E. Gergely and me[1], those of Colichman and Liu[2], and the quadrupole interaction measurements of Hatton and Rollin[3], and of Barnes, Miller and Wooten[4]. Colichman and Liu have attempted a correlation of their polarographic data on iodo-compounds with Hammett's σ-function. Hatton and Rollin have attempted a similar correlation of their quadrupole data and Hammett's σ for bromine and iodine compounds. However, Colichman and Liu found the same misbehaviour of *p*-iodoaniline as we did, and it is equally obvious that the *m*- and *p*-di-iodobenzenes (as evidenced from our own results which are not substantially different from theirs) would not fit their straight line. On the other hand, Hatton and Rollin found, in their quadrupole $-\ \sigma$ relationship, that these three substances fell very well into line. It is clear that the triangular agreement we expect to find from the results of these four groups of workers is very imperfect, and the interrelation of the three phenomena greatly in need of clarification.

Quadrupole resonances are invariably measured with the substances studied in the crystalline form, whereas polarographic studies and reaction kinetics are undertaken in solution. This distinction is only of importance when crystal forces can seriously modify the nature of the bonding of the relevant atom. At least we know the nucleus is moving in a crystalline, electric field, different sometimes from that where the molecule is gaseous or in the dissolved, liquid state. Moreover, change of vibrational level can modify the quadrupole frequency[5].

Hammett's[6] σ, defined as $-A/2{\cdot}303\ R$, is said to measure the tendency of the substituent to displace electrons. A has the dimensions of an energy term, and might be expected to represent a variation in some energy of activation necessary to overcome a potential barrier[7]. The same is true of the half-wave potential, although the idea behind this may be more elementary, involving the conception of an electron adding on to a molecule as a preliminary step in cathodic reduction. We would say that the greater the electron density at the region where the electron is expected to add on, the greater would be the half-wave potential.

Variations in the quadrupole frequency (or the quadrupole coupling constant, 20/3 times the first frequency in the case of iodine[7]) are due to changes in the asymmetry of the field modifying the nuclear motion. The half-wave potential may be regarded as some measure of the field in a region remote from the nucleus, but its variations may be of the same order as the variations in quadrupole frequency. I hope to accumulate more observations to test the relationships described in this communication, which, at present, must be regarded as forming the basis of only tentative hypotheses.

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Crystal Structure of Glycyl-L-Alanine Hydrochloride

In the course of a programme of research into the crystal structures of simple synthetic peptides undertaken in the laboratories of the Wool Industries Research Association, glycyl-L-alanine has been synthesized and the structure of its hydrochloride elucidated using two-dimensional methods. As indicated in an earlier communication[1], the hydrochloride and hydrobromide of glycyl-L-alanine are isomorphous, with the following cell constants:

	Hydrochloride	Hydrobromide
a (A.)	10·62	10·69
b (A.)	5·98	6·13
c (A.)	7·57	7·63
β	109° 2′	108° 36′

and from the systematic absences observed the space group may be inferred to be P_{2_1}. The density of the hydrochloride by flotation is 1·465 gm. cm.$^{-3}$, which necessitates the presence of two molecules of peptide and two molecules of water of crystallization in the unit cell. The existence of the latter was confirmed analytically.

The general features of the structure in projection along the *b*-axis had already been determined for the hydrobromide[1], and the atomic co-ordinates were refined by successive Fourier syntheses using the hydrochloride intensity data (reliability index 0·18).

From the various atomic arrangements possible along the *c*-axis, it was not found possible to select the correct one on the basis of a limited number of structure-factor calculations. However, the final choice was readily made by consideration of the double Fourier projection as employed by Bijvoet *et al.*[2], and Smits and Wiebenga[3]. The *hk*0 intensities of the hydrobromide and hydrochloride were employed to derive the phase angles with a sign ambiguity, and the structure factors were then inserted into the synthesis with both signs thereby obtaining a projection of the correct structure together with its mirror image. Successive applications of the least-squares method to the selected structure in order to minimize $F_0{}^2 - F_c{}^2$ improved the percentage agreement rapidly from 30 per cent to 13·7 per cent.

Comparison of the *x*-co-ordinates obtained from the (010) and (001) projections gave a probable error of 0·02 A. for atoms resolved in both projections. The poor resolution observed in the *c*-axis projection necessarily limits the accuracy of certain of the calculated bond-lengths and angles; but the values obtained are in good agreement with those observed in related structures (Fig. 1).

The dimensions of the amide group accord closely with those given by Corey and Pauling[4], and it is in the *trans* configuration. It shows, however, a significant departure from planarity, since the carbonyl oxygen is 0·5 A. out of the plane containing the remaining atoms of the amide group.

The glycyl-L-alanine molecules are hydrogen-bonded into continuous spirals by the water molecules, which form two hydrogen bonds of 2·77 A. and 2·62 A. with O_1 and O'_4 (Fig. 1). The angle between them is 105°. These spirals are joined laterally by other N—H . . . O and N—H . . . Cl bonds.

The Cl^- ion is surrounded by an approximately tetrahedral disposition of three terminal —NH_3^+ groups and a nitrogen atom in the amide group of an adjacent molecule all at distances of between 3·23 A. and 3·36 A.; that is, within the required limits for hydrogen bonding. The terminal —NH_3^+

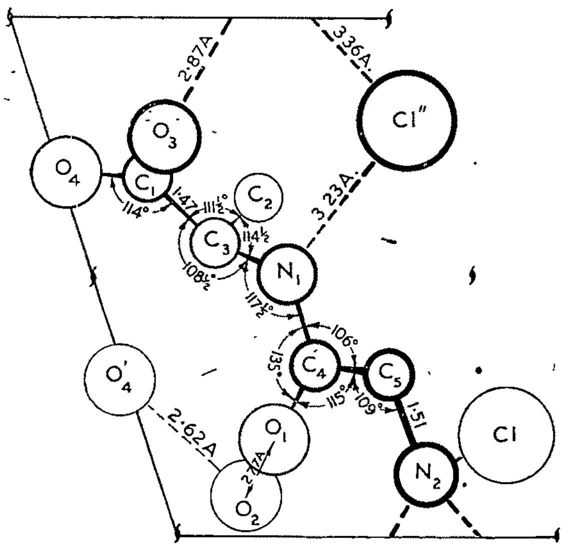

Fig. 1. Bond-lengths and -angles :

C_1O_4	1·26 A.	C_4O_1	1·21 A.	$\angle O_4C_1O_3$	123°
C_1O_3	1·24 A.	C_4C_5	1·52 A.	$\angle O_3C_1C_3$	125°
C_3N_1	1·50 A.	N_2Cl	3·18 A.	$\angle O_1O_2O'_4$	105°
C_4N_1	1 32 A.				

group, therefore, participates in the formation of three hydrogen bonds with surrounding Cl^- ions and forms a fourth N . . . H—O bond of 2·87 A. with the carboxyl group of a neighbouring molecule.

The structure conforms with Donohue's postulate[5] concerning the maximum use of the hydrogen-bonding capacities of the NH and OH groups present in the molecule for structures of this type.

A detailed account of this structure will be presented elsewhere. I am grateful to the Director and Council of the Wool Industries Research Association for permission to publish these results, and to the British Nylon Spinners, Ltd., for the facilities afforded for the completion of the work.

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A New Method for determining Ketohexoses in the Presence of Aldohexoses

A slightly modified anthrone method[1,2] has been described[3] which is suitable for the quantitative estimation of carbohydrate in chromatographic fractions. 10 ml. of a 0·02 per cent (w/v) solution of anthrone in 70 per cent (v/v) sulphuric acid is mixed with 1 ml. of the test solution, heated for 7·5 min. in a boiling water-bath and the optical density of the cooled solution read at 625 mμ against a blank. When solutions containing sucrose were analysed by this method, it was noted that, if the mixed solutions were allowed to stand before heating, there was a slow development of colour in the cold that was not apparent with solutions of aldohexoses or of oligosaccharides built up of aldohexose units. Table 1 gives a quantitative picture of the observed differences.

Table 1. Increase in the Optical Density at 625 mμ of Mixtures of Sugar Solution and Anthrone Reagent allowed to Stand at 15° C. (Coleman Universal Spectrophotometer, 1 cm. Light-Path).

Sugar	Molarity	Time elapsed after mixing (min.)		
		20	40	60
Glucose	0 02	0 01	0·01	0 02
Galactose	0·002	0·01	0·01	0·01
Mannose	0·002	0·01	0 01	0·01
Maltose	0 02	0 01	0·02	0·03
Lactose	0·002	0·01	0 01	0·01
Cellobiose	0·02	0 01	0·01	0·02
Sorbose	0·002	0 11	0·19	0·27
Fructose	0 002	0·17	0·31	0·41
Sucrose	0·002	0·17	0·31	0 45
Turanose	0·002	0·23	0·39	0·56
Raffinose	0·002	0·15	0 27	0·41
Melezitose	0 002	0·19	0·36	0·52
Xylose	0·02	0·06	0·12	0·17
Arabinose	0·002	0·01	0·01	0·02
Ribose	0·002	0·01	0 01	0 02
Rhamnose	0·02	0 12	0·18	0·23
Glucurone	0·002	0 01	0 01	0·01
Galacturonic acid	0·02	0·01	0 01	0·02
Glucosamine HCl	0·02	0 01	0·01	0 01
N-Acetylglucosamine	0·002	0 01	0·01	0·01
Heptose	0 002	0·01	0·01	0·01
Digitoxose	0·002	0 07	0·08	0·08

The temperature of the mixed reactant solutions in a 0·75-in. 'Pyrex' test-tube rose from 17° to 33° C.; but this heat of mixing was almost totally dissipated after 15 min., whereas the optical density continued to increase for periods up to 24 hr.

The blue-green colour developed by the rhamnose and pentose solutions in the cold showed a similar absorption maximum (about 625 mμ) to that from the ketose solutions. The digitoxose solutions rapidly developed a golden-brown colour with an absorption maximum at about 470 mμ, some half the final optical density being attained 1 min. after mixing. This reaction appears to be characteristic of 2-deoxy sugars, since deoxyribonucleic acid solutions slowly develop a similar colour in the cold whereas ribonucleic acid solutions do not. Moderate excess of ribonucleic acid has no influence on colour development by deoxyribonucleic acid solutions.

It is apparent that in the absence of methylpentoses, excess of pentoses (ten-fold excess of xylose over fructose gave a 40 per cent error) and large excess of aldohexoses (fifty-fold excess of glucose over fructose gave a 15 per cent error) this method

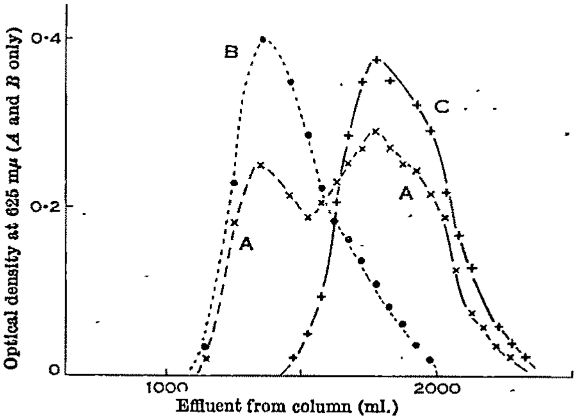

Fig. 1. Curve *A*, total carbohydrate by hot anthrone technique (fractions diluted 1 in 15). Curve *B*, ketose by cold anthrone technique (undiluted fractions, 20 min. standing). Curve *C*, reducing sugar (ref. 4)

may be used for giving a quantitative estimate of ketohexoses and their derivatives. Optical density at 625 mμ is proportional to ketose concentration in the range 0·001–0·003 *M*. The method is less sensitive than the estimation of total carbohydrate by heating, but in the system investigated (elution of sugars from charcoal columns) the concentration of sugars in the fractions was sufficient to give satisfactory results. Fig. 1 shows the application of the method to the incompletely resolved peaks of sucrose and lactose eluted from a charcoal column.

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Enzymatic Identification of the Anthocyanin Pigment of Blackberry

Karrer and Pieper reported in 1930 that the principal pigment of blackberry, *Rubus fructicosus* L., was either identical or isomeric with chrysanthemin or cyanidin-3-β-monoglucoside[1]. They obtained compact polyhedral rhombs of a pigment chloride which was indistinguishable in colour properties from an authentic sample of chrysanthemin chloride, and differed from it only in respect of crystal form. Natural chrysanthemin chloride from *Chrysanthemum indicum* L.[2], and the chloride of synthetic cyanidin-3-β-monoglucoside[3] were known to crystallize in diamond-shaped leaflets. It was suggested that the observed difference might be due to traces of impurity in the product from blackberry[1]. Afterwards, blackberry was shown to contain a second unidentified anthocyanin by paper chromatography[4]. More recently, I have isolated from blackberry[5] a crystalline anthocyanin chloride, essentially free from the second minor-component. The product was obtained in leaflets, and appeared to bear a reasonable resemblance to the crystals of chrysanthemin chloride shown in a published microphotograph[2]. However, an air-dried sample of this material was analysed correctly as a monohydrate[5], while chrysanthemin chloride crystals had previously been found to contain 1½ moles of water of crystallization[2,3]. No analysis for an air-dried sample was provided by Karrer and Pieper[1].

The data available[1,5] indicate conclusively that the anthocyanin from blackberry is a cyanidin-3-monoglucoside. Its identity with chrysanthemin would require that it be a β-glucoside. Confirmation on this point, however, appeared desirable in the light of results acquired in a study on the decolorization of berry fruit anthocyanins by fungal enzymes. It was found that the process involved, first, an enzymatic hydrolysis of the anthocyanin to anthocyanidin and sugar, and secondly, a spontaneous conversion of the aglucone into colourless derivatives[5]. Thus, if the blackberry pigment were actually a β-glucoside, the classical β-glucosidase of almond emulsin, which is capable of hydrolysing a variety of phenolic β-glucosides[6], would be expected to be an effective decolorizing agent. Emulsin, nevertheless, was found to have no measurable decolorizing action on blackberry anthocyanin.

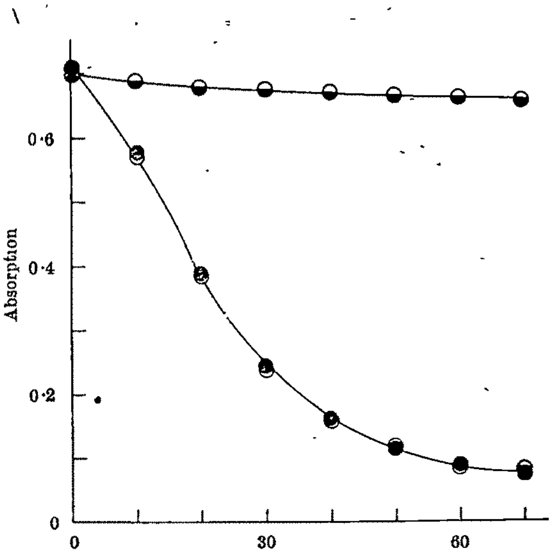

Fig. 1. Effect of anthocyanase *CN* 558 and emulsin β-glucosidase on blackberry anthocyanin and synthetic chrysanthemin. Each optically calibrated tube contained 1·10 μmole pigment and enzyme in 5 ml. of 0·045 *M* sodium lactate buffer at *p*H 3 95. The tubes were incubated at 30° C. and readings of the absorption at 510 mμ made at intervals as indicated. ⊙, Synthetic chrysanthemin and 1 mgm. of *CN* 558; ●, blackberry anthocyanin and 1 mgm. of *CN* 558; ◒, either pigment and 1 mgm. emulsin. Under the same conditions of enzyme, substrate and buffer concentration, hydrolysis of salicin by emulsin was 42 per cent. in 60 min.

It was possible to resolve the nature of this apparent discrepancy when a specimen of synthetic cyanidin-3-β-monoglucoside chloride became available. Equimolar quantities of the synthetic pigment and the blackberry product were each subjected to the action of anthocyanase *CN* 558 and of almond emulsin respectively. Both samples were dried at 50° C. *in vacuo* for 24 hr., and used in the anhydrous state. The enzyme preparations and experimental conditions were the same as those described previously[5]. The results are summarized in Fig. 1. The curves for the decolorization of the natural and synthetic pigments by *CN* 558 are evidently identical. They demonstrate conclusively, therefore, that the blackberry anthocyanin is chrysanthemin. Differences in crystal form and amount of water of crystallization noted earlier are consequently of minor importance. Furthermore, Fig. 1 shows that neither sample is attacked by emulsin. Lack of hydrolysis is accordingly a manifestation of the inherent specificity of emulsin β-glucosidase, and need not be taken as indicating the possibility that the glucosidic linkages in the substrates might be in the α-configuration.

I thank Sir Robert Robinson for the gift of a sample of synthetic chrysanthemin chloride.

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Blood Groups of Brazilian Indians (Carajás)

The Carajás Indians of Bananal Island, found by Golden[1] to include 51 per cent of persons of group *B*, are exceptional among South American Indians, who all belong to group *O*. The late Dr. E. M. da Silva died while working among the Carajás. He found the following distribution, in 113 of them:

$$O = 104; \quad A = 1; \quad B = 3; \quad AB = 5.$$

Such an incidence is impossible; but it shows that the Carajás do not possess a high percentage of group *B*. Golden, as well as da Silva, used slide methods, which are not suitable for testing anæmic people. Last July one of us (P. C. J.) went to the Carajás village and bled sixty-six Indians. The tests were made in our laboratory in Rio de Janeiro for the following blood-group systems: *ABO*, *Rh-Hr*, *MNS*, *P*, *Kell*, *Duffy*, *Lutheran* and *Lewis*. The complete results will be published elsewhere, after we have tested larger numbers of people; but two points are of special interest. The first is that all sixty-six Indians tested with anti-*A*, anti-*B* and anti-*AB* sera, by the minimum volume technique, belonged to group *O*. Using slide tests, we obtained doubtful results with the same bloods. This probably accounts for Golden and da Silva's results. The second point is related to the *Duffy* system: among fifty-five Indians we found twenty-three *Duffy* positives. This observation seems important, since it is contrary to the results of Pantin and Junqueira[2] among other Brazilian Indians, and it indicates a lower incidence than those obtained by Pantin and Kallsen[3], and several others working on North American Indians.

This work was made possible by the co-operation of the Serviço de Proteção aos Indios and the Brazilian Air Force, to which we are very grateful. We should like to thank Hetty Brendel, nurse at Bananal Island, for help in examining the Indians.

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The *Diego* Blood Factor

In 1953 a new low-incidence blood factor, *Diego* or Di^a, responsible for hæmolytic disease, was described with the aid of an antibody produced by a mother living in Caracas, Venezuela[1,2]. The antibody, anti-Di^a, reacted with the blood of the affected child (propositus) and two of the three siblings of generation IV. The blood factor was also present in the father and three of his six siblings of generation III. The factor was transmitted to them by the paternal grandmother (generation II) of the propositus, who received it from her mother of generation I. The factor was present in the blood of nine out of twenty-nine members of the Diego family tested.

The antibody reacted only in the indirect antiglobulin test to a titre of 1 : 512. Anti-Di^a failed to react with the red cells of a thousand group *O* individuals living in the United States—mainly caucasoids.

Study of the antigens for Di^a, *ABO*, *MNSs*, *Rh*, *Kk*, Fy^a, Jk^a, Le^a and *P* in this family failed to reveal obvious linkage. Nor was there any linkage to the sex chromosome.

More recently, it became possible to demonstrate that Di^a was serologically independent of seven other low-incidence blood factors (Mi^a, *Ven*, *Ca*, Be^a, Wr^a, By^a, *Rm*) among the twelve listed by Hart, Bosman and Van Loghem[3]. (Levine and Robinson demonstrated duplication in the list of the Dutch investigators because V^w was shown to be identical with Mi^a (Miltenberger).) The factor was also independent of the following: C^w, C^x, E^w, *He* and *V*. Nor was there any demonstrable serological or genetical relationship to such high-incidence blood factors as *H* (for group *O*), *U*, *Vel* or Tj^a. These facts could be established in tests with the rare essential antibodies and selected test cells preserved in the frozen state.

In the course of the studies of the four generations of the Diego family, it was observed by Layrisse and Arends that some of them showed physical features indicative of admixture with native Indians. Accordingly, studies were carried out on caucasoids and Indians living in Venezuela[4]. The results of their tests on the Venezuelan Indians have been briefly discussed by Layrisse, M., and Arends, T. ("A High Incidence Blood-Group found in Venezuelan Indians" (in the press)). These findings, including those with the thousand caucasoids of the United States and forty-eight Indians of Brazil[5], are presented in Table 1.

Table 1. Incidence of Di^a

Population tested	No. tested	No positive	Per cent positive
Caucasoid, United States	1,000	0	0
Random, Caracas	266	6	2·3
Random, Barcelona, Venezuela	61	2	3·3
Caribe Indians—Cachama	121	43	35·5
Arawaco Indians	152	8	5·3
Mixed Negroes, Venezuela	150	11	7·3
Kainganges Indians, Brazil	48	26	54·2

The studies with Venezuelan population were made by Layrisse, Arends and Sisco[4]. The anti-Di^a serum for the study of the Brazilian Indians was made available to Fernandez *et al.*[5] by Dr. Layrisse.

Among the forty-nine individuals in the Aribe group of the Caribe Indians, there were two large families many of whom were Di^a-negative, and Layrisse *et al.*[4] offer this as an explanation for the lower incidence of Di^a as compared to that of the Cachama group. Among the 170 members of both groups all but one were in group *O* and all were *Rh*-positive.

The occurrence of the blood factor in caucasoids of Venezuela is apparently indicative of admixture with native Indians characterized by a high incidence of the blood factor. Di^a may not be completely absent in the caucasoid population free from admixture with Indians, since a second example of anti-Di^a was recently found in the serum of a mother of an infant with hæmolytic disease (Levine, P., and Stroup, M., unpublished observations). The specimens, submitted to the Ortho Research Foundation by Witebsky and Rosamilia, were derived from a Polish family living in New York State, and there is no reason to suspect an Indian origin for the blood factor shown to be present in the father's blood and also present in the affected infant's coated red blood cells.

These findings indicate that a factor of extremely low incidence in a general population may have a much higher incidence in other population groups. To a lesser degree this applies also to other blood factors, such as the well-established differences in incidence of type Rh_0 in caucasoids and African negroes. The point at issue here is the usefulness of the term 'low incidence' to characterize certain blood factors. 'Low incidence' is preferable to 'family' or 'private', and the term is still helpful because it characterizes the first observations made with a particular blood factor.

Most significant is the occurrence of a high incidence of matings incompatible for a particular blood factor capable of causing hæmolytic disease in a population which is almost exclusively *Rh*-positive[4]. It can be safely predicted that, in the Caribe Indians or in any population with a high incidence of incompatible matings for Di^a, this factor may play a part in causing hæmolytic disease comparable in importance to the $D(Rh_0)$ factor in caucasoids provided that the two factors have the same degree of antigenicity.

If the genetically related Di^b and anti-Di^b exist, the antibody should be sought among the homozygotes of genotype Di^aDi^a of the Caribe Indians.

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The *Diego* Blood Factor in Brazilian Indians

IT has been pointed out[1] that what appears to be a rare, private or family antigen in one population may be fairly frequent in another. For example, the antigen which had sensitized an Amerindian woman so that she lost the child of her ninth pregnancy through erythroblastosis was found in the blood of her husband and of some of her children, but not in the blood of 794 other Amerindians, and it was therefore considered to be rare. However, when tested with the blood of Caucasians, the antibody could be shown just to be anti-*Kell*, the *Kell* factor being quite frequent in the Caucasian sample.

An analogous situation also involving Amerindians and Caucasians is provided by the *Diego* factor recently described by Levine, Koch, McGee and Hill[2]. This factor, discovered to be the cause of an erythroblastosis case in a Venezuelan family, was first considered to be rare because two hundred whites tested in the United States were all negative. However, Layrisse, Arends and Sisco[3], testing 266 people from Caracas and 61 from Barcelona (Venezuela), found 6 (2·3 per cent) and 2 (3·3 per cent), respectively, to be *Diego*-positive, and they ascribed this finding to Indian admixture. Testing two groups of Caribe Indians—121 in Cachama and 49 in Santa Clara of Aribi—they found 43 (35·6 per cent) *Diego*-positives in the first group and 7 (14·3 per cent) in the second. In addition, 8 (5·3 per cent) *Diego*-positives were found among 152 Guajires Indians belonging to the Arawco group.

We had the opportunity of testing two groups of Brazilian Indians with the anti-*Diego* serum using the anti-globulin method. The first group of 48 Kaingángues, living in a reservation near Palmas, State of Parana, included 22 (46 per cent) which gave a positive reaction. The second group consisted of 36 Carajás living at Santa Isabel, Bananal Island, among whom 13 *Diego*-positives (36 per cent) were found. Both groups of Indians belong to the linguistic family of the Ge and live some 1,100 miles apart.

If the *Diego* factor, as at present seems possible, is universally common among Amerindians and absent or mostly absent among whites, it might provide some indication of the degree of Amerindian admixture in many American populations. Studies of its infiltration and of the resulting antigenic incompatibility might also be rewarding.

Thanks are due to Dr. M. Layrisse for a gift of anti-*Diego* serum and to Dr. J. Dausset for its transport.

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Absence of Abnormal Hæmoglobins in some Australian Aboriginals

WHEN the sickle cell trait was found to be present in a number of Veddoid communities of southern India[1], it was also found that their rhesus chromosome distribution showed features differing from those of other Indian populations, and that it was more like those found in South-East Asia, Australasia, and especially in the Australian aboriginals. We therefore examined seventy-two Australian aboriginals for the presence of the sickle cell trait, but found that none of them showed this abnormality[2]. Since then, other abnormal hæmoglobins besides the sickle cell hæmoglobin have been discovered. One of them, hæmoglobin *E*, was found in the Veddas of Ceylon[3], and while the presence of sickling was confirmed in those Veddoid populations of India in whom it had been originally described, several other Veddoid populations[4]—including the Veddas themselves[3]—were found to be free from sickling. We decided, therefore, to examine once more Australian aboriginals, this time for the presence of hæmoglobin *E*.

We collected blood from a hundred and sixty-six aboriginals in Queensland; a hundred and forty-eight were of unmixed Australian ancestry according to their own accounts and also to their appearances. Of the others, seventeen had some European, one some Indian, and one some Chinese forbears. The bloods of fifty-five were collected on a visit to the Mona-Mona Mission, of fifty-five from a mission near Daintree, and of fifty-six from one near Yarrabah. The blood was taken under sterile conditions and arrangements were made for speedy transport with cooling on the way, so that the specimens were examined in London less than ten days after they had been obtained in Australia. All bloods were submitted to filter-paper electrophoresis. A barbitone buffer of *p*H 8·6 and of ionic strength 0·05 was used. All hæmoglobins moved as a single band in the position of normal adult hæmoglobin controls. Hence not only did these Australian aboriginals not carry hæmoglobin *E*, but also the presence of all other known abnormal variants of adult hæmoglobin could be excluded as well.

It is still too early to assess the extent to which the distribution of sickle cell hæmoglobin and of malarial infection are related[5]. It would be even more premature to speculate on the correlation of the distribution of malaria with that of other hæmoglobins such as *E*. Nevertheless, it is noteworthy that malaria is thought to be a recent importation into the Australian mainland, and that its aboriginals, unlike most of the older populations of tropical Africa and Asia, do not seem to possess multiple hæmoglobins.

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Stability of Iso-alleles

THE high stability of most genes when kept under natural conditions is deduced from the relative rarity of spontaneous mutations which produce striking deviations from normality. The existence of wild-type iso-alleles, that is, of different alleles usually causing the same normal phenotype although distinguishable by their effects under special conditions, raises the question whether mutations from one iso-allele to another are more frequent than mutations with more obvious new effects.

In order to obtain relevant data, males of a wild-type ('Canton-*S*') stock of *Drosophila melanogaster*, which had been made isogenic some time before the experiments, were crossed to homozygous $ci\ ey^R$ females (ci = cubitus interruptus, ey^R = eyeless-Russian; both located in chromosome 4). The resulting $F_1\ ci\ ey^R/+\ +$ individuals were expected to have uninterrupted fourth veins in their wings, since the Canton wild-type allele, $+^C$, is dominant over the ci allele. In case a mutation had occurred, from $+^C$ to an iso-allele of the type of $+^3$ which has reduced dominance[1], the appearance of interruptions on the wings would have been expected, the frequency of this event being dependent on the penetrance of the new '$ci/+^x$' genotype. Similarly, iso-alleles of ci might have been expected which would give vein interruptions in a new genotype '$ci^y/+^C$'.

More than 31,000 F_1 flies were raised, partly at 26° C. and partly at 18° C., the lower temperature providing a more sensitive environment in view of the known increasing penetrance and expressivity of the ci phenotype with decreasing temperature. Most of the F_1 flies had normal venation, but five females and fifteen males had the very weak ci or ci-like phenotype of class 1[2], characterized by localized thinning of the cubital vein (Table 1).

Table 1 F_1 FROM $ci\ ey^R/ci\ ey^R$ × CANTON ♂♂

	Normal		*ci*-like	
Temp.	♀♀	♂♂	♀♀	♂♂
26°	9,745	9,236	2	8
18°	6,669	5,392	3	7

Seventeen of these twenty possibly mutant flies were individually tested in crosses to flies homozygous or heterozygous for $ci\ ey^R$. (The other three individuals left no progeny.) Sixteen of the seventeen flies did not produce any further non-eyeless ci-type offspring. The deviant parents had apparently unchanged $ci\ ey^R/+^C+$ genotypes, and their ci or ci-like phenotype was simply an expression of rare penetrance of ci in $ci/+^C$ heterozygotes. The seventeenth individual, a female, proved to have been heterozygous for a new recessive mutant allele similar to the ci mutant employed in these crosses but with peculiarities in expression of its own, notably frequent interruptions in the inter-crossvein section of the fourth vein. This new ci mutant had arisen from the $+^C$ allele.

There is thus no evidence among some 31,000 tested gametes for mutation from $+^C$ to a recognizable wild-type iso-allele, or from ci to a recognizable mutant iso-allele, in contrast to the finding of a typically deviant ci mutant from $+^C$. It must be added, however, that at the temperatures used, incomplete penetrance could have kept a considerable fraction of wild-type iso-alleles from phenotypic expression.

A priori, no close relation between type of effect and frequency of mutation should exist. The limited experiments reported here agree with this expectation.

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Bulinus (Pyrgophysa) forskalii (Ehrenberg) as a Vector of *Schistosoma haematobium*

In a recent communication, McCullough[1] stated that although the snail *Bulinus* (*Pyrgophysa*) *forskalii* was known to be a vector of urinary bilharzia in the Gambia and in Mauritius, there was no direct evidence that it acted in a similar capacity in the Gold Coast; moreover, snails of that species collected in the Gold Coast were wholly resistant to experimental attempts to infect them with the miracidia of the causative organism, *Schistosoma haematobium.*

It seems appropriate to try to throw light on some aspects of this recurrent problem. First, no laboratory infection experiments can ever show beyond doubt that a species of snail is or is not a vector of a certain schistosome. Only by the finding of 'wild' snails shedding cercariæ and the infection of definitive hosts by those cercariæ, with the subsequent recovery and identification of the adult worms, can the role of a mollusc vector be established. Secondly, the apparent difference in receptivity to infection of a snail species in different countries can only be analysed when the identity of the snails is established beyond doubt. McCullough quotes his own work in collaboration with Duke[2] in the Gambia and that of Adams[3] and Cowper[4] in Mauritius to show that *B. forskalii* is a vector in those areas. In the first case, the evidence is largely epidemiological; but in the second, successful infection experiments were carried out. McCullough admits the possibility of separate and distinct species of snails being involved in the Gambia, Mauritius and the Gold Coast; but he maintains that if this is so, the differences between them have not been recognized.

So far as the Gambia is concerned, Smithers (in the press) has shown that the vector identified by McCullough and Duke as *B. forskalii* is in fact a different species which was identified by Mandahl-Barth as *B. senegalensis* Müller. My own observations (Wright, in the press) confirm the conclusion that the vector in the Gambia is a species distinct from *B. forskalii*; but I tentatively identify it with *B. ludovicianus* (Mittre). It is only by further taxonomic work, which is now in progress, that this difference of opinion can be resolved; but there can be no reasonable doubt that the important vector in the Gambia is not *B. forskalii* (which also occurs in that area) but another *Bulinus* which can be differentiated from it on both morphological and ecological grounds.

The evidence of Adams and Cowper from Mauritius rests also on an incorrect identification of the molluscan host. Specimens of Adams's material in the collection of the British Museum have been compared with the type series of *Bulinus cernicus* (Morelet), and there is no doubt that it is to this species that the Mauritian vector should be assigned. Adams states that his snails were identified by Connolly, who used the work of Germain[5], and it is this author who is responsible for the incorrect inclusion of Morelet's species in the synonymy of *B. forskalii.*

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Initial Absorption of Ions by Plant Tissue

Recent papers have stressed two aspects of the initial entry of ions into plant cells and tissue, namely, diffusion[1,2] and ion exchange[3,4]. It is important to realize that these processes are merely two aspects of the one system. Since the unity of the experimental facts may not be obvious, it is thought necessary to review some of the evidence, and to attempt to produce agreement amid apparent contradictions.

A proportion, depending on the medium concentration, *p*H, etc., of a piece of plant tissue is penetrated by both ions of a salt, such as potassium chloride, reversibly, in 20–40 min.[1,5]. The time depends on the geometry of the system[2,5]. The proportion of the tissue which appears to reach the external concentration in the initial uptake has been termed the 'apparent free space', a term originally due to G. E. Briggs. This varies from a few to more than 30 per cent[1,2,6]. Since the initial uptake and subsequent 'accumulation' are to a large extent independent, the vacuoles, which occupy a large proportion of the tissue volume, and into which the ions are finally accumulated, are thought not to be part of the apparent free space, which therefore includes intercellular spaces, cell-wall spaces and, very probably, some cytoplasm.

The dependence of the initial uptake and apparent free space on *p*H and concentration[3] of the medium is consistent with a Donnan equilibrium between the medium and a predominantly anionic phase in the tissue. The magnitude of the free space suggests that it includes some, if not all, of the cytoplasm as well as the aqueous phase associated with those cell-wall constituents which are anionic.

The mean concentration A of the Donnan (indiffusible) anions in the free spaces has been estimated[2] to be between $0 \cdot 006 M$ and $0 \cdot 04 M$ in maize and bean roots, depending on the age of the tissue. From measurements of the phase-boundary potential differences, Vervelde[7] estimated the surface of the roots of barley, oats, etc., to have the equivalent of $0 \cdot 02$–$0 \cdot 06 M$ of immobile anions at *p*H 5·5.

At external concentrations C_0 (of a single salt) comparable with or higher than A, the equilibrium concentration of mobile anions and balancing cations (C_i) in the cytoplasm is appreciable: for example, if $A = 0 \cdot 01 M$ and $C_0 = 0 \cdot 01 M$, $C_i = 0 \cdot 0062 M$. In addition to this diffusion of ions of both signs when $C_0 \geqslant A$, external cations will exchange with those initially paired with the immobile anions of the free space. This effect, as can be seen from Fig. 1, becomes increasingly important in comparison with the entry of ion pairs at external concentrations less than A: for example, if $A = 0 \cdot 01 M$ and $C_0 = 0 \cdot 001 M$, $C_i = 0 \cdot 0001 M$. This accounts for the conclusion by Scott Russell and Ayland[4] that diffusion in their experiments was unimportant compared with ion exchange.

In the Donnan system envisaged for the cytoplasm of the free space, cation exchange will depend on the affinity of the immobile anions (proteins and others) and the exchanging cations[4]. The specificity of binding found by Epstein has lately been referred to the ion carriers of accumulation[8] and not to the initial uptake. Exchange between anions adsorbed to cytoplasmic indiffusible cations and anions from the medium is unlikely. At *p*H 7, dissociation of the acidic groups of the surface of the protoplast is complete and cationic groups are unlikely to exist, as shown by electrophoretic studies (McLean, personal

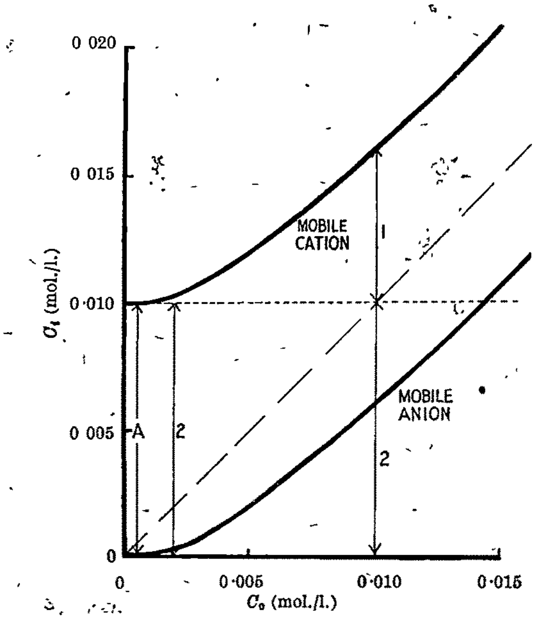

Fig. 1. Concentrations of mobile anions and cations in a Donnan phase with concentration of immobile anions A = 0·01 mol./l. plotted against external concentration C_0. The dotted line represents equality of concentration. The portions 1 and 2 of the total mobile cation concentration are those diffusible and potentially exchangeable respectively

communication). In any event, the initial uptake of anions is much less than that of cations[5], consistent with a Donnan equilibrium.

The time of equilibration in the initial uptake[2], the potential-difference drifts with time when tissue encounters a new concentration[1] and the time to reach a new level of respiration on adding salt are all consistent with the absence of a high-resistance membrane at the cytoplasmic surface. Vervelde[7] also stresses the three-dimensional nature of the equilibrium.

The cation exchange and apparent free space would depend on any metabolic changes in the cytoplasm which influence the concentration of immobile ions A. Butler[6] found that 2,4-dinitrophenol increased the apparent free space of wheat roots for the chloride ion from 24 to 34 per cent. Scott Russell and Ayland[4] found a reduction of cæsium ion uptake (exchange) in the presence of dinitrophenol. Both effects may be consistent with a lowered A.

It is concluded that the hypothesis of a complex Donnan system can account for most of the observations on the initial absorption of ions by plant cells. In addition to this system, a process dependent on respiration must be postulated to explain the subsequent irreversible absorption (accumulation) probably into the vacuoles.

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Effect of Streptomycin on *Acetobacter capsulatum* and its Associated Dextran–Dextrinase Enzyme System

In an earlier publication[1], we have reported that *Acetobacter capsulatum* N.C.I.B.4943 failed to grow in a yeast extract - glucose medium containing 1 μgm. per ml. of streptomycin sulphate. More recently, we have found that *A. capsulatum* is sensitive to 1 μgm. per ml. of streptomycin sulphate at *p*H 4·5 and to 0·01 μgm. per ml. at *p*H 6·5 during 48 hr. incubation at 25° in the same medium. The effect of *p*H on antibiotic activity is already well recognized; but the extreme intolerance of *A. capsulatum* to streptomycin would seem to be unusual and worthy of note.

We have previously suggested[1] that this high sensitivity of *A. capsulatum* might be related to the fact that the organism is remarkable in its ability to convert dextrin into dextran[2], and in view of the fact that Barker, Bourne, Stacey and Ward[3] have shown that streptomycin inhibits certain carbohydrate-synthesizing and degrading enzymes, we have examined further the effect of streptomycin on *A. capsulatum* dextran–dextrinase.

Experiments have been based on the observation that there is a linear relation between relative viscosity and concentration of *A. capsulatum* dextran in 0·5 *M* acetate buffer (*p*H 4·6) between 0·0 and 1·0 mgm. per ml. At *p*H 4·6, the addition of streptomycin (1 per cent w/v) had no effect on the synthesis of dextran by the isolated enzyme[2] with a substrate concentration of 1 per cent w/v, the ratio of inhibitor to substrate being comparable to that used by Barker *et al.*[3]. Attempts to detect inhibition of the enzyme system at *p*H 6·2 failed, as no enzyme activity could be detected at this *p*H value in the absence of streptomycin. Since the enzyme is not active at the higher *p*H (the optimum *p*H for growth of *A. capsulatum*), it may be concluded that inhibition of the growth of *A. capsulatum* by streptomycin is not due to disturbance of its dextran–dextrinase enzyme system. Further, we have shown that this enzyme is extracellular, and would therefore not be expected to play a vital part in the development of the organism under normal conditions of growth. On this basis, it would appear that streptomycin affects a more fundamental metabolic process of the organism; further work is in progress.

We are grateful to Dr. T. K. Walker for his continued interest.

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Evidence for the Presence of Noradrenaline in Submicroscopic Structures of Adrenergic Axons

The presence of sympathomimetic activity in adrenergic nerve tissue has been demonstrated by several authors[1]. The active substance later was shown to possess the characteristic biological and chemical properties of noradrenaline[2]. A comparison of the relative contents of noradrenaline in splenic nerves (10–20 μgm. per gm.) and the spleen (2–4 μgm.

per gm.) suggests that the transmitter is accumulated in the terminal parts of the nerves. Certain substances, such as acids, detergents and digitonin, which release catechol amines from adrenal medullary cell granules[3], also release the adrenergic transmitter from a perfused organ[4]. Moreover, since the adrenergic nerves may be regarded as homologues of the adrenal medullary cells, it may be expected that their specific action substance is similarly stored.

In order to test this hypothesis, experiments have been undertaken involving catechol analysis of granular fractions of homogenized splenic nerves of the ox and splenic tissue from ox and rat. Noradrenaline was estimated biologically and its identity checked by paper chromatography. Histamine was also determined in some cases.

The nerves were cut into 2–3 mm. pieces and homogenized in 15–50 ml. 0·3 *M* sucrose in a Waring blendor for 1 min. at 40,000 r.p.m. After centrifugation in an angle centrifuge for 6 min. at 800 *g*, the upper part of the homogeneous supernatant, free from visible sediment, was again centrifuged for 60 min. at 6,800 *g* at + 12° C. The small amount of sediment was suspended in 5–7 ml. water to which 0·2 ml. of 0·5 *N* sulphuric acid was added. The results of five experiments are given in Table 1.

Table 1

No.	Total amount of noradrenaline (μgm./gm. nerve)	Per cent of total noradrenaline activity in sediment	Total amount of histamine (μgm /gm. nerve)	Per cent of total histamine activity in sediment
N 1	—	19	—	—
N 2	—	19	—	—
N 3	—	18	—	< 2
N 4	9·1	17	82	< 2
N 5	8·8	15	105	< 2

Of the total activity found in the supernatant after the first separation, 15–19 per cent was present in the sediment after the second centrifugation as seen in Table 1. The sediment contained only very fine granules, less than 1 μ in diameter, but no fibre structures. No granules visible with light microscopy were found in the supernatant after the second centrifugation. The granules of the sediment apparently had a high density, since they were separated and packed well on centrifugation. The noradrenaline content of the small volume of the supernatant present in the sediment accounted for less than 10 per cent of the amount found in the granular sediment. Resuspension and washing the sediment with 0·3 *M* sucrose did not alter the results.

The total noradrenaline figures of the nerve homogenate were determined in two cases and found to be 8·8 and 9·1 μgm./gm., which agrees with previous estimations[2]. Secondary adsorption of noradrenaline on the granular sediment seems unlikely, since sediment obtained in the same way from liver did not take up noradrenaline from a 0·3 *M* sucrose solution.

In two experiments the histamine content of the supernatant and the sediment was also estimated. The total amount in the homogenate was 82 and 105 μgm./gm., in agreement with previous findings[5]. Of this, less than 2 per cent was found in the sediment, which is evidence against histamine being a constituent of the same granular fraction as contains noradrenaline.

In nine experiments the noradrenaline content was determined in the corresponding fractions of ox spleen homogenized by the Potter–Elvehjem method. The homogeneous supernatant was recentrifuged once or twice. The sediment contained 16–44 per cent of the total activity, on an average 32 per cent. Similar results were obtained in five experiments with rat spleen (14–29 per cent, average 23 per cent).

While the experiments reported here have demonstrated the presence of noradrenaline in a readily sedimentable granular fraction from adrenergic nerves, analogous to the form of storage found in the chromaffin cell, detailed statements as to the nature of these particles must await further experiments. Histamine, although present in large amounts in the adrenergic nerves of the ox, is not present in these structures.

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Simultaneous Recording of Inspired Oxygen Concentration and Peripheral Tissue Oxygenation

It is often of great convenience in physiological work to secure continuous rather than intermittent records of the variables under investigation. Recently an apparatus was described for analysing continuously the gas mixture presented to infants undergoing treatment in nursery incubators[1], and an extension of this principle has now been used in some animal experiments with the view of examining the response of the organism to changes in oxygen content of its inspired air. By a combination of such records it should be possible to derive an estimate of the minimal change in inspired oxygen which will produce a significant change in the peripheral tissues of the animal or infant.

The method employed for measuring oxygen tension in the tissues is a development of the polarographic techniques introduced by Davies and Brink[2], and afterwards extended by Montgomery and his co-workers at the University of Philadelphia[3]. The electrodes used are a cathode of 0·005 in. diameter platinum wire, insulated except for a length of about 0·5 mm. near the tip with 'Diamel' enamel, and a non-polarizable anode of 0·01 in. diameter silver wire electrolytically coated with silver chloride[4]. (When suitably applied, 'Diamel' enamel gives a tough yet flexible high-resistance insulating coating to the wire.) These electrodes were inserted through truncated hypodermic needles for a distance of about 2 mm. through the skin of a rabbit's back. The points of insertion were coated with collodion, and the area covered with transparent plastic tape. The rabbit, anæsthetized with 'Nembutal', was placed

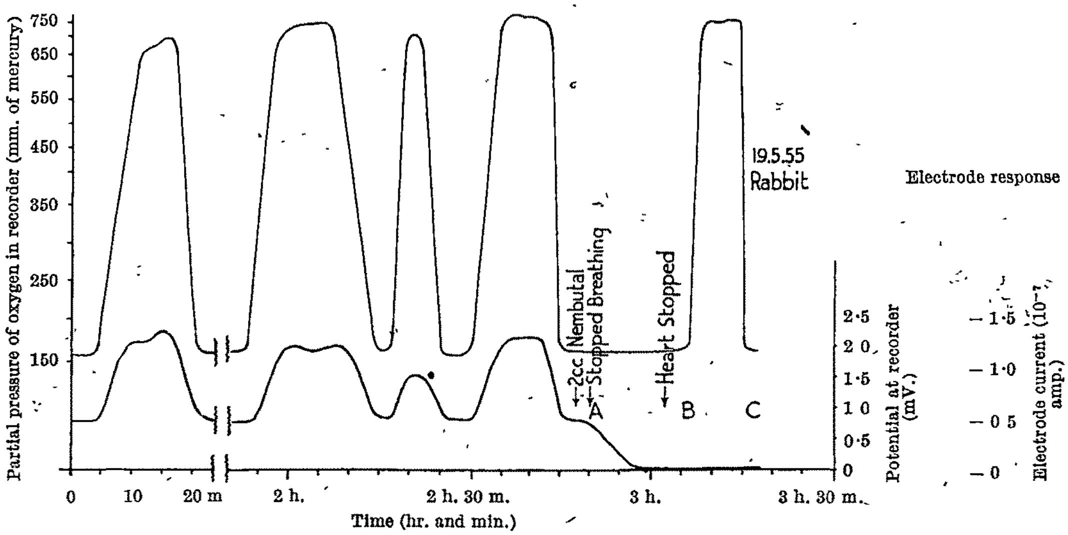

Fig. 1. Upper curve: oxygen partial pressure in the chamber: recorded by the magnetic oxygen meter. Lower curve. simultaneously recorded subcutaneous oxygen-electrode currents

in a closed chamber into which varying mixtures of oxygen and air could be admitted from gas cylinders. The oxygen content of the gas in the respiration chamber was recorded by means of a magnetic instrument, based on that of Naumann[5] but designed to record continuously from zero to 100 per cent oxygen concentration at or near atmospheric pressure (Kay, R. H., and Hobson, A., unpublished). Simultaneously, the polarographic current passing between the electrodes when an e.m.f. of 0·6 V. was maintained across them was amplified and recorded. The final display was an Elliott six-channel potentiometer recorder, inspired-oxygen concentration being fed to the even-numbered channels, polarographic electrode currents to the odd. Fig. 1 shows a record obtained in a typical experiment.

It was necessary to be sure that the oxygen tension registered by the electrodes was determined by the circulation and not by diffusion across the skin of the rabbit. This is shown by the last portion of the curves in Fig. 1 where, on abolishing the rabbit's respiration by a large additional dose of barbiturate, it was possible to observe a fall in electrode current to zero when the rabbit was exposed to air (*A*), while a subsequent exposure to pure oxygen produced no rise in the tissue tension (*BC*).

To summarize briefly the results of these preliminary experiments, which were carried out at room temperature: (1) when the oxygen content of the inspired gas is varied cyclically between 21 per cent and 100 per cent (as in Fig. 1), the recorded tissue electrode current begins to rise or fall within one minute of the beginning of the rise or fall of concentration of the inspired oxygen. (2) The initial rate of change of both tissue-electrode current and concentration of inspired oxygen are usually closely similar, provided the latter does not change more rapidly than 1 min. to half-total change. (3) There is evidence that a rapid reduction (from 100 per cent) of inspired oxygen concentration is more quickly reflected in the tissue response than is a similarly rapid increase (from 21 per cent) of concentration of inspired oxygen.

The amplitude of the tissue-current response, corresponding to the five-to-one change in concentration of inspired oxygen, is usually of the order of three to one. This order of magnitude corresponds well with intermittent tissue-tension measurements by subcutaneous gas depots in animals[6].

Although it is extremely difficult to calibrate the electrode current in terms of absolute oxygen tension in the tissues (this is easy *in vitro*), nevertheless there is good reason for supposing that the changes recorded reflect the ratio of oxygen tensions under different conditions quantitatively.

Similar records have been obtained from monkeys with electrodes in the back and scalp, and it is proposed to use this technique on human subjects in order to study their response to inhaled oxygen. The method is now repeatable and safe. Detailed results will be published later.

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Autoradiographic Localization and Measurement of Intracellular Antibody, using Labelled Antigen

Following on work in which much indirect evidence implicated the plasma-cell as the site of antibody production[1], microscopic demonstration of antibody in plasma-cells was effected by a fluorescein-conjugate technique[2]. However, this method is limited to some extent by the difficulty in studying the morphology of antibody-containing cells, by the possibility of non-specific staining and by its inability to yield quantitative results. Further, since

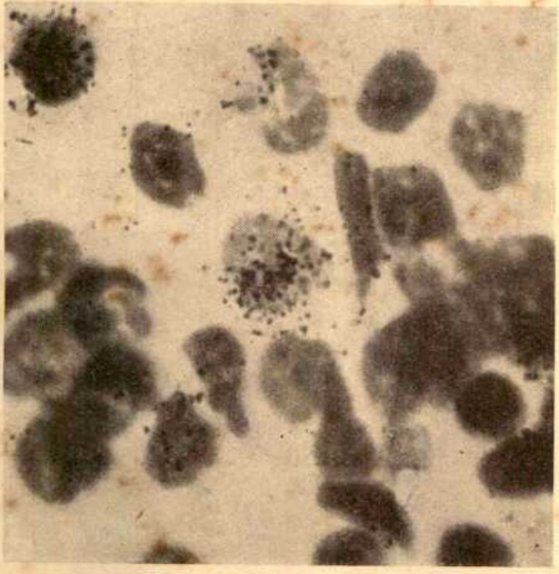

Fig. 1. Imprint of spleen showing fixation of labelled polysaccharide by certain cells. Kodak autoradiographic stripping film. Exposure 40 days. Stained with Leishman–Giemsa

this technique renders both antibody and antigen in tissues fluorescent, it would be difficult to exclude the presence of a small amount of antibody in the neighbourhood of persisting injected antigen.

In the present investigation, rabbits were immunized with a formalin-killed culture of a *Klebsiella*. Touch-preparations of spleen and lung on slides were fixed in 95 per cent ethanol at 37° C. for 30 min. The same organism was grown in a synthetic medium with sodium acetate - 1 - ^{14}C as the sole source of carbon. The polysaccharides were extracted[3] and had a specific activity of about 1 μc. per mgm. (kindly determined by Dr. A. S. McFarlane).

The touch-preparations were covered with labelled polysaccharide (0·1 mgm./ml. in saline) for 1–2 hr. at room temperature, and uncombined material washed off. Autoradiographs were made, with exposures of 30–40 days, and the preparations stained[4].

Radioactivity due to fixation of polysaccharide showed the presence of antibody in a proportion of cells. No evidence of radioactivity was seen over the many reticulo-endothelial cells present.

The number of silver grains over individual cells was counted and, since the specific activity of the polysaccharide was known, this enabled the amount of polysaccharide deposited per cell to be estimated.

From a sample of the serum of one rabbit, 1 mgm. of polysaccharide precipitated 4·2 mgm. of antibody. When the serum was dried, fixed in ethanol and re-dried in the same way as were the tissue preparations, the antibody suffered an eight-fold reduction in combining power. Accordingly, the amount of antibody per cell was calculated by multiplying the amount of polysaccharide deposited by 4·2 × 8. The result varied from 5 to 50 μgm. per cell. This would correspond to about 3–33 per cent of the protein of a cell of 1,000 μ^3 volume.

Although, owing to initially inadequate touch-preparation technique, the morphology of the antibody-containing cells is not clear, this method offers the possibility of correlating antibody content with cell morphology and with the level of circulating antibody. The production, storage and release of antibody may thus be studied quantitatively, and on a cytological level. The method may also be applied to the study of allergic states.

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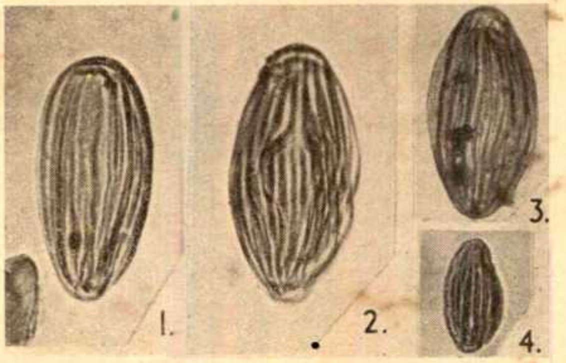
Pollen Grains of the *Ephedra* Type in Australian Tertiary Deposits

POLLEN grains with the same shape, approximate size-range and exine characters as those of *Ephedra* and *Welwitschia* have been found recently in certain Lower Tertiary deposits in south-eastern Australia. The pollen grains of *Ephedra* and *Welwitschia*[1] are characterized by the more or less prominent longitudinal ridges into which the exine is raised, and the structureless nature of the exine itself; but, whereas those of *Welwitschia* have a distinct germinal furrow, the pollen grains of most species of *Ephedra* have no furrow. The absence of a furrow from the Australian fossil pollen grains in question suggests that they are more closely related to *Ephedra* than to *Welwitschia*.

In the southern hemisphere the living species of *Ephedra* are restricted to South America, where they are most abundant in the Andes region of Bolivia and Paraguay; they also extend southward to Chile and Patagonia. The occurrence of pollen grains of the *Ephedra* type in Australian Lower Tertiary deposits, therefore, indicates that *Ephedra* was more widely distributed in the southern hemisphere during early Tertiary times than it is at present.

Fossil pollen grains of the *Ephedra* type have been recorded from: Post-glacial deposits and other sediments in Tierra del Fuego and Patagonia[2]; the Eocene Green River oil shales, United States[3]; Paleocene deposits in the Province of Hanover[4];



(1) Acetolysed pollen grain of *Ephedra nana*. × c. 600. (2)–(4). Pollen grains of the *Ephedra* type from Australian Tertiary sediments. × c. 600

Cretaceous deposits in Iraq, Nigeria and Venezuela[5]; and an Upper Eocene deposit in the United States[5].

The Australian pollen grains of the *Ephedra* type have been found in sediments situated near Launceston, Tasmania, near Nelson, Victoria, and near Lake Frome, South Australia, that range in age from Paleocene to Eocene. Their occurrence in these sediments is extremely sparse.

ISABEL C. COOKSON

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University of Melbourne.
Aug. 10.

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[1] Wodehouse, R. P., "Pollen Grains" (McGraw-Hill Book Co., N.Y.).

[2] Auer, V., *Acta Geog.*, **5**, 1 (1935). Auer, V., Salmi, M., and Salminen, K., *Ann. Acad. Sci. Fennicae*, A, **3**, 3 (1955).

[3] Wodehouse, R. P., *Bull. Torr. Bot. Club*, **60**, 479 (1933).

[4] Thiergart, F., *Jahrb. Reichsstelle f. Bodenforschung*, **61**, 109 (1942).

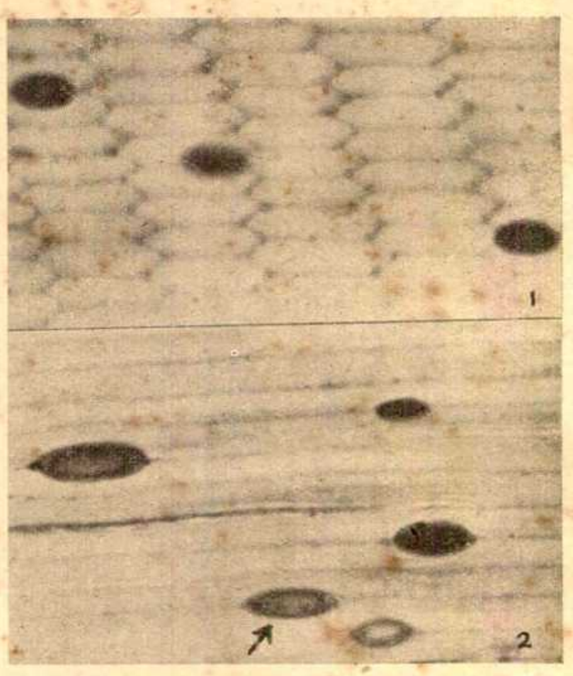
[5] Kuegl, O. S., Muller, J., and Waterbolk, H. Th., *Geolog en Mijnbouw*, **17**, 49 (1955).

Lipide (Sudan Black Positive) Corpuscles in the Bovine Lens

DURING the course of histochemical investigations on lipides in the adult bovine lens, I observed certain sudanophilic corpuscles which do not appear to have been previously described. These bodies were discovered because of their intense staining with sudan black *B* (and also with its acetylated derivative[1]), which was applied to frozen sections of thin lens slices that had been fixed in calcium chloride formol immediately after death. They are to be found in a restricted zone (1 mm. or so wide in the radial direction) which lies 2–3 mm. from the lens equator and extends a few millimetres on either side of the equatorial plane.

The bodies were present in all twenty bovine lenses examined; they lie between the lens fibres and are seemingly embedded in the cement substance, which also stains with sudan black. In equatorial sections they are found along the broad sides of the unequal hexagons which are characteristic for cross-sections of the lens fibres in this zone (Fig. 1). These corpuscles possess an ovoid form which is elongated in a direction concentric with the lens nucleus, as can be deduced by comparing their appearances in equatorial and meridional sections (Figs. 1 and 2). They vary considerably in size, with a length ranging from 2 to 15μ; but the larger forms are more frequent. Prolonged staining with sudan black *B* causes many of them to become intensely, almost homogeneously, blackened. When only lightly stained (for example, for 5 min. in a saturated solution of sudan black in 70 per cent alcohol at room temperature) a dense outer rim and a paler central core can be discerned in these structures. When sections of the lenses were cut parallel to the plane of an equatorial tangent, many of the corpuscles were seen to contain a fine, often crenated, filament forming an incomplete circle in the peripheral zone. This filament is only occasionally evident in meridional (Fig. 2) and equatorial sections. Sometimes, minute, strongly sudanophilic granules are present in the interior of the corpuscle (Fig. 2).

Once these corpuscles had been located with sudan black, it was then possible to submit them to other histochemical and tinctorial tests. Other fat stains, such as sudan IV and Fettrot 7*B*, coloured these objects in pale shades of orange. The usual chromatin stains, including the Feulgen reaction, were negative. After applying the periodic acid – Schiff routine the corpuscles were faintly positive; the performic acid – Schiff technique and direct Schiff reaction were both negative.



Frozen sections of the bovine lens. Fixation in calcium chloride formol. Stained with sudan black *B*. Both × 1,500.

Fig. 1. An equatorial section illustrating sudanophilic corpuscles and their relationship to the broad sides of adjacent lens 'hexagons'. The cement substance, in which the corpuscles appear to be embedded, is also sudanophilic.

Fig. 2. A meridional section. The relationship of corpuscles to the cement material and to the lens fibres is again evident. Several corpuscles exhibit a dense rim and paler core. One corpuscle (indicated by arrow) shows the coiled filament and minute granules described in the text

The nature and significance of these corpuscles remains, at present, obscure. One is struck by the resemblance which they bear to nuclei; this resemblance, however, is superficial, for their morphology, tinctorial and histochemical properties, together with their location between the fibres and their situation in a zone lying some distance from that of the true nuclei, all point very strongly against a nuclear relationship.

In view of the notorious ease with which artefacts can occur in microscopic sections of the lens, an attempt was made to eliminate this possibility. Fresh frozen sections of material preserved by freezing (– 80° C.) immediately after death were examined with the phase-contrast microscope; the corpuscles were well seen and their relationship to the cement material again confirmed. Examination with the polarizing microscope did not reveal birefringence.

Similar corpuscles were also observed in lenses from the cat and the dog. As I have been unable to find any previous reference to these structures, I should be most grateful for comments or additional information.

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Aug. 17.

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[1] Casselman, W. G. B., *Quart. J. Micr. Sci.*, **95**, 321 (1954).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 9

Association of Applied Biologists (joint meeting with the Society of Chemical Industry, Pesticides Group, in the Large Chemistry Lecture Theatre, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 10.30 a.m. and 2 15 p m.—Symposium on "The Resistance of Insects to Insecticides".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p m —Discussion on "The Efficient Use of Technical Personnel".

Society of Chemical Industry, London Section (joint meeting with the Food Group, at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6.30 p.m.—Mr. Rupert Car : "Management and Food Science".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Miss Freya Stark: "Some Minor Battlefields of Alexander in Asia Minor".

Tuesday, January 10

Institution of Chemical Engineers (joint meeting with the Chemical Engineering Group of the Society of Chemical Industry, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. H. F. Smith: "Explosions and Poisons—A Comparison of American and British Precautions".

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m —Mr. G. T. Winch: "Recent Developments in Photometry and Colorimetry".

Institution of Electrical Engineers, Education Discussion Circle (joint meeting with the Education Group of the Institution of Mechanical Engineers, at Savoy Place, London W C.2), at 6 p.m.—Discussion on "Teaching Electrical Engineering to Mechanical Engineering Students".

Institute of Metal Finishing, Organic Finishing Group (at the British Institute of Management, 8 Hill Street, London, W.1), at 6.30 p.m.—Mr. R. J. Brown and Mr. A. J. Birch: "Performance Testing of Paint Films".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. W. S. Hemp: "Some Modern Structural Problems".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting on "Hopes and Aims of the International Geophysical Year". Chairman: Sir David Brunt, F.R.S. Speakers: Dr. Lloyd V. Berkner and Sir Graham Sutton, F.R.S.

Royal Society of Medicine, Psychiatry Section (at 1 Wimpole Street, London, W.1), at 8 p.m.—Prof. L. S. Penrose: "The Prospects of Genetical Research in Mental Illness"; Dr. J. Fraser Roberts: "Some Preliminary Results of Two Surveys on Mental Deficiency"

Wednesday, January 11

Society for Applied Bacteriology (joint meeting with the Microbiology Group of the Society of Chemical Industry, at the Institution of Civil Engineers, Great George Street. Westminster, London, S.W.1), at 10.45 a.m.—Symposium on "Anaerobes".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Frank Dixey: "The East African Rift System".

Institute of Physics, London and Home Counties Branch (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. D. T. Germain-Jones: "Modern Methods of Geophysical Prospecting for Oil".

Antiquarian Horological Society (at the Science Museum, South Kensington, London, S.W.7), at 7 p.m.—Dr. Joseph Needham, F.R.S.: "Time Measurement in Ancient and Medieval China".*

Thursday, January 12

British Psychological Society, Industrial Section (in Room 424, Birkbeck College, Malet Street, London, W C.1), at 1 p.m.—Mr. A. Crawford: "The Study of the British Road User".

Physical Society, Low Temperature Group (in the Lecture Theatre of the Royal School of Mines, Prince Consort Road, London, S.W.7), at 3 30 p.m —Dr. H. M. Rosenberg: "The Fatigue of Metals at Low Temperatures".

Aslib (joint meeting with the Scientific Film Association, at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Sir Arthur Elton. "The Documentation of History by Film".

Royal Aeronautical Society (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Mr. N. E. Rowe: Presidential Address

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. B. W. Balls: "Liquid Flow Control".

Friday, January 13

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m —Geophysical Discussion—"Irregular Changes in the Rotation of the Earth". Chairman: Sir Harold Spencer Jones, F.R.S. Speakers: Mr. T. Gold, Dr. W H. Munk and Prof. S. K. Runcorn.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Principal Scientific Officer (with at least a second-class honours degree in metallurgy or physics or equivalent qualifications, and a sound knowledge of theoretical physical metallurgy) with the Industrial Group of the U.K.A.E.A., Research and Development Branch, Windscale, Sellafield, Cumberland, to lead a team engaged on the study of materials of interest associated with nuclear reactors—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1215 (January 10).

Mathematician/Statistician (with an honours degree in mathematics or statistics and some experience in the analysis of experimental data) in the Scientific Department at London H Q., for duties which include providing advice on scientific problems, design of experiments and analysis of experimental data obtained by scientists in the coalfields and involve some travelling—National Coal Board, Staff Department (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting SS/160 (January 12).

Assistant Lecturer (with an honours degree in agricultural botany or botany, and preferably some teaching experience) in Agricultural Botany—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (January 14).

Chemist (under 35, with a degree or equivalent qualification in chemistry, and preferably with training in physics or geology) in the Department of Research and Specialist Services, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which include routine and research work on soil fertility and on all related agricultural products and problems, and may necessitate periods of up to six months in the field on soil surveys—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (January 14).

Hospital Physicist (with a first- or second-class honours degree in physics and at least five years experience in the medical field, including radiotherapy), to take charge of a laboratory engaged in experimental and routine work for the medical staff—The House Governor, King's College Hospital, London, S.E.5 (January 14).

Assistant (with a degree in electrical engineering and preferably some research or industrial experience) in the Department of Engineering—The Secretary, The University, Edinburgh (January 15).

Lecturer, Grade II (graduate in mining with underground experience, and preferably with research experience) in Coal Mining—The Registrar, The University, Edgbaston, Birmingham 15 (January 16).

Physical Chemists (with a good honours degree) for work covering fundamental and applied research on coal (Ref. SS/140); and Scientific Technical Officers (with experience in physical or analytical chemistry) (Ref. SS/141)—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting appropriate SS Ref. No. (January 17).

Research Assistant (with a university honours degree, or equivalent, in botany) at the Department of Agriculture Cereal Station, Ballinacurra, Midleton, Co. Cork—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (January 17).

Chemist (with a good honours degree or equivalent) in the National Coal Board's Coal Survey Laboratory, Edinburgh, for analytical investigational work—The National Coal Board, Staff Department (Personnel), Hobart House, Grosvenor Place, London, S W.1, quoting SS/148 (January 21).

Lecturer or Senior Lecturer in the Department of Electronic Engineering, and a Lecturer in the Department of Electric Power Engineering—The Registrar, The University, Liverpool (January 21).

Lecturers/Senior Lecturers (2) in Geology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 21).

Lecturer (first-class honours graduate in mathematics, and preferably with a special interest in some branch of applied mathematics or in statistics) in Mathematics—The Registrar, College of Technology, Manchester 1 (January 23).

Assistant Lecturer (with an honours degree in agriculture or a pass degree in agriculture with a postgraduate diploma, or equivalent qualifications) in Agriculture—The Registrar, The University Reading (January 28).

Johns-Manville Senior Fellow in the Chemistry Department, to assist in research on autoclaved Portland cement—The Secretary, Marischal College, University of Aberdeen (January 31).

Lecturer or Senior Lecturer in Inorganic Chemistry at the University of Tasmania and Hobart Technical College—The Agent General for Tasmania, 457 Strand, London, W.C.2, or The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hobart, January 31).

Research Officer (recent graduate) with the Australian Leather Research Association, Lane Cove, near Sydney, New South Wales, Australia, for duties which will involve the study by chemical and physical means of the properties of tannins, other than wattle, in Australian native flora, or in exotics cultivated in Australia (principally *Pinus radiata*) with various eucalypts and mangroves as the subjects of subsidiary investigations—The Director, Australian Leather Research Association, c/o Mr. W. Ives, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C 2 (January 31).

I.C I. Research Fellows in Biochemistry, Chemistry, Engineering, Pharmacology Physics or Chemical Technology—The Secretary, The University, Edinburgh (February 13).

Regius Professor of Geology and Mineralogy in the University of Edinburgh—The Private Secretary, St. Andrew's House, Edinburgh 1 (February 18).

Abstractor (with a degree, higher national certificate or equivalent, and a knowledge of languages, particularly German)—The Assistant

Secretary, Ref. B 67, British Coal Utilization Research Association, Randalls Road, Leatherhead.

ASSISTANT LECTURER, Grade B (graduate of a British university) **IN INORGANIC CHEMISTRY**—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

ELECTRICAL ENGINEER (with a first- or second-class honours degree or equivalent in electrical engineering) at the Royal Aircraft Establishment, Farnborough, Hants, to work on research in and development of radio and other fuzing techniques for guided weapons and bombs—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.580/5A/TA.

ENGINEERS and **PHYSICISTS** (particularly with electronics), Senior Scientific Officer and Scientific Officer grade (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments, chiefly in the Weymouth and Portsmouth areas and home counties—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.344/5A.

ENGINEERS, MATHEMATICIANS and **PHYSICISTS** (with a first- or second-class honours degree or equivalent qualification) at the National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.661/5A/AA.

PROFESSOR OF CHEMICAL ENGINEERING—The Head, Department of Chemistry, University of Saskatchewan, Saskatoon, Sask., Canada.

SCIENTIFIC OFFICER, PHYSICIST (with a first- or second-class honours degree in physics or mechanical engineering), to assist in a group studying the effects of vibrations and impulse stresses on weapon assemblies—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.703/34.

SCIENTIFIC OFFICER (with an honours degree, preferably in engineering) for dairy engineering research, initially in connexion with machine milking—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/26.

SENIOR BIOCHEMIST (with experience in clinical chemistry or hormone assay), and a **BIOCHEMICAL ASSISTANT** (with some research experience) to work in a Clinical Research Laboratory—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

SENIOR PHYSICS MASTER—The Headmaster, School House, Cranbrook, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Fuel and Power: Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. North Western Division. By G. Hoyle. Pp. ii+29+5 plates. 2*s*. net. West Midland and Southern Division. By J. E. Henshaw. Pp. ii+29+2 plates. 2*s*. net. (London: H.M. Stationery Office, 1955.) [3110

Scottish Marine Biological Association. Annual Report, 1954–55. Pp. 40. (Millport, Isle of Cumbrae: Scottish Marine Biological Association, 1955.) [111

Discovery Reports. Vol. 27. Pp. 377–395+plates 20 and 21: Cestodes of Whales and Dolphins from the Discovery Collections. By S. Markowski. (Cambridge: At the University Press, 1955. Issued by the National Institute of Oceanography.) 12*s*. 6*d*. net. [211

Hospitals and the State: Hospital Organisation and Administration Under the National Health Service. Background and Blueprint (1). Pp. iii+44. (London: Acton Society Trust, 1955.) 4*s*. [311

Department of Scientific and Industrial Research. Methods for Detection of Toxic Gases in Industry. Leaflet No. 4: Benzine Vapour. Second edition. Pp. iv+5. (London: H.M. Stationery Office, 1955.) 1*s*. net. [311

The Principles of Argon-Arc Welding Aluminium. Prepared by P. J. Houldcroft. Pp. v+18. (London: British Welding Research Association, 1955.) 2*s*. 6*d*. [311

British Electrical and Allied Industries Research Association. Technical Report L/T 316: Polarization of Dielectrics by Slow Particles, 3. By H. Pelzer. Pp. 9. (Leatherhead: British Electrical and Allied Industries Research Association, 1954.) 7*s*. 6*d*. [311

Building Research Station Digest. No. 18 (revised October 1955). Smoky Chimneys. Pp. 5. (London: H.M. Stationery Office, 1955.) 3*d*. [411

British Rayon Research Association. Report of the Director of Research for 1954–55. (8th Annual Report.) Pp. 6. (Manchester: British Rayon Research Association, 1955.) [411

Ministry of Housing and Local Government; Department of Health for Scotland. (Alkali etc., Works Regulation Act, 1906, and Alkali etc. Works Orders 1928–1950. Alkali etc. Works Regulations (Scotland) Acts, 1906 and 1951.) Ninety-first Annual Report on Alkali etc. Works by the Chief Inspectors, 1954. Pp. 84. (London: H.M. Stationery Office, 1955.) 3*s*. net. [411

Royal Greenwich Observatory. Sunspot and Geomagnetic-Storm Data derived from Greenwich Observations, 1874–1954. Compiled under the direction of Sir Harold Spencer Jones, F.R.S. Pp. viii+106. (London: H.M. Stationery Office, 1955.) 25*s*. net. [411

Forestry Abstracts. Vol. 16, No. 4 (October 1955). Abstracts 3710–4856. Compiled from World Literature. Pp. 453–598. (Farnham Royal: Commonwealth Agricultural Bureaux, 1955.) 18*s*. [411

Department of Scientific and Industrial Research Chemical Research Laboratory. Safety Measures in Chemical Laboratories. Second edition. Pp. vi+22. (London: H.M. Stationery Office, 1955.) 1*s*. 6*d*. net. [511

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 661, Vol. 239 (3 November, 1955). The Functional Morphology of the British Ellobiidae (Gastropoda Pulmonata), with special reference to the Digestive and Reproductive Systems. By J. E. Morton. Pp. 89–160. 22*s* 6*d*. No 662, Vol. 239 (3 November, 1955): Studies of the Post-Glacial History of British Vegetation. 13: The Meare Pool Region of the Somerset Levels. By H. Godwin, F.R.S. Pp. 161–190. 9*s*. 6*d* (London: Royal Society, 1955.) [511

Physics and Philosophy. By Lord Cherwell. (Being the first Robert Grosseteste Memorial Lecture delivered on 21 May 1955, in the Chapter House of Lincoln Cathedral.) Pp. 21. (London: Oxford University Press, 1955.) 2*s*. 6*d*. net. [811

Other Countries

The Diffusion Technique for the Validation of Test Items (a New Method). By Md. Firdouse Khan. (First published as an article in the *Dacca University Studies*, Vol. 7, June 1951, Nos. 1 and 2.) Pp. 8. (Pathantooly, Chittagong: Mrs. K. A. Begum, B.T., 1955.) 3 annas. [3110

Western Australia. Geological Survey. Bulletin No. 108: The Geology of the Irwin River and Eradu Districts and Surrounding Country. By W. Johnson, L. E. De La Hunty and J. S. Gleeson. Pp. 131+6 plates. (Perth: Government Printer, 1954.) [3110

Smithsonian Miscellaneous Collections. Vol. 128, No. 8: A Review of the Upper Eocene Artiodactyla of North America. By C. Lewis Gazin. Pp. iii+96+18 plates. (Publication 4127.) Vol. 131, No. 1: Leading Operations of the Smithsonian Astrophysical Observatory, 1895–1955. By C. G. Abbot. Pp. 8. (Publication 4222.) (Washington, D.C.: Smithsonian Institution, 1955.) [111

United States Department of the Interior. Geological Survey Bulletin 1015-F: Geology and Coal Resources of the Henryette Mining District, Okmulgee County, Oklahoma. By R. J. Dunham and J. V. A. Trumbull. (A Contribution to Economic Geology.) Pp. iv+183–225+plates 21–24. (Washington, D.C.: Government Printing Office, 1955.) 1 dollar. [111

Colony of Mauritius. Annual Report of the Observatory Department for the year 1954. Pp. i+14. (Port Louis: Government Printer, 1955.) 25 cents. [111

Development of Seed Production and the Seed Trade in Europe. (Project No. 214.) Pp. 138. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1955.) 350 francs; 7*s*.; 1 dollar. [111

United States Department of Agriculture. Circular No. 964: The California Five-Spined Engraver: Its Biology and Control. By George R. Struble and Ralph C. Hall. Pp. 21. 15 cents. Technical Bulletin No. 1121: Effects of Certain Insecticides in Soil on Crop Plants. By Victor R. Boswell, W. J. Clore, B. B. Pepper, Clifford B. Taylor, Paul M. Gilmer and Robert L. Carter. Pp. 60. 30 cents. (Washington, D.C.: Government Printing Office, 1955.) [111

New Zealand Forest Service. Information Series. No. 13: Careers in Forestry. (Revised edition.) Pp. 8. No. 21: Woodsman Training. Pp. 12. No. 22: Technical Training in Forestry. Pp. 7. (Wellington: New Zealand Forest Service, 1955.) [111

New Zealand Marine Department: Fisheries Laboratory. Fisheries Bulletin No. 11: The Escapement of Small Fishes from Trawl Nets and Its Application to the Management of the New Zealand Snapper Fisheries. By R. Morrison Cassie. Pp. 100. (Wellington: Government Printer, 1955.) [111

United States Department of Commerce. Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12 and 24 hours. Part 11: North Carolina. Pp. ii+81. 45 cents. Part 12: Oregon. Pp. ii+106. 55 cents. (Washington, D.C.: Government Printing Office, 1955.) [111

Southern Rhodesia. Report of the Trustees and Director of the National Museums of Southern Rhodesia for the year ended 31st December, 1954. Pp. ii+20. (Salisbury: National Museums of S. Rhodesia, 1955.) [111

East Africa High Commission. East African Tsetse and Trypanosomiasis Research and Reclamation Organization. Annual Report, 1954–55. Pp. 62+2 plates. (Nairobi: East African Tsetse and Trypanosomiasis Research and Reclamation Organization, 1955.) [211

Biological Sciences Serial Publications: a World List, 1950–1954. Prepared under the Sponsorship of the National Science Foundation by the Science Division, Reference Department, Library of Congress. Pp. viii+270. (Philadelphia: Biological Abstracts, University of Pennsylvania, 1955. Published for the Library of Congress.) 2 dollars. [211

Clinic for Psychotherapy, Melbourne. Bulletin No. 2: Aspects of Psychotherapy. By Dr. C. Kent. Pp. i+6. Contributions to Modern Thought. No. 1: Head-Sensations and the Concept of Inhibited Growth. By Dr. C. Kent. Pp. 24. Series: Our Peace of Mind. No. 3: Repetition Compulsion. By Dr. C. Kent. Pp. ii+6. No. 5: Resistance Against Psychotherapy. By Dr. C. Kent. Pain. By Jane Kamm. Accident Proneness. By Dr. C. Kent. Aggression. By Dr. C. Kent. Pp. ii+30. No. 6: Another "Jill". By Jane Kamm. Aspects of Emotional Health. By Dr. C. Kent. Alcoholism. By Dr. C. Kent. On Headaches, and the Possibility of Inhibited Growth. By Dr. C. Kent. Pp. ii+30. Bulletin No. 1: Aspects of Love. By Dr. C. Kent. Pp. i+7. (Melbourne: Clinic for Psychotherapy, 1954 and 1955.) [411

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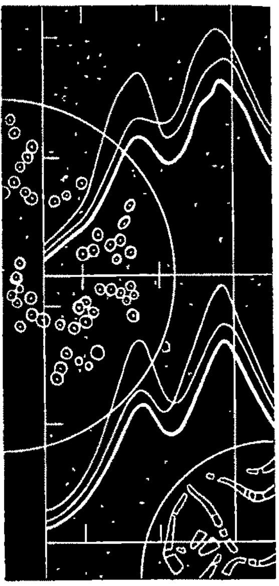

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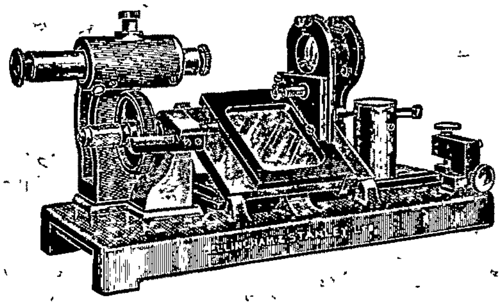

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SCIENCE, TECHNOLOGY AND MAN-POWER

THE report entitled "Notes on Science in U.S.A., 1954" recently issued by the British Commonwealth Scientific Organization, North America (see p. 76 of this issue), emphasized the continued preoccupation of the United States with problems of man-power and its increasing awareness of the challenge of the U.S.S.R. in this field. There is no doubt that Americans have been surprised by Soviet achievements, and this alone may result in an increased emphasis on the importance of fundamental science to the United States. More recently, Mr. Lewis Strauss, chairman of the Atomic Energy Commission, has expressed the opinion that the United States is rapidly falling behind the Soviet Union in training engineers and scientists, and that in ten years it might be hopelessly outstripped. The United States, he said, is turning out less than half the number of scientists and engineers it requires, and while there are about a million trained scientists and engineers in the Soviet Union and in the United States, only about 35 per cent of those in the United States are working at their profession. Last year the United States had about 23,000 science and engineering graduates compared with the Soviet Union's 53,000, and between 1950 and 1960 the Soviet Union was expected to produce 1,200,000 trained engineers and scientists compared with the United States 900,000. Moreover, 250,000–400,000 high-school students in the United States are being taught mathematics and science by teachers not trained to teach these subjects.

Such comparisons must be accepted with reserve and taken as indicating no more than trends, for the supply of professional personnel, and to a great extent its qualitative characteristics, depend upon the ability of an educational system to adjust itself to the changing needs of a society and upon the ability of that system to train a sufficient number of persons for a variety of specialized tasks. They depend, accordingly, both upon the nature of the educational system and upon the nature of the society which it serves. These must both be considered in attempting any comparisons of this kind, and even as between Great Britain and the United States figures can be very misleading if allowance is not made for such qualitative differences.

The difficulty is particularly acute in comparisons with Soviet Russia, and this is brought out well in the scholarly study of the availability and growth of the specialized man-power resources of the U.S.S.R. carried out by Mr. Nicholas De Witt under the auspices of the National Academy of Sciences—National Research Council, with the support of the National Science Foundation*. Mr. De Witt examines the evidence provided by the Soviet educational effort during the past twenty-five years which, because the type of training given aims definitely at preparing a specialist in a narrow field of professional activity, thus diminishing the opportunities of changing his professional occupation, is more useful for the purpose than the census enumeration or statistics of the employment of specialists. The Soviet policy of placing graduates in jobs coinciding with their field of formal training and their occupational specialities, and various totalitarian control measures, act in the same way.

Despite the pitfalls to which he directs attention, Mr. De Witt believes that it is possible to gain a fairly accurate idea of the general position in the Soviet Union; and apart from this his several chapters give clear and concise accounts of the general setting of the Soviet educational system—of primary and secondary education and of secondary semi-professional training—before he deals specifically with higher education and professional training, with research training programmes and advanced degrees and, finally, presents his conclusions on the supply and quality of Soviet professional and specialized man-power. It is these latter chapters that are of most interest to the scientist and technologist, and they are relevant to the current discussion on the expansion of technological education in Britain and the problems that are indicated in the report on the recruitment of scientists and engineers by the engineering industry which the Advisory Council on Scientific Policy has now released*. The earlier chapters, nevertheless, should not be overlooked. They bring out the major premises on which Soviet educational philosophy rests: the reliance on the central planning of education and research to advance science and technology; the belief that scientific and educational effort are primarily to be directed to the advancement of the national interests; and the static view of human life, of nature and of the universe, which leaves the teacher and the scholar with no further task than to demonstrate and apply established truth.

These premises go far to determine the strength or weakness of the Soviet man-power situation, and Mr. De Witt finds that in fact the expansion of professional training in higher educational establishments is not new and is unlikely in the future to be handicapped by a lack of satisfactory candidates from the secondary schools. Indeed, he expects a better and wider selection of candidates to be available in future; complaints, comparable with those voiced by some engineering firms in Britain, are already being made that school leavers are being directed to higher educational establishments when they should be directed to become skilled workers or craftsmen. It appears that there is a particular shortage of what would be termed in Britain technicians, and that a determined effort is being made to increase the numbers of such men.

---

* Soviet Professional Manpower: Its Education, Training, and Supply. By Nicholas De Witt. Pp. xxviii+400. (Washington, D.C.: National Science Foundation, 1955. Copies obtainable from U.S. Government Printing Office.) 1.25 dollars.

* Office of the Lord President of the Council. Advisory Council on Scientific Policy: Committee on Scientific Manpower. Report on the Recruitment of Scientists and Engineers by the Engineering Industry. Pp. 31. (London: H.M. Stationery Office, 1955.) 1*s*. 3*d*. net.

Mr. De Witt gives a fairly full general account of the thirty-three Soviet universities, which together have only accounted over the past twenty-five years for 8–12 per cent of the output of higher education graduates, most of whom come from the 758 institutes that give no general education and teach enough theory to permit the acquisition of applied knowledge in a given field. Thus they differ sharply from the basis on which even technical education is organized in Britain; but De Witt thinks it probable that in the universities the undergraduate chemist, for example, probably receives a training comparable with, but more extensive than, that in American universities, although there may be reservations on the teaching of selected topics. About half the Soviet students graduate with a major in the humanities and social sciences, and the other half with a science major. Moreover, there seems to be some correlation between academic performance and the positions to which graduates are assigned—the best going to research and those only average into school teaching.

Advanced degrees in the U.S.S.R. are obtained in research institutes as well as in regular higher educational establishments, and up to 70 per cent of them are obtained in scientific fields; while, even more than in the United States, those who acquire such degrees tend to remain in the academic field. Nevertheless, the ratio of professional technical workers in industry to production workers appears to have increased over the past twenty-five years by more than fourfold; and a substantial number of engineers are employed in administrative or managerial positions. Mr. De Witt suggests that in recent years the total number of trained engineers and the ratio of engineers to production workers in industry in the Soviet Union has been about the same as in the United States or even slightly higher. Likewise, the 160,000 scientists estimated as in the U.S.S.R. in 1952 is about four times as great as in 1930, and of these more than a third held advanced degrees.

When all allowance is made for the many reservations which Mr. De Witt emphasizes, he believes that higher education is more accessible in the United States than in the U.S.S.R., and for 1953 he gives the number of those with completed higher education as 5·8 million and 2 million, respectively. In engineering, medicine, agriculture and like fields, however, the U.S.S.R. had as many as, or even more trained men than, the United States: for example, about 500,000 professional engineers compared with 530,000 in the United States; about 280,000 physicians (but only 20,000 dentists) compared with 195,000 (and 90,000 dentists); and 170,000 agriculturists compared with 150,000. In proportion to the population, the number of trained professional men is lower in the U.S.S.R. than in the United States, but higher in relation to the workers not engaged in agriculture. Moreover, of the two million teachers, only about 37 per cent had completed higher educational courses, compared with 70 per cent of the 1·4 million teachers in the United States; and in 1952 there were only 90,000 teachers in higher educational establishments compared with 210,000 (in 1953) in the United States.

Figures such as these need to be kept in mind in comparing the man-power situation in the Soviet Union with that elsewhere, and its orientation primarily to the training of specialists in engineering, agriculture and medicine, and in considering the rather alarmist picture which Lord Simon of Wythenshawe presented recently in his annual report to the Court of the University of Manchester. At present, Lord Simon said, Britain is turning out only roughly half as many scientists and technologists per thousand of population as the other great powers, or roughly a fifth of the number produced by America and an eighth of the number produced by the U.S.S.R. Those figures do not agree with Mr. De Witt's; but much more important than any such comparison is a sound estimate of Britain's own man-power requirements and her available resources to meet them. We need some reasonable estimate of the country's needs for scientists and technologists of particular kinds, and of the supporting technicians. It is only on that basis that we can wisely begin to plan both how to provide the necessary supply, and also the measures to ensure that effective use is made of what at best is always a limited resource and unlikely ever to be in excess of demand.

There is even yet very little accurate information as to Britain's real needs, which may well differ from the apparent demand. Last spring, Sir Harold Hartley estimated the number of research scientists in Britain as about 58,600, a figure which may be compared with a total of 90,000 scientists which the increased output of 5,000 qualified scientists a year recommended by the Barlow Committee in 1946 was expected to achieve by 1955. The report which has just come from the Committee on Scientific Manpower of the Advisory Council on Scientific Policy covers only the engineering industry, and it indicates rather the difficulties with which the problem bristles. Statistically, it examines the recruitment of scientists and engineers by some fifty engineering firms, the average annual intake of which during 1951–53 was 7,156. Of these, 935 possessed first degrees (mainly technologists), 39 higher degrees and 70 first degrees in other subjects. Since university first degrees in engineering awarded to internal students averaged 2,300 over the period, and the nationalized industries took 203, while a considerable proportion found employment in the Civil Service, local government, teaching and the Atomic Energy Authority (some firms complained of intense competition from the Civil Service and the Atomic Energy Authority), the inquiry covered some 50 per cent of industry's intake of engineering graduates from the universities, and the total recruited was 25 per cent below the number required.

The Committee recognizes that this figure may be misleading and may even be an under-estimate, as the demand for such men is rising with the general level of industrial activity. Sir Ben Lockspeiser, for example, has strongly emphasized the need in Britain for greater numbers of research scientists, technologists and technicians, and for the infusion of management with a strong element of technological experience, particularly in relation to fully automatic production engineering, the fruits of which will not otherwise mature. Many firms, moreover, remarked that too few of the graduates possessed real qualities of leadership and suggested that more attention should be paid to general education and the development of character. Most of the firms which co-operated in the inquiry stressed the importance of quality. It was also contended that engineering is not attracting its fair share of the available talent, and there was overwhelming support for recruitment at the first-degree stage except for research posts.

The University Grants Committee has already expressed concern at the conflict between the immediate need of industry for technologists and the claims of postgraduate work, and the Committee on Scientific Manpower quotes a passage from a note from the University Grants Committee to certain universities regarding special recurrent grants for higher technological education during 1954–57, which asks for a broad view of the national interest to be taken in planning postgraduate developments. For this reason, the plans for the expansion of the Imperial College of Science and Technology recently outlined by Dr. R. P. Linstead will be examined with special interest. The University Grants Committee does not consider it opportune to make any further suggestions about the development of technology.

That position, however, is only reasonable on the understanding that in the meantime the opportunity is taken to acquire, as a matter of urgency, much fuller and more accurate information about the requirements of Great Britain for trained man-power and its present distribution, and that plans are prepared, at least tentatively, to deal with the impending increase of some 50 per cent in the potential number of university students. By September 1956, when the universities have decided on their development plans for the quinquennium 1957–62, that increase will be hard upon us. Sir James Mountford estimates that by 1963–64 university numbers could be increased by 50 per cent without affecting quality if we can provide places and funds.

It is indeed reasonable that we should consider the shape and detail of further development in the light of the achievements of the past three years of the present quinquennium; but we should also at least be considering at this stage whether the national interest would not suggest that the universities should raise their standards and also that a large proportion of this impending 'bulge' should go to the technical colleges and not to the universities. Further, it must be remembered that, as Sir James Mountford points out, even the present expansion of British universities lags far behind what was planned for the seven years 1947–54 in terms of new building. Within that period expenditure of some £56 million on new building was approved. While costs have risen steeply, only £22·5 million was actually expended. As against the £80 million that the University Grants Committee stated in July 1946 would be required for new sites, buildings and equipment during the decade 1947–56, up to the end of July 1952 Sir James estimates that, in terms of 1947 prices, no more than £10 million had been completed.

This gives force to his contention that the expenditure of £40 million on university building in Britain during the next five or six years would give double the return to the nation of twice that sum later. The fear that the expansion of higher technological education might be detrimental to the interests of certain sections of the engineering industry noted in the report on recruitment by that industry did not impress the Committee which prepared the report; but it points to the need for some closer inquiry as to the balance to be struck between technical and technological education. Industry requires recruits from both sources—good graduates as well as good apprentices—and there is substance to-day in the argument that, under present social and taxation conditions, industry may draw in as apprentices boys of leadership and ability from middle-class homes with a long tradition of responsibility who formerly would have entered the university.

None the less, there is undoubtedly an increasing tendency for the ablest boys and girls to go to the universities, and the chances of recruiting outstanding talent except from such sources are diminished by the whole trend of educational and taxation policy. There is this to be said, moreover, for expediting as a matter of urgency the plans for new university building set in train nearly ten years ago: their execution, apart from permitting in due course a temporary increase of perhaps 30 per cent in the number of students of science and technology, as the bulge passes from the secondary schools, could be used to effect a permanent rise in standards, through the additional laboratory and library facilities and the increase in number of teachers. If a determined attempt is made to ascertain the real national needs, plans already in being should provide much of the flexibility needed to meet those needs without any considerable modification or further expansion.

The essential conditions are not indeed in conflict provided, as the Committee suggests, the universities and industry consult, and industry both makes its needs known precisely and co-operates in meeting them. The universities must examine their undergraduate courses in engineering, technology and science, and ensure that they are not too narrow and specialized or too cramping to men and women of initiative and of wide and original interest. But the supply of good recruits for apprenticeship courses requires more attention than the Advisory Council on Scientific Policy or its Manpower Committee suggests, and in particular the position of the technical colleges may well be a key. If Britain is to solve her problems of scientific and technical manpower, she must make the best use of her resources in that respect. To do so means giving both the average and the brilliant student the type of education from which they can best profit; and perhaps it is not so much a large expansion in university and technological education, especially at the postgraduate level, that is needed, as a great increase in the number of students of average ability who proceed to the technical colleges instead of, as at present, to the university. Nor is this view inconsistent with Sir Alexander Todd's suggestion that industry needs many more men with a good general science degree.

In this connexion, it is worth noting that Sir Eric Ashby has suggested that technology may hold the key to general culture. Unlike science, it involves an understanding of popular art and of commerce and psychology, something of morals and justice and some skill in the art of communication. It is the spirit of pursuit that matters, and we would be wise to explore such possibilities carefully. Further, there may be more substance in the criticism that the engineering research carried out at the universities is concerned with topics of little value to industry than the Committee on Scientific Manpower seems disposed to admit. All such matters are best discussed in the light of a review of the distribution of Great Britain's scientific effort, in terms not only of man-power but also of finance and materials, which should be a constant preoccupation of the Advisory Committee on Scientific Policy no less than of the Defence Research Policy Committee. The primary need is that these resources should be continually reviewed, not in relation to the efforts of other countries, but in relation to our own changing needs, in the broadest possible perspective. It is only in the light of such a factual survey that measures for the expansion of technical and university education or for any redistribution of effort and resources can be soundly planned.

RECENT ADVANCES IN NUCLEAR SCIENCE

Progress in Nuclear Physics

Edited by Prof. O. R. Frisch. Vol. 4. Pp. vii+379. (London and New York: Pergamon Press, Ltd., 1955.) 70*s*. net.

VOL. 4 of this series, offering a survey of various fields in nuclear physics, seems the most readable one of those published up to now. All the articles are of interest, the problems properly formulated and the English of great clarity, due no doubt to the pains taken by the editor. The topics dealt with are: photodisintegration experiments with nuclear emulsions (E. W. Titterton); scintillation spectrometer statistics (Ernst Breitenberger); meson phenomena and the meson theory (R. H. Dalitz); focusing in high-energy accelerators (T. G. Pickavance); isotopic spin and nuclear reactions (W. E. Burcham); heavy ions of high energy (D. Walker); nuclear properties of the very heavy elements (J. O. Newton); the preparation and chemistry of the transuranium elements (H. A. C. McKay and J. Milsted); and neutron spectroscopy (D. J. Hughes).

To pick out one or the other article for comment seems unfair, but one has one's preferences. The summary on photographic plate studies of the nuclear photo-effect (E. W. Titterton) is excellent, as it does not go too much into technical details but shows up the power of the photographic-plate method, discusses the main results and very thoroughly the theoretical implications. A particularly useful contribution deals with the statistics of the scintillation counter (E. Breitenberger). Those very versatile tools, the 'generating functions', are developed to the point where a physicist can use them, and the author has followed, with their help, the many statistical effects which influence the width of a spectral line caused originally by a monochromatic quantum radiation. It is to be hoped that this article, which seems more like a piece of research, will encourage physicists to treat their fluctuation problems with the help of generating functions. Another impressive piece of reporting comes from the pen of Prof. Burcham on the use of isotopic spin. The crystal-clear and didactically outstanding introduction to the, at first, abstract notion of isotopic spin is very valuable, since the concept is so very useful in low- and high-energy nuclear and meson physics. I would appeal to the theoretical physicists to study it closely and find out how not to create a potential mountain for the experimentalist when explaining theoretical concepts.

The two companion articles on the physics and the chemistry of the very heavy elements are very timely; but it is a pity that they were written just before a large mass of information was being declassified for the Geneva Conference. For a physicist it is fascinating to watch the chemist separate in cation-exchange columns such tough problems as mixtures of the rare earths or the actinide series (see p. 321). This section is of considerable interest to the chemist and the physicist. The printing and reproduction are excellent.

E. BRETSCHER

SEXUAL MORALITY

Sex and Morality

By Prof. Abram Kardiner. Pp. 274. (London: Routledge and Kegan Paul, Ltd., 1955.) 18*s*. net.

Homosexuality

By Dr. D. J. West. Pp. xiii+145. (London: Gerald Duckworth and Co., Ltd., 1955.) 15*s*. net.

IT is a surprising thing that we do not know for certain what is the normal psychosexual development of a human being, or even an animal in the wild. We know, of course, through Freud's patient researches, how human beings develop in our culture and, through anthropological investigations, we have some idea how they develop psychosexually in other cultures; but it is impossible to isolate man from his environment and discover how he would grow up uninfluenced by custom.

Prof. A. Kardiner, in his interesting book "Sex and Morality", points out various developments such as liberalism which made women feel they should be freer, the romantic movement which stressed equality, and finally feminism which urged that women should have careers the same as men. These were protests against previous oppression, but produced profound effects on morality. The invention of successful contraceptive devices and medical advances against venereal diseases freed women from moral impediments and tended to break down custom still further.

Women's attempt to escape from the kitchen and the home and to substitute a career for family life led to compromise and often failure. When there were children there was inevitably some rejection of them, and such rejection has a profound effect on development. It can lead to aggression, which may appear later so that the child becomes a juvenile delinquent heading towards a life of crime. Maternal rejection can also lead to perversion such as homosexuality, or finally to neurosis.

In examining our culture and methods of investigating it, Kardiner discusses the work of Freud and Kinsey. He gives one of the best commentaries on Kinsey's work which have so far been published and, since he has done considerable anthropological work, is able to draw on his experiences to check his conclusions. Far from being purely negative, Kardiner's criticisms enable him to give sensible remedies for many of the troubles which endanger modern civilizations. His book is an interesting one and well worth reading for its forthright views, although not every psychiatrist will agree with them. It is a pity that it is not provided with a better index.

Dr. D. J. West's book on "Homosexuality" is more of a popular medical one and should be easily comprehensible to the non-medical reader. He gives a careful outline of every aspect of homosexuality. It is considered in different communities, including our own, and discussed from the point of view of different types with their effect in creating legal and social problems. Two 'typical' cases are given.

Dr. West examines the influence of the endocrine glands, inheritance and psychological factors in causation. He discusses the relationship of homosexuality to mental abnormality and concludes his work with a somewhat sketchy chapter on treatment and prevention. This suggests that he has not had much practical experience in the therapy of the homosexual.

Medically this is not a controversial book, and it is easy to agree with nearly all that he says; in fact, it is what many psychiatrists have been preaching for the past two decades. His outlook, however, is generous, kindly and reasonable, as one would expect from a medical man educated in psychiatry. The adverse criticism one is inclined to make is that he is over-cautious regarding treatment, which is well worth while in the less-severe cases. There are an excellent index and a long list of a hundred and sixty references in the bibliography. There is also a list of novels which have homosexuality as a subject.

Clifford Allen

OUTLINE OF PARASITOLOGY

Introduction to Parasitology, with Special Reference to the Parasites of Man

By Prof. Asa C. Chandler. Ninth edition. Pp. xiv + 800. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 68*s*. net.

THE ninth edition of this book, which began its successful career as long ago as 1918, reflects on every page the remarkable advances in knowledge that have so greatly increased our control of animals parasitic in man and other hosts. The book has always been one of the most readable of all books on parasitology. Its author, Prof. Asa C. Chandler, has the gift of the graphic and imaginative phrase; he can put, often in a simple arresting sentence or two, the complex relationships of the parasite and its environment; and man, who has good reasons for thinking that he has conquered some, at any rate, of his parasites, is warned against patting himself too complacently on the back. "In spite of spectacular advances in our struggle with parasites," Chandler says, "it is obvious . . . that the battle is far from won." In 1947 Stoll made the startling estimate that there are in the world to-day 2,200 million helminthic infections [of man]—enough for one for every inhabitant [of the world] if they were evenly distributed". Nor is the author concerned with human parasites alone. He has extended, in this edition, the text that dealt in earlier editions with the parasites of domesticated animals. He also discusses the spirochaetes, rickettsias and filterable viruses that are transmitted to man by arthropods. A number of chapters or sections have been entirely re-written, and changes have been made on every page. These changes are the measure of the advances that have been made since the eighth edition appeared in 1949.

This, therefore, is not a reprint of a formerly successful book. Although the general plan of the book has not been substantially altered, the reader is given a new and up-to-date account of this subject, the importance of which the author so graphically describes in his introduction. The illustrations, formerly not adequate for so valuable a book, have now been greatly improved. They have, no doubt, enabled the author to lighten the text by transferring to the illustrations much of the morphological detail that some readers often find rather heavy going. Besides, it is precisely here, in conjunction with the drawings themselves, that one finds this kind of detail most convenient. Mr. George Newman, of the University of Texas Medical School, who drew most of the new illustrations, is to be congratulated on his work.

Another feature of the book is the fact that classification and taxonomy are given only in so far as they help the student to understand the general relationships of the major groups of parasites; but simple keys for the identification of arthropods are given, and these are set in small type, so that they can be omitted if the reader wishes to do this. The emphasis is on the biological aspects of the subject—on life histories, epidemiology, host-parasite relationships and the principles on which treatment and prevention are based.

References to the literature are given at the ends of the chapters, not all together at the end of the book, as many readers would prefer. A list of journals and books from which further information can be obtained will help the reader who is not familiar with the literature. The make-up of the book has certainly now acquired a new look; it is brighter and generally more attractive to read. This edition will undoubtedly hold for this book the place that former editions have given it.

G. Lapage

MODERN DAIRY FARM PRACTICE

Dairy Cattle

Selection, Feeding, and Management. By Prof. William Wodin Yapp and Prof. William Barbour Nevens. Fourth edition. (Wiley Farm Series.) Pp. xii + 420. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 38*s*. net.

DAIRY husbandry, depending on many branches of biology, changes as these sciences develop. During the past two decades these changes have been rapid and sometimes revolutionary in character. For example, before the Second World War artificial insemination of cattle was little used in commercial dairy farming, whereas at present half the cows in England and Wales are bred by this method. The third edition of Yapp and Nevens's book issued in 1941 was therefore due for revision, and in the fourth edition the authors have greatly improved the book by completely re-writing the whole to include more recent experimental findings and modern trends in dairy farm practice.

The book remains primarily a student's text-book; but is written in a simple style and can be followed by a reader with little technical knowledge of the subject. Nevertheless, the book covers a very wide field including genetics, nutrition and physiology, and for teaching at university-level an expansion of those sections dealing with the technical background of the subject would seem to be desirable. It must be admitted that this would make the book more voluminous and less attractive to the practical man.

To the farmer and student in Britain, Yapp and Nevens's book will be very useful so long as the reader is familiar with the differences in milk production between the United States and Britain. Apart from Brown Swiss cattle in America, the breeds of dairy cattle are the same in the two countries. In other respects, however, there are differences. The social and economic background of milk production in the United States is the family farm. In that country the summers are warmer and the production of good-quality bulky foods is, on average, easier. Maize and lucerne can be produced in many areas with little risk of a light crop or of a poor-quality product. Since land is plentiful compared with Britain, milk production is often carried on with little purchased feeding-stuffs.

There are certain aspects of the subject that are important in Britain, but which apparently barely merit mention by Yapp and Nevens. One of these is the use of the electric fence for strip-folding grass and fodder crops. Another is the tactical use of nitrogenous fertilizers for flushing swards. However, these are exceptions; and if the differences in environment and differences in terminology and values are borne in mind, this new book on dairy cattle would still merit a place among the most useful half-dozen books on dairy husbandry for the British reader.

It is unfortunate that any book on dairy husbandry begins to be out of date as soon as it is published. Thus, the chapter on artificial breeding was written before the development of techniques using deep-frozen semen. The implications of these changes may be profound, but they must await the next edition; and it is hoped that the fifth edition may follow the fourth before the back-log of new developments becomes too great.

ARTHUR S. FOOT

NORTH AMERICAN MOSQUITOES

Mosquitoes of North America (North of Mexico)
By Stanley J. Carpenter and Walter J. La Casse. Pp. vii+360+127 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 75s. net.

SINCE the publication of the comprehensive works of Howard, Dyar and Knab (1912–17), Dyar (1928) and Matheson (1944), our knowledge of North American mosquitoes has greatly increased, and recent literature on the subject has become vast and scattered; nevertheless, a great deal remains to be done. But before taking further steps, it is wise to pause and survey what has already been accomplished, and from such a survey to compile a summary which will enable us to see more clearly what still remains unknown. In this book the authors have presented such a summary. They have attempted to bring together in one volume much of the published knowledge on the mosquitoes of this region, and they have endeavoured at the same time to present the information in as concise and up-to-date a form as possible. They have also kept in mind the needs of the "systematic entomologist, the technician and the field worker engaged in mosquito control".

The first point is well covered, for all statements are fully documented, and throughout the text numerous references occur to the bibliography, which contains nearly eight hundred titles. Regarding other aims, it is well realized that scientific investigation of any organism demands, before anything else is started, that the identification of the organism be established beyond doubt. The authors have therefore first given a general account of the life-history of the mosquito and some instructions on collecting and preparing material for study. They then pass to descriptions of the external anatomy of all stages and the internal anatomy of the female. In classification they have closely followed the system of Edwards and have divided the family Culicidae into three sub-families—Dixinae, Chaoborinae and Culicinae. A rather full account is then given of the North American genera and species of the sub-family Culicinae, which includes all the true mosquitoes.

The descriptions of some hundred and forty species occupy three hundred pages or so, the names being arranged alphabetically under genera or sub-genera. Each description is illustrated with figures of distinguishing morphological features of the adult and larva of that species and is accompanied by brief notes on biology, geographical distribution (first in the world and then by States and provinces of North America) and on medical importance wherever this applies. In addition, keys have been constructed to assist in the identification of females, male terminalia and fourth-stage larvæ, and 127 females are figured on as many full-page plates. All this is rounded off with a systematic index of six pages.

The work is thus an entomological tool to be used rather than a book to be read, and the real value of a tool is only assessed in use. The systematic entomologist or the mosquito specialist may at first regret that the taxonomic niceties of variations among species and the relationships in species 'complexes' are not more fully treated. The technician may think that his side has received insufficient attention, and the field-worker engaged in mosquito control will not find a section devoted to his special activities. But, to include discussions on these matters would have made an already large book even larger, and might even have necessitated a two-volume work. The interested reader will find the titles of relevant publications in the bibliography.

It is clear that it was not the authors' intention to develop these aspects of their subject, but to concentrate first on the essential identifications, and then to provide a starting-point from which workers could proceed further. It is certain that not only those mentioned but also many other people will have frequent need to consult this book, and because of the convenient lay-out they will find it easy to use as a work of reference for some years to come.

Numerical Tables for Nuclear Physics

By Charles Noël Martin. (French and English Texts.) Pp. viii+258. (Paris: Gauthier-Villars, 1954.) Paper 36*s.* 9*d.*; cloth 44*s.* 11*d.*

THIS book is devoted solely to tabulations from a number of semi-empirical formulæ. The first half contains tables of nuclear masses, alpha and beta decay energies, etc., from von Weizsacker's mass formula. All the computations were made by hand without benefit of a machine, and graphical checks were employed. I find it hard to believe that the computational effort put into this book by M. C. N. Martin is in any sense justified. The mass formula has already been extensively tabulated by Metropolis and Reitweisner in America and merits nothing more than a thorough exposition of its many defects.

M. Martin would have done a better service if he had himself confronted the formula with experimental fact, and would have realized that for this purpose, and especially for comparisons with beta-decay data, it is more useful to have tabulations of the parameters usually connoted by M_A, B_A, Z_A, δ_A. It does not seem to be generally appreciated even now that the reliable experimental data are confined exclusively to the trough of the mass valley, so that the parameters B_A and Z_A are relatively ill-determined; on the other hand, nuclei further removed from beta stability (and for which no experimental data are available) are high up the parabolic walls, and their masses and decay energies are particularly sensitive to correct choice of the parameter Z_A of most stable charge.

Many of the tables in the second half of the book are rather trivial and suffer from too extensive tabulation: that makes the book more expensive and more complicated in use. For example, the recoil correction Em/M arising in nuclear bombardments and in alpha decay can be speedily and accurately assessed with a slide-rule. So far as nuclear radii and geometrical cross-sections are concerned, it would suffice to tabulate the cube roots of A and A^2. On the other hand, Coulomb barrier heights in MeV. and the barrier penetration factors involve several steps in computation and are more usefully tabulated. To be just it is necessary to add that, given the need for a table of semi-empirical masses, then M. Martin's production is well presented, well illustrated with examples, and convenient to handle.

J. S. STORY

Seismology

By Prof. K. E. Bullen. (Methuen's Monographs on Physical Subjects.) Pp. viii+132. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1954.) 8*s.* 6*d.* net.

THE small book under review is a worthy addition to the well-known series of "Methuen's Monographs on Physical Subjects". The chapter headings are as follows: the significance of seismology in physics; macroseismology; instrumental seismology; *P* and *S* waves; fitting elastic wave theory to the Earth; seismology and geology; seismic rays, phases and travel times; Earth models based on seismology; microseisms—seismology and meteorology; and some interesting earthquakes. The first three and last two chapters are shorter than the others. In addition, there are in the text eleven small line-diagrams, three large graphical diagrams, one map and an index.

Prof. K. E. Bullen, who is professor of applied mathematics in the University of Sydney and president of the Section of Seismology and Physics of the Interior of the Earth of the International Union of Geodesy and Geophysics in the present triennium, is a very brave man to try to get the whole of seismology into some forty thousand words, even though he limits the meaning of the word seismology and also freely employs mathematical symbolism including differential equations and triple integrals. His own researches have been largely concerned with travel-time tables and the determination of the numerical values of the physical constants of materials likely to be found at various great depths in the Earth. In this book he states the parts of the scientific method which he has used in his researches, gives the theoretical basis for his calculations, and summarizes the results so far obtained.

In fact, Prof. Bullen has dipped his 'spoon' of mathematics into the 'basin' of seismology, and mathematical physicists will be grateful for the 'taste' he offers them. Should they desire to go further, I would recommend them to begin with "Lectures on Seismometry", by Prince B. Galitzin, in addition to Prof. Bullen's larger book, "An Introduction to the Theory of Seismology" (second edition, 1953).

ERNEST TILLOTSON

Collected Papers on Aviation Medicine

Presented at Aeronautical Panel Meetings of the Advisory Group for Aeronautical Research and Development, Palais de Chaillot, Paris. (AGARDograph No. 6.) Pp. vi+209+38 plates. (London: Butterworths Scientific Publications, 1955; published for A.G.A.R.D.) 37*s.* 6*d.*; 5 dollars.

EIGHTEEN different papers presented at various meetings of the Aeronautical Panel of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, are published in this volume. The selection of the various papers in no way covers the field of aviation medicine in systematic form. Instead, the reader is confronted with an unusually random choice of topics, the standard of which varies from the informal and superficial to the advanced and original academic paper one might expect to find in a specialist technical journal. This is due to the different aims of the meetings and also the function of the various authors. In this type of publication, therefore, there is an inherent diversity of approach and level of treatment, all the more apparent owing to lack of editorial supervision. Such criticisms, however, have sometimes been regarded as offset by refreshing variations in style, and in addition the book is very well illustrated. One cannot help feeling, however, that a more limited choice of papers could, with advantage, have been supplemented by the inclusion of discussion abstracts on the more controversial subjects.

Much of the progress of aviation medicine is concerned primarily with research in basic physiological and psychological problems, so that this type of publication should have its appeal to the specialists in these sciences also. A detailed paper by John P. Stapp covers his more important and original work on body tolerances to crash decelerations, and other topics include such subjects as a theoretical approach to cockpit layout, arctic survival, high-intensity noise and visual problems. Of particular interest is a short critical survey of present concepts relating to explosive decompression. Throughout, the reader is left in no doubt that aviation medicine research depends on a detailed application of electrometrical recording techniques, which are also introduced by a composite paper describing recent advances in this field.

F. LATHAM

PHYSIOLOGICAL CONTROL OF POPULATION GROWTH

By Sir SOLLY ZUCKERMAN, C.B., F.R.S.
University of Birmingham

THE heavy consumption of raw materials during the war years of 1939–45, and the phases of shortage that have punctuated the post-war period, have tended to encourage the belief that one day—in the words of the now-famous Paley Report of 1952*—the world will lack the material means to sustain its civilization. The emphasis of the discussion has now begun to shift. To-day we are being increasingly led to believe that modern technology can be relied upon to provide new resources in place of old: nuclear energy for coal; synthetic for natural fibres; and even factory-made food for the food that now grows in the fields. At the same time, however, we are hearing more about the raising of living standards in the under-developed countries, where the bulk of the world's population now lives and multiplies in abject poverty.

The present fear is not that the world's physical resources are in any immediate danger of exhaustion as such, but that plans for the economic growth of 'resource-needy' countries are going to be frustrated by the unrestrained growth of population. This view is the underlying theme of "World Population and Resources", a study recently issued by Political and Economic Planning (*Nature*, January 7, p. 5). It is given further point in the report of the October 1955 meeting of the Consultative Committee for the Colombo Plan (Cmd. 9622), which indicates that population is increasing in the Asian countries far more rapidly than new developments are creating new jobs; and the fear could not be better stated than it has been by the Economic Commission for Asia and the Far East (April 19, 1955) in the words: "despite the strenuous efforts made in the post-war years to increase output and raise levels of living, most countries of the region still found themselves, nearly a decade after the war, with *per capita* real incomes that were either lower than before the war, or barely at pre-war levels". Schemes of economic development may therefore well be nullified if the means are not found for adjusting both sides of the 'population-resources equation' in those 'over-populated' countries where the two are most out of balance.

In these circumstances it is highly encouraging that certain American organizations are making urgent efforts to focus attention on the need to study the problems that are involved in attempts to limit the growth of population. After some preliminary discussions between the Planned Parenthood Federation and the Committee on Reproduction of the National Research Council, the National Academy of Sciences in 1952 convened a meeting out of which emerged a new organization called the Population Council. This was set up with the support of Mr. John D. Rockefeller III; and the next step was the appointment of Dr. Warren O. Nelson, professor of anatomy in the State University of Iowa, as medical director of the Council, with offices in the Rockefeller Institute. Dr. Nelson has made it his business to become acquainted with all work, wherever it may be taking place, that bears on the problem of the control of fertility; and in October 1955 the Council assisted the International Planned Parenthood Federation to gather together at a meeting in Tokyo a number of economists, social workers and students of reproductive physiology. The result was an up-to-date assessment of the present position about the physiology of birth-control.

Reports about population and economic growth, given by the spokesmen of the resources-needy and impoverished countries of Asia, and of countries like Egypt, all struck the same note. Everywhere population was growing much more quickly than new resources were being created, and nowhere was there any adequate method of checking present rates of reproduction, which were high not because of any increase in fertility, but because of sharp declines in mortality-rates brought about by such events as the elimination of malaria following the discovery of DDT. In Japan the situation had become so serious that abortion had been legalized in an effort to reduce the strain of increasing numbers on an economy which has been struggling desperately to recover from the destruction of war.

The physiological papers dealt with possible means of checking or limiting the actual process of reproduction at one of its many stages, and were mainly concerned to show which lines of research held the greatest promise. In a general review, Dr. Nelson considered the various steps of the process, emphasizing particularly those which appear 'vulnerable', and therefore susceptible to 'designed interference'. For example, one of the more vulnerable stages of spermatogenesis is the meiotic division which primary spermatocytes undergo during the process of chromosomal reduction. The nitrofurans and related compounds can inhibit these changes; but their use in human subjects is contra-indicated because they produce undesirable side effects such as nausea and vomiting. Dr. Nelson's view was, therefore, that research along these lines is no more than "mildly encouraging". Such, too, was his general opinion of current efforts to use steroid hormones, and certain plant extracts (for example, species of the genus *Lithospermum*), to interfere with the action of gonadotrophic hormone.

Dr. S. N. Sanyal, of India, who announced some years ago that there was an anti-fertility substance in the legume *Pisum sativum*, presented a paper in which further claims were made for the anti-fertility properties of *m*-xylohydroquinone, the presumably active substance in the pea. Clinical trials were referred to; but the published results are difficult to assess. The results of animal experiments which Sanyal had reported earlier have not been fully corroborated by research workers either in Great Britain or the United States.

Work on plant extracts was also referred to by Dr. A. S. Parkes, of the National Institute for Medical Research, Great Britain, who in addition directed attention to earlier work on anti-gonadotrophins. Both he and Dr. M. C. Chang, of the Worcester Foundation for Experimental Biology, U.S.A., dealt with the part played in mammalian fertilization by hyaluronidase and hyaluronidase-inhibitors; but again the disappointing conclusion was reached that there was no likely prospect that conception could be controlled by the systematic administration of an inhibitor which could inactivate spermatozoal hyaluronidase—an idea which was once thought to hold considerable promise.

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* Resources for Freedom. In 4 volumes. (Washington, D.C.: Gov. Printing Office, 1952.)

New work on anti-gonadotrophins was reported by Dr. W. O. Maddock. When an animal is injected with gonadotrophins prepared from the tissues of another species, antibodies are formed which are not species specific, so that an animal so treated may become 'immune' to its own gonadotrophins. By proceeding along these lines, Dr. Maddock and his collaborators induced anti-hormone formation in a number of men and women who were receiving daily injections of sheep or hog follicle-stimulating hormone. One month after the cessation of injections, anti-hormone titres were at their maximum, and they usually remained at 'detectable levels' for 2–4 months. Spermatogenesis was apparently unaffected during the first month after treatment; but it was inhibited, as shown by a variety of tests, including testicular biopsies, during the second month. Corresponding signs of the suppression of endogenous gonadotrophin were also observed in the female patients, and in both males and females it was believed that the inhibitory effects of the anti-hormones were more pronounced during succeeding courses of treatment.

The expense, as well as the dependence on medical services of the procedures involved, scarcely encourage one to believe that methods of birth-control deriving from this approach are likely to have any general application in the greater part of the Asiatic world. The experimental results are, however, distinctly encouraging, and it is conceivable that they hold a key to the practical control of reproduction. Another physiological observation which may do the same was outlined by Dr. M. C. Shelesnyak, of the Weizmann Institute of Science in Israel. It has long been known that mechanical irritation of the endometrium during the luteal phase of the œstrous cycle will provoke the formation of decidual cells, and it has also been appreciated that this response can be related to the manner in which a placenta is formed when the endometrium reacts to the presence of an implanting blastocyst. Shelesnyak took as a working hypothesis the idea that a common factor, probably histamine, is always involved when a decidual reaction occurs. This hypothesis proved valid, and further experiment showed that 'histamine antagonists' inhibit the formation of deciduomata. It was then found that a single subcutaneous injection of ergotoxine will interrupt pregnancy in the rat. This physiological observation can be related to the well-established clinical fact that ergot may sometimes act as an abortifacient, although in circumstances which are not clearly understood.

The two communications which excited most attention dealt with the influence of progesterone and related compounds on ovulation, and with the abortifacient effects of a variety of substances described generally as 'anti-metabolites'. The clinical results of the first set of studies remain equivocal, although as Dr. Gregory Pincus, of the Worcester Foundation for Experimental Biology, pointed out, there is no doubt that progesterone can inhibit ovulation in rabbits and apparently, also, in rats. According to his own studies, the indications are that progesterone, when taken by mouth, will also inhibit ovulation in women, as determined by various indirect indices. This view was not, however, shared by Dr. Massomi Ishikawa, whose clinical trials had failed to provide any indication of the suppression of ovulation, though it was possible that the changes induced by the hormone in the cervical mucus might interfere with the penetration of sperm sufficiently to prevent fertilization, nor by Dr. A. Stone, of New York, who also reported on the negative effects of the oral administration of progesterone. These discouraging observations were, to some extent, counterbalanced by a few observations, also reported by Dr. Pincus, which suggest that 19-nor-17-ethinyl-testosterone and 17-ethinyl œstraenolone may be more effective than progesterone in inhibiting ovulation.

The most dramatic story was that of Dr. J. B. Thiersch, of the University of Washington, who discussed the abortifacient action of certain anti-metabolites which are related to various aspects of nucleic acid metabolism, and some of which resemble in their molecular structure naturally-occurring compounds. The investigation began with the observation, made by chance during the course of work on the suppression of cancerous growth, that the folic-acid-antagonist 4-amino-PGA (aminopterin) will destroy the litters of mice, rats and dogs when given in the first trimester of pregnancy. Twelve anti-metabolites were then systematically studied, and nine were found to have a similar effect when given to rats on the seventh or eighth day of gestation. None was able to destroy the whole litter if given before implantation of the embryos, and no compound was effective when given late in gestation. When the drugs failed to destroy all the fœtuses, those young which survived usually developed abnormally, and were born in a malformed state. It was also observed that the placentas frequently survived even when the embryos were destroyed, and also that in certain cases the anti-metabolites had toxic effects upon the maternal organism (for example, on the bone-marrow). The most successful abortifacient in rats was azaserine, or azaserine given in combination with 6-mercaptopurine.

Aminopterin has now been given a clinical trial on twenty-six patients in whom pregnancy had to be terminated for medical reasons. The idea was that the anti-metabolite would be tried first, and in case of failure would be followed by operation. In the great majority of patients the drug acted as an effective abortifacient; but in the remainder there were complications (for example, either an abnormal fœtus was born, or it was necessary for the surgeon to intervene, in which case an abnormal fœtus was found; or general ill-effects occurred in the mother).

It was clear from this, as from all the other physiological papers of the conference, that the practical goal of these urgently needed researches—the discovery of a 'pill' which can be taken by mouth, and the only physiological effect of which would be that of inhibiting the development of the fertilized ovum, or of suppressing ovulation or gametogenesis at will —is so remote from realization that at this stage no one can say how, when or even whether success will ever be achieved. Other communications made it equally obvious that much study will have to be carried out in the field before it will be possible to say how different peoples are likely to react to efforts, officially sponsored or not, to spread a knowledge of birth control. The pressure of population on resources is being felt most acutely in those parts of the world which have never known anything but illiteracy, poverty, overcrowding and squalor. Experience has proved that Western methods of birth control can scarcely be used in such conditions. Moreover, however much some of the people concerned would like, to have small families, most of them are either too ignorant or too resigned even to take the trouble to understand the simple facts that are involved in human reproduction. Great efforts have been made in a few areas to overcome these obstacles; but so far with results that are trivial in relation to the size of the problem.

The situation would obviously be transformed if the 'pill' were ever discovered. But the 'pill' would need to be essentially 100 per cent certain, and commercialization would have to be resisted until the most rigorous clinical trials had been carried out, and until it had been shown that there was no danger of any long-term deleterious effects. The Asian peoples are not provided with lavish medical services, and it would be unthinkable to encourage the use of a drug which was not virtually certain in its action, if its failure meant that a medical man would have to be called in. Moreover, if the drug only affected germ cells or an embryo deleteriously, without destroying them fully, the results could be even more disastrous to the future than the unrestrained growth of population. The West will, therefore, be hurting, not helping, the underdeveloped areas of the world, and would be doing irremediable harm to the good name of Western physiological science, if a 'pill' were launched upon the world before its capacity to satisfy all the desiderata, scientific and social, had been established. But the West will be doing nothing but good if it continues to press on with the kind of physiological research of which the Tokyo meeting provided so useful a résumé.

THE SCIENTIFIC WORK OF BENJAMIN FRANKLIN

By Prof. E. N. da C. ANDRADE, F.R.S.

IN 1746 Benjamin Franklin received from Peter Collinson, of London, a glass tube suitable for carrying out experiments on frictional electricity, with directions as to how to use it*. He set to work on the subject with enthusiasm, writing "For my own part, I never was before engaged in any study that so totally engrossed my attention and my time as this has lately done". He was thus forty years of age (having been born on January 17, N.S., 1706) when he first took up the subject which was to make his name immortal in the world of science, and for seven full years thereafter he was engaged in pioneering experiment, shrewd deduction and simple but penetrating theory. The results of his electrical researches were communicated in a series of letters, beginning in 1747, to Collinson, who was a Fellow of the Royal Society. The publication of these letters as a book in 1751 made Franklin famous throughout Europe and two supplements were issued, the last in 1754. In 1757 Franklin came to England as official representative of the American Colonies, and after that date, although he continued to take a lively, stimulating and practical interest in scientific matters, the pressure of his public duties as a negotiator and statesman made the systematic pursuit of experiment impossible.

One of Franklin's earliest observations, of which he made full use, was on the power of a metal point to discharge an electrified conductor, in his case a large shot insulated by being placed on a clean, dry glass bottle. He generously acknowledged that the first experiment was made by his friend Hopkinson, who, apparently, did nothing to follow it up. If a pointed bodkin was attached to the shot it rapidly lost its charge, as it also did if the bodkin, earthed by being held in the hand, was presented, even at a distance of 8 in., to the shot. If the bodkin was insulated, no such effect took place. He later carried out a similar experiment with a very large charged cylinder made of pasteboard covered with metal foil, when he showed that an insulated man, presenting the point of a needle, became charged. Franklin likewise observed the glow at the point that accompanied the discharge. He put forward an explanation of the discharge from a pointed conductor in terms of the attractive force by which the charged body retained its electrified atmosphere: at a point there was a very small attractive surface and a relative inability to hold the charge. These experiments were to lead to the lightning rod.

Very early Franklin carried out experiments in which a man on an insulating base (a block of wax) electrified a glass tube by rubbing and then communicated a charge to another man similarly insulated. By variations of circumstance, including an earth provided by a man standing on the floor, he came to the sound conclusion that, as he put it, electricity was not created by friction, but collected —that there was a separation of electricity which left behind it a corresponding defect. In consequence, he introduced the terms 'positive' and 'negative' electricity, as still used, the electricity of the rubbed glass being positive. His theory was therefore called the 'one-fluid theory'. He also brought into regular use the terms 'non-conductor' and 'conductor' (the term 'conductor' had already been used by Desaguliers) in place of 'electric per se' and 'non-electric' then in general use.

His work on the Leyden jar, which had been discovered in a primitive form by von Kleist in 1745 but brought into general notice by Musschenbroek, of Leyden, in the following year, added clarity to what was a very obscure subject. He showed that the two coatings were oppositely charged and, in particular, that one coating had to be earthed while the other was electrified. He showed the large part played by the glass in the action—in fact, he declared that the whole power of the jar to give a shock lay in the glass. The correct elucidation of the action of the dielectric had to wait for Faraday. While carrying out this work, he simplified the whole matter by making the first plane condenser, of sheets of glass between plates of lead, the so-called Franklin panes, which enabled the coatings and the glass to be readily separated and conjoined. (Franklin has a note to his Letter IV, of 1748, "I have since heard that Mr. Smeaton was the first who made use of panes of glass for this purpose", but I have been unable to trace any record of this work of Smeaton's.)

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* With regard to an erroneous date given in Franklin's "Autobiography" and to the general history of Franklin's introduction to the study of electricity, which has been somewhat obscure, see Heathcote, N. H. de V., *Isis*, 46, 29 (1955).

It was, of course, Franklin's work on lightning and the lightning-rod that was chiefly responsible for his scientific fame. He was not the first to direct attention to the resemblance of the light and sound of the electric spark to lightning and thunder. Hauksbee (1705), Wall (1708), Newton (1716) and Gray (1735) had all referred to it casually, the last-named saying, for example, "that power [electricity] which by several experiments . . . seems to be of the same nature with that of thunder and lightning". It was, however, left to Franklin to show systematically that there was something more than a superficial resemblance, that thunder clouds were actually seats of electric charge which could be shown to behave like normal charges and that the action of pointed conductors, which he had so thoroughly investigated, might be used to dissipate the charge or, if this action was insignificant, to attract the lightning discharge and carry it harmlessly to earth, so as to protect buildings. He proposed what is known as the Philadelphia experiment: that a sentry box should be placed on a high building, with a long pointed rod, well insulated, protruding upwards. He anticipated that, when thunder clouds were overhead, a man in the box would be able to draw sparks from the rod by presenting to it an earthed wire, held by an insulating handle. The experiment was first carried out in France, in May 1752, by D'Alibard at Marly and by Delor in Paris independently. It met with a full success, which created a sensation, Delor obtaining sparks nearly an inch long.

It was later that Franklin carried out the famous kite experiment, described in a letter dated October 19, 1752. The lower end of the string of the kite, which became conducting when wet, was attached to a silk ribbon, which insulated it from the hand. Sparks were obtained, a Leyden jar charged and other standard electrical experiments performed. Among the last experiments made by Franklin were some on the sign of the charge on thunder clouds, which he found to be in most cases negative, although occasionally positive charges occurred, which modern observation has confirmed.

Of Franklin's design of lightning rod, pointed above and earthed below, it will suffice here to quote the modern lightning expert Dr. B. F. J. Schonland: "Franklin's specifications for the rod . . . have proved substantially correct".

Other effects of atmospheric electricity were also studied by Franklin. He recognized the aurora borealis for a phenomenon of electric discharge. He stated that the atmosphere at above a certain height was so rare as to be almost a vacuum and therefore a good conductor of electricity. The discharge he supposed caused by electrified vapours rising from the sea and proceeding to the pole, where the non-conducting nature of the ice played a part—an explanation on scientific lines at a time when greater correctness could not be expected. He may be said to have foreseen the ionosphere: "Who knows but there may be, as the Antients thought, a region of this fire [the electric 'fire'] above our atmosphere, prevented by our air, and its own too great distance for attraction, from joining our earth ?".

While it was for his experiments on electricity that Franklin was best known, these constitute by no means his only claims to consideration as a man of science. Among meteorological phenomena he was much interested in whirlwinds and waterspouts, which he recognized as due to the same cause, a very rapid local circulation of the air, with a consequent region of low pressure in the neighbourhood of the axis. He thought, however, that the waterspout consisted of water, whereas it is a cloud of water drops and droplets, and so was puzzled by the height, for he clearly recognized that the atmospheric pressure could not hold up a volume of water more than 30 ft. in height.

There are a host of original observations to be found in Franklin's collected papers. He makes the generalization that good conductors of heat are good conductors of electricity, long before the days of voltaic electricity. He explains that clothes keep the body warm by retaining and confining the natural heat, wool being warmer than cotton because it is a much poorer conductor. He has some penetrating remarks on the cooling produced by evaporation, from which he proceeds to explain the beneficial effects of perspiration in keeping down the body temperature in hot weather.

Everywhere his acuteness is evident. For example, he was, after looking closely into the matter, strongly in favour of inoculation against smallpox; but, after systematic trial, considered that electric shock from the discharge of a Leyden jar was of no use as a cure for paralysis and such-like ills, saying that he had never known any advantage that was permanent. This was at a time when John Wesley was writing of the most extraordinary cures, even of blindness, produced by electric shocks and when Priestley wrote that "electricity is now become a considerable article in the *materia medica*".

As an inventor Franklin is best known for his stove, his 'Pennsylvanian Fire-Place'. He pointed out that with the fireplaces then in use the hot air passed up the chimney, its place being taken by air coming as a violent draught through crevices, which was a great promoter of the common cold. In Franklin's invention the stove stood a foot or so in front of the wall. From the front part where the fire was burning the hot air within the stove rose to strike a horizontal plate and was then led down a pipe of rectangular cross-section, which enclosed a so-called air-box between itself and the fireplace proper. This pipe entered the chimney at floor level. The hot air thus heated the whole stove and, in particular, the sides of the air box, as well as the wall. The fresh air was supplied through a pipe under the floor. In pointing out the saving of fuel and the absence of violent draught Franklin, ever a man of sense and of the senses, directed attention to the fact that one did not lose the pleasant sight of the fire and could also use the flat top to warm flat irons or keep food warm. Among his other inventions the most familiar to-day is that of bifocal spectacles.

It may be fitting to conclude these very brief notes on Franklin's scientific work with words that appear to be little known, though spoken by one of England's greatest natural philosophers, Sir Humphry Davy. They cannot well be bettered. "The experiments adduced by Dr. Franklin in support of his hypothesis were most ingeniously contrived and happily executed. A singular felicity of induction guided all his researches, and by very small means he established very grand truths. The style and manner of his publication are almost as worthy of admiration as the doctrines it contains. He has endeavoured to remove all mystery and obscurity from the subject; he has written equally for the uninitiated and for the philosopher; and he has rendered his details amusing as well as perspicuous—elegant as well as simple".

STATISTICS AND AERODYNAMICS OF THE SEA SURFACE

THE importance of physical oceanography to meteorology arises partly because of similarities in the circulation patterns in the atmosphere and in the ocean and partly through the exchange processes at the shared boundary between them. The atmosphere is thermally driven, the ocean in part thermally but mainly by the frictional drag of the wind. The similarity of their circulation patterns, which exists in spite of their different boundaries, is presumably due to the rotation of the Earth. No realistic theory of the general circulation of either the atmosphere or the ocean is, however, possible without an extension of our knowledge of the transfer of heat, water vapour and momentum at the sea surface.

With this in mind, the Council of the Royal Meteorological Society recently invited papers on physical oceanography for publication in its *Quarterly Journal*. Several such papers have now appeared, and the Society organized two symposia on oceanographic subjects. The first, a joint meeting with the Challenger Society, was held in London on June 15, and the second formed part of the Society's summer meeting, held during July 22–23 at Ashburne Hall, University of Manchester. At both symposia the main topic was the statistics and aerodynamics of the sea surface.

The mechanism by which water waves are initially generated by wind is not yet understood. Distinct from this is a wide variety of problems, ranging from the reflexion and refraction of electromagnetic radiation to the motion of ships, the solution of which needs an adequate description of the statistical structure of the sea surface. One mathematical model which has recently been found to give realistic results is obtained by regarding a physical quantity, such as the height of the sea surface at a given point, as the resultant of a spectrum containing a large number of sinusoidal components of differing frequency the phases of which are uncorrelated. Such a model has been intensively studied by Rice[1] as a description of the statistics of random-noise currents in electronic devices. The word 'random' here implies the mathematical model already mentioned and is often replaced by the word 'gaussian', since on this model instantaneous amplitudes have a gaussian distribution. Many of Rice's results can be directly applied to the statistics of sea waves, for example, the change of height of the sea surface observed at a single point; they are being extended by Longuet-Higgins and others to take account of the movement of sea waves in different directions.

At the joint meeting of the Royal Meteorological Society and the Challenger Society in June, Dr. M. S. Longuet-Higgins gave an account of his paper[2] in which he discussed the distribution of wave heights, measured from crest to preceding or succeeding trough, for the case of a narrow spectrum. In this case the result is the well-known Rayleigh distribution, which has been found to agree closely with observation by several workers, including Commander C. R. Darlington[3], who has recently analysed waves automatically recorded by ingenious apparatus in an ocean weather ship. The good agreement exists in part because the wave records examined have been made by equipment which attenuates components of higher frequency, so that the spectrum is artificially narrowed. Rice has also derived an expression for the statistical distribution of maxima in gaussian noise with an arbitrary energy spectrum. The expression is complicated, but depends on a single parameter which can be derived from the energy spectrum or otherwise; it is applicable to a wide range of geophysical variations. Mr. D. E. Cartwright described his application of the formula to the distribution of the maxima in records of ship motions and ocean waves, the maxima now being measured from the zero line and not, as in Dr. Longuet-Higgins's paper, from an adjacent minimum. The theoretical distribution is in good agreement with those observed for energy spectra of different shape. It is clear from Mr. Cartwright's paper that the mathematical model of gaussian noise, and any extension to it, will be useful in the interpretation of many geophysical time-series, particularly records of ocean waves, and may well suggest physical ideas about the mechanisms which are involved.

From the statistics of the sea surface the meeting then turned to its aerodynamics. One of the most important problems common to oceanography and meteorology concerns the mechanism by which momentum is transferred to the sea surface. The drag and some of the statistics of the sea surface must be closely related; but, since as yet it is not clear which of the statistics are relevant, both statistics and drag are usually discussed in relation to the wind at a known height. The remainder of the meeting was devoted to observational estimates of the drag of the wind on the sea, expressed in terms of the stress coefficient C defined by the equation $\tau_0 \equiv C\rho u^2$, where τ_0 is the surface shearing stress, ρ the density of the air, and u the wind speed at a known height, usually about 10 m. above the surface.

Mr. J. S. Hay read his paper on air flow over the sea[4]. He had measured the vertical distribution of wind velocity to a height of 8 m., from a large raft moored some 800 m. downwind of a Hebridean island. In neutral and unstable conditions, the wind increased linearly with the logarithm of the height; but when the sea was colder than the air, the profiles were slightly curved, being convex to the log z axis. Wind profiles over land in neutral conditions are well known to be represented by

$$u/u_* = (1/k) \log(z/z_0) \qquad (1)$$

where u is the velocity at height z, u_* is the friction velocity defined by $\tau_0 \equiv \rho u_*^2$, k is von Kármán's constant ($= 0{\cdot}4$) and z_0 is a length known as the roughness parameter which is thought to be determined by the statistics of the surface. Making the very reasonable assumption that wind profiles over the sea can be expressed by the same equation, Mr. Hay determined C and z_0 from his observed profiles. Both C and z_0 varied approximately linearly over the range of wind speed of 650–1,150 cm./sec. at 10 m., the former from 0·0016 to 0·0024 and the latter from 0·05 to 0·25 cm. Uncertainties introduced by possible errors in the height of the anemometers were estimated and found to have little effect. Others, such as those due to the platform and to tidal streams, could not be assessed, but the profiles were considered typical of the sea surface in spite of a cliff 60–90 m. high about 1 km. upwind.

Dr. H. U. Roll, a guest of the Society from Hamburg, then gave an account of an investigation he had made[5] by comparing Beaufort force estimates of wind at sea, apparently based on the appearance of the sea surface, with the measured wind in relation to the temperature difference between sea and air. In spite of the experimental scatter, it was clear that for a given Beaufort force the wind was stronger in stable conditions than in unstable conditions. He had also found that the estimates of Beaufort force were linearly proportional to the wind speed 50 cm. above the surface and, by combining the two results, had made estimates of the drag coefficient in neutral, stable and unstable conditions. In neutral conditions, he found that the drag coefficient increased roughly linearly from 0·0008 to 0·002 as the wind at 19 m. varied from 2 to 15 m./sec. Dr. Roll considered these values were in fair agreement with what he thought were the most reasonable earlier estimates, although there was some evidence that at low wind speeds the drag coefficient increased as the wind speed decreased.

After some interesting observations by Dr. H. Arakawa on the complicated wave trains produced by fast-moving typhoons, Mr. J. Darbyshire gave an account of estimates[6] of drag coefficient made by an old method, that of observing the tilt to leeward of an enclosed body of water under the influence of wind. The slope of the surface of Lough Neagh in Northern Ireland had been determined from continuous records of water-level at four points near the shore, and the corresponding winds were taken from anemometer records at Aldergrove nearby. The experimental scatter was such that the variation of drag coefficient with wind speed could not be determined; there was some indication that the drag increased as the wind speed was raised to a power between two and three. Stability appeared to have a marked effect, the drag coefficient for moderate instability being about twice that for moderate stability. The drag coefficient also appeared to vary linearly with the distance between the observing points, indicating a possible effect of fetch. This is an important point which has not been brought out in previous investigations; it deserves further investigation.

It was clear from this joint meeting of the Challenger Society and the Royal Meteorological Society, and from the discussion which followed, that experimental determination of wind stress by any known method is a matter of some difficulty, so that estimates made by different workers are significantly different. Nevertheless, there is a growing belief that the drag increases with velocity rather more quickly than u^2 but slower than u^3. At the summer meeting of the Royal Meteorological Society at Ashburne Hall, two attempts were made to deduce the variation with wind speed, but both were necessarily hypothetical and tentative.

The first[7], by Prof. W. H. Munk, was based on various assumptions, one being that the drag due to skin friction can be linearly added to that of form drag against the waves to give the total drag. The remainder of the paper is concerned with the estimate of form drag, using an extension to Jeffreys's sheltering theory to cover the case when there is a spectrum of waves and not a simple sinusoidal wave-train. It turns out that the relevant statistic is the mean-square slope. Cox and Munk[8] have recently estimated the mean-square slope from photographs of the sun's glitter on the sea surface and find that it varies linearly with wind speed. The overall result is then that the form drag varies as the wind speed cubed. If the drag due to skin friction, approximately proportional to wind speed squared, is added, then the total drag varies with wind velocity in the expected way. Further, since the drag is associated with the slopes of the waves rather than with their heights, the effect of fetch would be expected to be small. Prof. Munk's paper could be, and was, criticized on many points of detail, but there was general admiration for this new and deductive attempt to clarify a major problem—the relation between real and aerodynamic roughness—which has not been resolved even for the simpler case of solid surfaces.

Munk's treatment is in terms of the wind speed at 'anemometer' height, but he is well aware that the variation of wind with height is an important factor, the aerodynamic roughness usually being defined from the wind profile. Wind profiles over water have been investigated by Mr. H. Charnock, whose paper supplemented that of Munk and was read immediately after it. From careful measurements over a large reservoir, he found that the wind speed varies linearly with the logarithm of the height as in equation (1). To characterize the profiles, their slope u_*/k is plotted against their intercept log z_0. This allows a direct comparison with other profiles, including those measured in the laboratory. The agreement is better than expected, and it is surmised that z_0 is comparatively independent of fetch and stability, but is determined largely by u_*. The relation between u_* and z_0 agrees roughly with the simplest non-dimensional relation between them, $u_*^2 = \text{constant} \times z_0$, so that one is led to a generalized wind profile for flow over a water surface:

$$u/u_* = (1/k) \log(gz/u_*^2) + \text{constant},$$

which specifies the drag, given the wind at one known height, the constant being approximately 12·5. This expression is in rough agreement with earlier work but the experimental scatter is large.

These two papers attempted to deal with the same problem from completely different points of view. The conclusions agreed to some extent and pointed to the need for more precise observations. Dr. Longuet-Higgins described an attempt to measure the form drag of the larger waves by making detailed recordings of pressure at the sea surface. The equipment, constructed at the National Institute of Oceanography, consists of a flat circular buoy about 6 ft. in diameter and arranged to float low in the water. Inside are two gyroscopes to record pitch and roll, a vertical accelerometer from which vertical displacements can be obtained, and a sensitive micromanometer to record small variations in air pressure. Successful recordings have already been made at sea and are being analysed.

Other discussion ranged over a wide field and showed the common interest of meteorologists and oceanographers in problems of the sea surface. Judging from these meetings, the Council of the Royal Meteorological Society has no cause to regret its decision to regard physical oceanography as a reasonable extension of its sphere of interest.

H. Charnock

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[2] *J. Mar. Res.*, **9**, 245 (1952).

[3] *Quart. J.R. Met. Soc.*, **30**, 619 (1954).

[4] *Quart. J.R. Met. Soc.*, **31**, 307 (1955).

[5] *Ann. Met. Hamburg*, **6**, 257 (1953/4).

[6] *Quart. J.R. Met. Soc.*, **31**, 333 (1955).

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FRUIT AND SEED PRODUCTION*

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EVERYONE who owns a garden in which fruit is grown soon becomes aware that the crops of plums and apples are liable to great fluctuations. For these fluctuations the weather is popularly blamed, but is in fact only in part responsible. In so far as we can blame the vicissitudes of our climate, it is important to remember that the flower rudiments, which must be formed for fruit to eventuate, are laid down ten or eleven months before the fruit tree produces flowers. So that the failure of a fruit crop as affected by weather may be due to conditions operating at any one of the critical phases in flower and fruit development, either directly, or indirectly as by affecting the growth hormones. For example, it may be the effect of frost when the flower initials are laid down in June, it may be cold winds at pollination time that prevent the bees visiting the flowers, or late frosts that check the growth of the germinating pollen and inhibit fertilization. But, in addition to these hazards of nurture extending over a period of more than a year, there are inherent idiosyncracies of the kind of plant with which we are concerned.

Some plants only fruit once in their life-time—a characteristic that we are apt to assume is inevitable for the annual. But in fact some annuals, if most of their flower buds be removed, will not only survive from year to year but also can be permitted each season to set a limited amount of seed. Moreover, the fruiting period of annuals varies greatly in length. In many this is quite brief, while in others, such as some strains of the chickweed, flowering and fruiting may extend over months. In a biennial such as the mullein (*Verbascum thapsus*) there is a period of accumulation by the rosette stage during one season, followed by fulfilment in the second, and here again prevention of flowering and fruit formation can prolong the life of the plant. There are, however, a number of unquestioned perennials which only fruit once in a life-time and then die. A classical example is the talipot palm (*Corypha umbraculifera*) that remains in the vegetative state for about forty years, and then all its accumulations of food are spent in one magnificent display of flower and a prodigious production of fruit. Similarly, some bamboos in India exhibit prolonged vegetative growth and then simultaneously flower and fruit over an extensive range of country, with important economic and social consequences.

All these and other such examples might seem to suggest that food accumulation and its depletion were the primary factors, and that all are mere variations on the same theme, since most trees and shrubs have to attain a certain maturity before they produce fruit.

It has been shown by numerous experiments on a variety of plants that the initiation of flower rudiments is greatly influenced by the relative length of daylight and darkness, which may thus not only regulate the seasonal flowering of a species but also its geographical range. It must, however, be emphasized that though photoperiodic stimulation and temperature are clearly important external factors in determining flower initiation and subsequent development, yet for these to operate a certain internal environment is requisite which Klebs termed "ripeness to flower", and the ratio of carbohydrates to mineral nutrients, although not causal as at one time supposed, is probably an important aspect of these internal conditions.

When I was a child the commonly cultivated *Cosmos* was a markedly short-day plant, so much so that it was only stimulated to form flowers so late in the season that the plants would attain a height of six or seven feet and get cut down by frost before the flower-heads opened. The common annual mercury, on the other hand, is indifferent to day-length, but its time of flowering was shown by M. Troupin to be greatly influenced by the temperature at night. If this were high, flower-buds might be formed twelve days after germination, whereas with low night temperatures these might not appear for four weeks.

Nevertheless; the variation in time that elapses before sexual maturity is often a characteristic of the species or variety. Particular interest is attached to the fact that scions obtained from the same individual apple variety grafted on to one type of root-stock always come into bearing early; grafted on another type of root-stock they fruit some years later. Thus it is the vegetative part of the dual organism presented by the grafted apple tree, and not the reproductive partner, that mainly determines the period of fruition.

But whatever root system upon which we graft, we see evidence of the individuality of the reproductive portion from the fact that certain apple varieties such as Ribstone Pippin tend to bear crops every year, whereas many other varieties, such as Blenheim Orange, normally fruit appreciably in alternate years only. The forester also is familiar with the periodic fruiting of oaks and beech trees, which exhibit mast years at intervals, the regularity of which is mainly influenced by climatic conditions. These may shorten or lengthen the interval between heavy crops, but not sufficiently to obscure the general periodic character of their occurrence.

Many trees that occur as natural dominants appear to exhibit periodicity in some degree; and it may well be that this, as I have suggested for herbaceous species of intermittent habitats, has a definite survival value in tending to evade the build-up of large populations of pests and predators. Copious intermittent seed production and seedling populations might thus have marked advantages over the steady annual output at a lower level of fruitfulness.

What determines periodic fruitfulness still remains to be determined; but the fact that drastic thinning of apples early in the year of marked fruitfulness, or prior removal of fruiting spurs, only in part overcomes the biennial fruiting habit, suggests that accumulation and exhaustion of food reserves is but one aspect of a complex problem.

Apart from the more striking intermittences of fruitfulness, there is, in temperate climes at least, a periodicity imposed by the seasons. Quite commonly the seasonal production of seed does not coincide with the conditions favourable for germination, and when these recur the advent of temperature and moisture conditions that would induce germination may occur at times unfavourable to survival.

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* Substance of a Friday Evening Discourse delivered at the Royal Institution, London, on October 28.

We now know that many seed coats contain water-soluble substances that tend to inhibit germination until removed. Thus seeds of succulent fruits, despite the access of moisture and warmth, remain dormant until after the seed is shed. In very wet seasons these inhibitors may become washed out so that the seeds germinate precociously, and the apparent inconsistence of an inhibitor is realized, in fact, as an asset that, like the dormancy imposed by many seed coats, owing to their impermeability until they have undergone some measure of decay, is in reality a feature which confers a degree of temporal distribution on seedling production that is an insurance against catastrophic elimination.

The seed has a resistance to extreme conditions and a capacity for survival of adverse circumstances far surpassing that of the plant itself. Seeds have been known to survive the temperature of liquid air and that of boiling water. Moreover, the evidence of the seeds of the lotus (*Nelumbium speciosum*) from the Manchurian peat indicates a capacity for the retention of viability for perhaps a millennium. The annual plant has become a marked feature of the desert, where the adverse season is evaded by the resistant seed phase. Further, the abbreviated span of life that many annuals have assumed has not only fitted them for areas with short growing seasons due to natural causes, but also for the artificially limited growing seasons imposed by man's cultural operations. This short life-history of but a few weeks can, under more continuing favourable conditions, be translated into a succession of life-cycles so that if all the offspring of each generation were to survive, the total population at the end of one year would be numbered in thousands of millions. Thus by sheer pressure of potential offspring their successional frequency is well-nigh assured, and many such have become notable weeds.

If a high seed production be one important factor favouring success, and studies carried out on a large number of British species warrant this conclusion, it is nevertheless clear that for a given capacity for food manufacture, determined in large measure by the total leaf surface of the plant and the environmental conditions in which it is situated, the number of seeds produced must in some considerable degree be inversely related to the seed size.

The size of the seeds of one and the same species does not usually exhibit any great variability. Indeed, the grain of primitive wheats was, as we know, a measure of weight to which the nomenclature of the curiously antiquated system of Britain still bears witness. But variation in seed size is by no means negligible in some species, and thus has an important bearing on dispersal as it affects competition.

When we consider the diversity in size of individual seeds of different kinds of plants, the range is astonishingly large. On one hand we have the minute seeds of many epiphytic orchids and parasitic plants that are dust-like and of which more than thirty-five million would be required to weigh an ounce. At the other extreme there is the double coconut (*Lodoicea sechellarum*), the single-seeded fruit of which may weigh 40 lb. It is not surprising that the palm which produces these prodigious fruits does not start fruiting until it is 20–30 years old, and that each fruit takes about a decade to mature. The baby palm after the seed has germinated is not weaned from its bottle for several years, but such is the plentitude of food provided for the young plant that apart from any catastrophe its establishment is almost assured. But such a large fruit can only be dispersed by water, and its very restricted distribution bears witness to the fact that it suffers from the defects of its virtues, as is also shown by records of seedlings that have perished from the burden of their inheritance when stranded with the plumule underneath.

Some years ago, from an extensive study of the seeds of British plants, I was able to establish the fact that there was a marked association between seed size and the natural habitat conditions of the species concerned.

The more advanced the type of plant community of which the species was a normal colonizer, the heavier the seed or fruit tended to be. The more open the vegetation and the less shaded the habitat the smaller would appear to be possible the seed size without detriment to survival. Put in other terms, this seems completely plausible, since the more closed and shaded the community of plants the larger the food reserve requisite to enable the seedling to raise its foliage into a position where it can obtain the essential illumination.

It is undoubtedly true that genetical factors govern seed size and that, in general, related plants tend to possess seeds of similar dimensions. Most members of the Onagraceae, for example, have very small seeds like the willowherbs. The fuchsias, which are largely plants of the forest margins of South America, have seeds that are not much larger, though the enchanter's nightshade (*Circaea*) has quite sizable one-seeded fruits and is a shade plant. Since certain families are often associated with particular types of habitat, it might be thought that any kind of relation between seed size and situation was purely fortuitous. Comparison, however, of the seeds of species belonging to the same genus but occupying differing types of habitat does reveal that the same relation generally obtains, namely, of the smaller seed with the more open type of community.

It is not without significance that many of the most striking of the apparent exceptions are plants which, because of their special modes of nutrition, are to a greater or less extent immune from the effects of shading. Thus, saprophytic and parasitic plants in general, even those of deep shade, have normally minute seeds. An exception among the parasites is the toothwort (*Lathraea squamaria*), which is definitely a shade species, but as it is parasitic on the hazel, lime and wych elm it may well be that the larger food reserve is requisite for the seedling to penetrate to sufficient depth to establish contact with the roots of the host plant. Nearly all orchids, whether saprophytic or not, have minute seeds; but many, and perhaps most of these, are largely if not wholly saprophytic in the early stages of development, and the seedlings are notoriously tolerant of shade.

Some idea as to the small size of orchid seeds can be gained from considering those of the sweet-scented orchids of the chalk downs of Britain, of which it would require more than fifty million to weigh one pound. The seeds of the parasitic broomrapes are not quite so light; but an ounce of these would represent about a million and a half seeds.

Seed size then, I suggest, is to be regarded as mainly determined by the average requirements for establishment. The larger the food supply provided by the parent the better, so long as this does not conflict with other assets of survival value, of which the necessity for dispersal to diminish competition between the offspring and with the parent is one, and number of seeds produced is another. Natural selection has imposed a compromise between these conflicting requirements. It is in the light of such a concept that we must consider fruit and seed production.

It is manifest that species of open habitats, particularly those which are pioneers on bare soil, are in the best position to dispense with a large food reserve, and they are also those which can most benefit from a large seed output because such habitats offer ample colonizing space. It is, in fact, among such that the smaller seeds and the larger outputs are to be encountered; but, apart from the special nutritional classes already referred to, the maximum outputs appear to be associated with what I have termed the species of intermittent habitats—those environments such as woodland clearings or bare mud exposed during periods of drought which offer, periodically, habitats for the opportunists of the vegetable kingdom. In the woodland the foxglove and the mullein are examples, while on the mud we might cite *Chenopodium rubrum* and *Veronica anagallis*. The individual fruits of the foxglove usually contain more than a thousand seeds, there being normally more than eighty capsules on one plant, and the average seed output of a plant is more than 85,000. The largest specimens, however, may produce well over a million seeds. The stupendous populations that are sometimes encountered on areas of felled woodland are in marked contrast to the few individuals that are to be found at the woodland margins during the intervening period. So, too, the mullein (*Verbascum thapsus*) produces more than 226 capsules, each containing about six hundred seeds; the average output is therefore about 136,000 seeds, and the largest specimens I have seen must have produced more than 1,200,000 seeds. A single pod of a vanilla orchid was estimated to contain some sixty thousand seeds, and a single plant may produce more than thirty such, or some two million seeds.

The red orache (*Chenopodium rubrum*) is often seen on manure heaps and rich garden soil; but, as a really wild plant, it is a feature of the exposed mud of ponds and reservoirs, where almost pure stands sometimes occur, developed from seeds dormant in the mud for many years, and a rough estimate of the productiveness of such plants was well over 250,000.

It is worth noting that what has been described as the smallest British flowering plant, the chaffweed (*Centunculus minimus*), grows on exposed mud, and having regard to the very small leaf area it presents its output is remarkable, namely, an average of 245 seeds, but these, needless to state, are very small, weighing only about 0·00003 gm.

Herbert Spencer believed, and the view was widely accepted, that seed output of a plant was proportional to the risks of its survival. It is obvious that such risks must be covered by an adequate insurance, and the comparative stability of plant populations over long periods might lend colour to this view. But that it is entirely misleading is obvious from the fact that those species which would be expected to take out the highest premiums in the form of a large output have taken out a low one. Indeed, it is usually the rarest species and those which demand the most specialized conditions that have the smallest seed production, while it is the commonest and most widespread that form large numbers of seed. The common pink centuary (*Centaurium umbellatum*), so widespread on the chalk downs of Britain and in woodland rides, has an average production of about eleven thousand seeds, whereas the local *Centaureum littorale* produces an average of approximately two thousand. The water plantain (*Alisma plantage*), that is to be found in almost any shallow pond, averages some thirty-six thousand, whereas the rare and local starwort (*Damasonium alisma*) produces a meagre 230, of which perhaps not more than one-quarter are viable.

It is probable that one of the reasons why many species are rare is because they are unable to exert sufficient population pressure. That they are able to survive despite the low premium they pay in seed output may well be in part due to greater precision in dispersal as, for example, by birds that frequent the particular type of habitat that they and the plant share. Moreover, it is generally true that the more specialized the habitat conditions the fewer the number of species associated with them. If we think of plants for our present purpose as belonging to two categories, namely, the specialists and the general practitioners, the former at the sacrifice of a more limited range of possible habitats are likely to be confronted with a smaller range of competitors and perhaps fewer of them. Thus the probability of similar demands in time and space from their associates are appreciably lessened.

It follows from what has been said that, in general, trees will possess the heaviest seeds because so many of them are natural inhabitants of shady places, and in the British flora the trees with light fruits, such as the birch, the pine and the ash, are colonizers of the open and pioneers, while the trees of the closed woodland, such as the oak and the beech, have fruits with appreciable food reserves. In the tropics, however, many tree fruits are very large. The double coconut is a shade species of palm, while the fruits of *Caryota mitis*, a palm which grows in open situations, are comparatively small. We are all familiar, too, with the large stones of the avocado pear and the mango, both of which are shade trees. The seeds of *Paulownia*, one of the few scrophulariaceous trees, are small, like those of other members of the family. Again, jungle climbers may have very large seeds, and in this connexion the genus *Entada* is of interest as illustrating effective water dispersal which obviates one disadvantage accruing to large seeds. Some few years ago, when staying with the Van der Byles at Caledon, Cape Colony, Lord de Saumarez came in to dinner bringing with him to show me two seeds that he had picked up on Cape Agulhas, the southernmost point of the African continent. One was *Entada scandens* and the other *Entada gigas*, the latter a native of the West African forests and the former of the forests of the Amazon valley. From the distribution of the ocean currents it is probable that the large seeds of the *Entada gigas* were washed into the sea off the West African coast, carried across the southern Atlantic towards the mouth of the Amazon, and thence carried back in company with its congener, *Entada scandens*, to the beach at Cape Agulhas. Seeds of *E. scandens* often reach the coast of Cornwall and have been found to be viable, and I have little doubt that these from South Africa were also. Similarly, the dangerously hooked fruits of *Harpagophyton* are so efficiently dispersed by animals, whose death they not infrequently bring about, that their large size is not detrimental except in so far as it limits their number.

The seeds of many members of the marrow family are of only moderate size, but the fruits in which they are contained are among the most diverse in size and form, and some attain large dimensions even in the wild state. They are dispersed by flotation, and after the fruits cease to be buoyant the seeds will often float for weeks.

Unless the dispersal of fruits or seeds be reasonably efficient, it is manifest that no advantage will accrue from a large output and little from a large food supply, and the great diversity of so-called dispersal mechanisms is evidence of their considerable survival value; but beyond a certain efficiency the higher the output consistent with adequate reserves in the seed for establishment, the greater the frequency of the species is likely to be.

It is worth noting that man, in the cultivation of his fruits, has often selected out seedless types. Sometimes this is the outcome of hybridization and resultant genetic infertility; sometimes it is the accompaniment of the mere replication of chromosomes. The seedless banana, the seedless orange and the pineapple are familiar examples of such fruits, which emphasize for us that fruit formation and seed production, though commonly associated phenomena, may be independent of one another. We can indeed, by the use of artificial growth-promoters, cause pears to develop which contain no fertile seeds. In the wild state we find that chromosome replication is not infrequently accompanied by a reduction in fertility but an augmentation of vegetative propagation. Thus, many woodland species that have low seed outputs spread rapidly by runners, of which a striking example is afforded by the lesser periwinkle (*Vinca minor*), which flowers freely but very rarely fruits, yet spreads with remarkable rapidity. The vegetative mode of propagation has many advantages in a shady habitat.

All the evidence we at present possess would appear to lead to the conclusion that seed output is an important factor in successful colonization, and its magnitude is as much a character of the species as height or any other of its variable qualities.

OBITUARY

Prof. P. A. Buxton, C.M.G., F.R.S.

The news of the death of Prof. P. A. Buxton on December 13 at his home, Grit Howe, Gerrards Cross, shocked and sorrowed his friends and admirers in all parts of the world. Only a year previously he was travelling through difficult forest country in Central America, a few months ago he was still castigating committees with his caustic wit, and right up to the end he was giving that critical help to his colleagues and students for which they will never find a substitute.

Buxton was born on March 24, 1892. He read the Natural Sciences Tripos at Trinity College, Cambridge, and received his medical education at St. George's Hospital. He became acquainted with tropical conditions first during the First World War in Iraq and Iran, then for two years in Palestine and later for two years in the Pacific Islands. In 1926 he became director of the Department of Entomology of the London School of Hygiene and Tropical Medicine, and in 1933 professor of medical entomology of the University of London, appointments which he held until his death. He was elected a Fellow of the Royal Society in 1943, was made C.M.G. in 1947, received the Mary Kingsley Medal of the Liverpool School of Tropical Medicine in 1949 and was awarded the Linnean Gold Medal in 1953.

Buxton altered the course of medical entomology from museum systematics to the study of the living insect, its physiology and its relationship to the environment. His highly original mind was drawn to this practically unexplored field, and a series of classical papers followed. From these observations he was able to synthesize the findings in five books, characterized by the most lucid exposition of the subject. The first, "Animal Life in Deserts", was reprinted in 1955, and is in constant use by a circle of workers much wider than entomologists. Then after his visit to the Pacific appeared three volumes dealing with medical conditions and entomology in Samoa and other islands. His book on the louse went into two editions and is a perfect example of his outlook. Finally, two works on trypanosomiasis and the tsetse fly appeared, first a preliminary memoir and then, just before his death, the comprehensive "Natural History of the Tsetse Flies", a book which all workers in Africa have been awaiting for years.

Buxton's creed may be summed up in his own words: "field observations are a necessary preliminary, but their function is to set problems which should be solved in the laboratory". He communicated this point of view to some carefully chosen students, all of whom have attained positions of eminence in this field; he thus founded a school of thought which has the strongest influence wherever entomology is studied. Buxton's own journeys helped this dissemination, for not only was he widely travelled but also foreigners found him *sympathique*.

The part that Buxton played in introducing the synthetic insecticides into medicine is perhaps not fully recognized. Early in 1943, the insecticide DDT was brought to him from Switzerland, where it had recently been resynthesized; he immediately appreciated its significance, and he was largely responsible for its rapid introduction as an insect killer in the various theatres of the Second World War.

Buxton's advice was sought more and more frequently by committees or councils at home and abroad, and much of his time latterly was occupied in this way; he never really liked this diversion from his research and teaching, but felt that it was his duty as a scientist to give advice to official bodies; and they always got it in forthright terms. He was due for 'retirement' in two years time, and he had already acquired a subject which would have kept him busy for years; he had started studying the breeding of Diptera in fungi, and only twelve months before his death he bought a binocular microscope with which to observe these flies at his house in Gerrards Cross. Many people all over the world will remember his garden there, its interesting plants and trees, and above all, the welcome they received.

P. C. C. Garnham

NEWS and VIEWS

Geology at Bedford College, London: Prof. Leonard Hawkes, F.R.S.

The retirement of Prof. Leonard Hawkes from the chair of geology at Bedford College, University of London, is a milestone in a life devoted to the establishment of a university department renowned for the liberal and cultural bias of its geological teaching. Between the World Wars, as the first occupant of the chair, Prof. Hawkes brought to his task experience gained in the Universities of Durham and Kristiania, and enlivened the substance of his teaching with much original research, some of it exploratory research in difficult ground, on the volcanic history, the petrology and the geomorphology of Iceland. For many years he has been a wise counsellor in geological affairs, notably in the activities of the Geological Society, of which during 1934–42 he was an honorary secretary and afterwards a vice-president; and he is known with affection and regard by many younger geologists as a tolerant and generous friend. His qualities as scientist, educator and administrator were recognized by the award by the Geological Society of the Murchison Medal to him in 1946. His Department did not escape the devastation of war, and in 1945 he was faced with the burden of planning its rebuilding. He leaves Bedford College in the sure knowledge of foundations well laid and superstructure well designed in both material and academic senses.

Dr. Basil C. King

Prof. Hawkes's successor, Dr. Basil King, has had a varied career in the Colonial Survey service and in universities. A graduate of Durham, London and Glasgow, he was for more than ten years a petrologist and field-geologist in Uganda and Nigeria, where he contributed greatly to knowledge of Pre-Cambrian and igneous rocks, and to the exploitation of economic minerals. Returning to Britain in 1948 to become senior lecturer in the University of Glasgow, he has achieved high distinction for his researches on petrogenesis, notably on rock transformations in the granitic suite. His work on ancient volcanoes is illustrated by reconstructions of former conditions in Arran and in Africa—a continent in which he continues to take an active interest most recently expressed by the survey of an igneous field in Bechuanaland. Latterly, structures in the Scottish Highlands have attracted his attention and are being studied by a small research team under his supervision. A lucid and persuasive lecturer, he is an effective tutor and administrator in university extramural work. By a happy coincidence, he returns to Bedford College as professor in the Department in which he received his first professional appointment twenty years ago.

Physical Chemistry in Queen Mary College, London: Prof. K. W. Sykes

Dr. K. W. Sykes, senior lecturer in the University College of Swansea, has been appointed to the newly created chair of physical chemistry in the University of London, tenable at Queen Mary College. Dr. Sykes read chemistry at Oxford, where he held the Rigge Exhibition and Percival Benefaction at the Queen's College. After obtaining first-class honours in 1943, he carried out research on war-time problems under Sir Cyril Hinshelwood for his D.Phil. He remained in Oxford for a further three years as an I.C.I. Fellow, and in 1948 was appointed to a lectureship, and in 1951 to a senior lectureship, in the University College of Swansea. At Swansea Dr. Sykes had the task of completely reorganizing the course in physical chemistry and establishing a school of research. Dr. Sykes's own researches have been mainly in the field of solid – gas reactions, to which he has made distinguished contributions; he has also published important papers on the ferric – iodide reaction and on complexes of the ferric ion. Dr. Sykes is a chemist with wide interests, and his appointment will be a great asset to the growing school of chemistry at Queen Mary College.

Capper Pass Awards for Papers on Metallurgy

The following Capper Pass Awards have been made by a joint committee representing the Institution of Mining and Metallurgy and the Institute of Metals for papers published during 1954 in the *Transactions* of the Institution and the *Journal* of the Institute: £100 to G. Lawrie Fairs (a method of predicting the performance of commercial mills in the fine grinding of brittle materials); £100 to F. King and Dr. A. N. Turner (control of quality in the hot and cold rolling of aluminium and aluminium alloys); £50 to G. L. Hopkin, Mrs. J. E. Jones, A. R. Moss and D. O. Pickman (arc melting of metals and its application to the casting of molybdenum); £50 to Prof. M. Rey (flotation of oxidized ores of lead, copper and zinc). The Awards are made from a fund given by Capper Pass and Son, Ltd., for the encouragement of scientific and technical papers on processes and plant used in extraction metallurgy and on the subject of assaying, and also papers and processes used in all branches of the non-ferrous metal industry.

Government Support of Agricultural Research in Britain

The Agricultural Research Bill, which received an unopposed second reading in the House of Commons on December 13, provides that, except for Scotland, the financial and general administration of the grant-aided research institutes in England and Wales, as well as their scientific direction, will be unified under the Agricultural Research Council; the institutes will accordingly be transferred from the Vote for the Ministry of Agriculture, Fisheries and Food to the Vote for the Agricultural Research Council, which will be removed from that of the Treasury and appear under a separate head. It is also proposed to reconstitute the appropriate Privy Council Committee so that in future it consists only of the Lord President of the Council, the Minister of Agriculture and the Minister representing the Scottish Department, and to amend the Charter of the Council so that the two Departments have direct representation on the Council. To avoid constituting the Council as a separate government department and making certain research workers Civil servants, an Agricultural Research Fund is to be set up, which will receive an annual Parliamentary grant-in-aid.

The Bill was introduced by the Minister of Agriculture, Fisheries and Food, Mr. D. Heathcoat Amory, and was also welcomed by Mr. Thomas Williams for the Opposition, who urged the importance of increasing the support for agricultural research. Sir Leslie Plummer pointed out the necessity of planning research for more than one year at a time, and this was widely supported in the debate. It was also suggested that the Agricultural Research Council should make increasing use of the universities for research. In replying to the debate, Mr. G. R. H. Nugent, the Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, admitted the need for such long-term planning, but pointed out that an annual Vote would be needed, even with a quinquennial programme. He thought the arrangements for disseminating the results of research are working well, and, in reply to questions as to a veterinary research council, said that this had been considered by the Lord President but was thought to offer no advantage at the present time. Eleven of the sixteen experimental farms and six out of seven horticultural experimental farms have been established.

British Section of the International Union for the Study of Social Insects

A NUMBER of entomologists present in Amsterdam at the ninth International Congress of Entomology in 1951 felt that an organization should be formed to bring together those scientists who were engaged in studying the physiology, biology or systematics of the social insects. Thus the Union Internationale pour l'Étude des Insectes Sociaux was initiated, under the presidency of Prof. P.-P. Grassé. The purpose of the Union has since been expanded to include researches on gregarious insects. A Congress was held in Paris in 1952, followed by a highly successful one at Würzburg earlier this year ; the next Congress, in 1957, will again be held in Paris. The international journal *Insectes Sociaux*, published in Paris, is completing its second volume. National Sections have been formed in many countries, but until recently British workers in this field have been members of the French Section ; however, a British Section has now been formed under the chairmanship of Dr. J. D. Carthy. The subscription to the Section is 10*s*. a year, which includes membership of the International Union, and the Union supplies members with lists of current papers on the subject and notes concerning the activities of the Union as a whole. The cost of *Insectes Sociaux* is 2,000 francs a year for members and 3,000 francs for non-members. The honorary secretary of the new Section is Dr. C. G. Butler, of the Bee Department, Rothamsted Lodge, Hatching Green, Harpenden, Herts, from whom further information can be obtained.

The Breeding of Laboratory Animals

IN the past, experiments on animals were usually done in qualitative terms. To-day biological research has become quantitative in character, and with this approach it is becoming evident that healthy, vigorous and uniform stock is essential for controlled experimental studies and for assaying drugs and other therapeutic agents not susceptible to chemical standardization. What is needed are standardized animals or ones nearly so ; Mr. A. L. Bacharach suggests that a standardized animal is to the biologist what a pure reagent is to the chemist. The way in which these animals might be bred was described at a symposium organized by the Laboratory Animals Bureau on May 9, 1955. The subjects discussed included some aspects of animal production for routine biological assay ; genetical aspects of the breeding of laboratory animals ; the value of littermate controls in endocrinological research ; pre-natal and post-natal reproductive wastage ; and the problems of a curator of a small animal breeding station at a university. The papers, and some of the ensuing discussion, have now been put together in book form and can be obtained from the Laboratory Animals Bureau, Medical Research Council Laboratories, Holly Hill, Hampstead, London, N.W.3 (7*s*. 6*d*.).

Linen Research Association : Annual Report

IN proposing the adoption of the report of the Council of the Linen Research Association and the accounts at the annual general meeting of the Association on December 16, the chairman, Mr. H. B. McCance, said that the trade subscriptions now amount to £32,385 compared with £7,033 in 1939, and the floor space of the Institute has been increased from 33,408 sq. ft. to 45,837 sq. ft. In seconding the motion, Mr. M. Wallace expressed the opinion that any fundamental change in the basic methods of preparing and spinning flax is unlikely, but that the servo-drafting control mechanism is an example of how new control methods can be applied to improve an old process. The director of research, Dr. A. J. Turner, in his report, instanced the reduction of lick-up on the rollers of preparing frames by simultaneous application of a number of auxiliary devices, as an example of the real progress being made towards the solution of obstinate spinning problems. In the Weaving Department attention has been concentrated on the improvement of the preparatory processes, while in the Chemistry Department much further experience has been obtained of synthetic resin finishes and promising results obtained in applying new synthetic compounds in waterproofing flax canvasses. After stressing the new opportunities for research and the importance of maintaining a scientific staff of high calibre, Dr. Turner said that the Institute's studies of the processing of such fibres as acetate rayon; nylon, 'Terylene' and 'Orlon' have already accumulated a considerable store of knowledge on these fibres, individually and in blends; he expressed the belief that man-made fibres could be introduced with advantage into the textile economy of Northern Ireland and that the dry-spinning industry in Scotland would likewise benefit from these investigations.

Peaceful Uses of Atomic Energy

THE Association of Scientific Workers and the Labour Research Department have produced a useful pamphlet on the "Peaceful Uses of Atomic Energy" (pp. 16 ; 1955 ; from the Association ; 6*d*.), which is designed to give the ordinary citizen a clear idea of the nature of nuclear science and the nature and possibilities of nuclear power, particularly for Britain, including the uses of radioactive materials. The pamphlet is simpler and much shorter than that of the Central Office of Information on "Nuclear Development" or the White Paper "A Programme of Nuclear Power". Though the pamphlet does less than justice to British developments with radioactive isotopes, it can be commended as likely to assist the general understanding of potentialities in this field. Little is said of the demand its development may make on our resources of materials or of scientific man-power.

Chemistry of Colouring Matters : Symposium in London

A SYMPOSIUM on 'Recent Advances in the Chemistry of Colouring Matters" has been arranged by the Chemical Society and will be held in the Royal Institution, Albemarle Street, London, W.1, during the afternoon and evening of February 2. There will be two sessions, under the chairmanship of Dr. R. P. Linstead and Sir Alexander Todd, respectively, at which papers on the following topics will be read: steric effects in azo and indigoid dyes (Wallace R. Brode); cis-trans isomerism in azo-dyestuffs (R. H. Peters and E. Atherton); synthesis of azaporphins and related macrocycles (J. A. Elvidge); synthetic carotenoids (O. Isler, H. Lindlar, M. Montavon, R. Rüegg, G. Saucy and P. Zeller); and modern theories of colour (M. J. S. Dewar). The papers and subsequent discussion will be published later as No. 4 in the Society's series of "Special Publications". Advance proofs of the papers and admission tickets for those other than Fellows of the Society can be obtained from the General Secretary of the Society at Burlington House, London, W.1, to whom all inquiries relating to the symposium should be directed.

University of London: Appointments

The following appointments have been made in the University of London: Mr. J. G. Ball, head of reactor metallurgy in the Metallurgy Division of the Atomic Energy Research Establishment, Harwell, to the University chair of physical metallurgy tenable at the Imperial College of Science and Technology; Dr. Walter Murgatroyd, principal scientific officer, Atomic Energy Research Establishment, Harwell, to the University chair of nuclear engineering tenable at Queen Mary College; Prof. H. O. W. Richardson, professor of physics in the University of Exeter, to the Hildred Carlile chair of physics tenable at Bedford College; Dr. L. Fowden, lecturer in botany at University College, to the University readership in plant chemistry tenable at that College; and Dr. C. W. Jones, lecturer in applied mathematics in the University of Liverpool, to the University readership in applied mathematics tenable at the Imperial College of Science and Technology.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: D. R. E. Jackson (agricultural officer, Eastern Region, Nigeria), senior agricultural officer, Eastern Region, Nigeria; A. Johnston (plant pathologist, Federation of Malaya), senior plant pathologist, Federation of Malaya; N. W. Smyth (agricultural officer, Sarawak), agricultural officer, Bechuanaland Protectorate; G. A. Southwell (agricultural officer, British Honduras), agricultural officer, Grenada, Windward Islands; R. M. Steven (senior agricultural officer, Sierra Leone), principal agricultural officer, Sierra Leone; J. W. Bride (assistant conservator of forests, Sierra Leone), assistant conservator of forests, Northern Region, Nigeria; J. L. Coldwells (assistant conservator of forests, Gold Coast), assistant conservator of forests, Nyasaland; J. E. M. Horne (assistant conservator of forests, Federation of Nigeria), principal, Forestry School, Federation of Nigeria; J. J. Lawrie (assistant conservator of forests, Somaliland Protectorate), principal forestry officer, Somaliland Protectorate; J. S. Lightbody (assistant conservator of forests, Nigeria), assistant conservator of forests, Kenya; L. A. W. Hayward (senior scientific officer, Federation of Nigeria), principal scientific officer, West African Stored Products Research Unit, Department of Marketing and Exports, Federation of Nigeria; D. L. Johns (research officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organization), senior scientific officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organization; R. Hill, agricultural officer, British Solomon Islands Protectorate; I. M. Johnson, agricultural officer (soil conservation), Kenya; J. M. Bigg and J. R. F. Lushington, assistant conservators of forests, Tanganyika; R. F. Mackenzie, assistant conservator of forests, Northern Region, Nigeria; W. S. Moffat, geologist, Gold Coast; T. L. Gracey, assistant bacteriologist, Medical Department, Jamaica; F. Lothe, pathologist, Medical Department, Uganda; M. W. Service, entomologist, Malaria Service, Federation of Nigeria; M. C. Round, field zoologist, Veterinary Department, Kenya; J. R. Wells, veterinary officer, Uganda; M. J. Cawderry-Hope, scientific officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organization; G. A. H. McClelland, scientific officer, East African Veterinary Research Organization.

Announcements

The Royal Academy of Sciences in Sweden has elected the following to foreign membership: Prof. T. H. Goodspeed, professor of botany in the University of California, Berkeley; Dr. Mervin J. Kelly, president of the Bell Telephone Laboratories; and Sir Geoffrey Taylor, of Cambridge, Yarrow research professor of the Royal Society.

The Esso Development Company has made a grant (for one year in the first instance) to the University College of North Staffordshire to support a postgraduate research student in the Department of Chemistry. The work will be concerned with cationic polymerization, under the direction of Dr. P. H. Plesch.

Three new appointments to senior positions have recently been made in the United Nations Food and Agriculture Organization: Mr. Joseph L. Orr (United States), since 1951 special assistant to the Director-General, will be the Organization's liaison officer at the United Nations Headquarters; Mr. Harold L. Vogel (United States) will be the representative of the Director-General in North America; and Mr. Adolfo Alarcón (Mexico) will be the regional officer for Mexico, Central America and the Caribbean.

The Medical Research Council is offering a further series of fellowships in clinical research, tenable at centres in the United Kingdom during the academic year 1956–57. The fellowships, which may be renewed up to a maximum of three years, are worth £950–£1,100 a year, and are open to medical graduates with some clinical experience who wish to prepare themselves for a career in clinical research. Application forms, to be returned by March 1, and further information can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

A symposium on "Perspectives in Marine Biology" will be held in the Scripps Institution of Oceanography, La Jolla, of the University of California, during March 24–31 under the joint sponsorship of the Institution and the United States Office of Naval Research. The discussion will be centred on potential developments in marine biology rather than on past accomplishments, and a large number of scientific workers from outside the United States have been invited to participate. Those wishing to attend should write to Prof. A. A. Buzzati-Traverso, Scripps Institution of Oceanography, La Jolla, Calif.

GENERAL ELECTRIC RESEARCH LABORATORY, SCHENECTADY

NEW METALS AND CERAMICS BUILDING

By ROBERT L. FULLMAN
Materials and Processes Section,
AND
ROBERT M. PARKE
Materials Application and Evaluation Section,
Research Laboratory, General Electric Company, Schenectady New York

A NEW Metals and Ceramics Building was dedicated late last summer in Schenectady, N.Y., as the facilities of the General Electric Research Laboratory were enlarged. The new building reflects the current widespread interest in research into metals and ceramics, and is part of a 15-million dollar expansion programme now being undertaken at the Laboratory.

The programme of work to be undertaken in the new building includes the following: (1) to ascertain and analyse the areas of most critical need for materials and processes; (2) to develop new processes for new businesses; (3) to develop new materials to improve products; (4) to study existing materials and obtain a better understanding of their properties and processing; (5) to operate pilot plants and obtain economic data.

Dr. J. Herbert Hollomon, manager of the Metallurgy and Ceramics Research Department, has stated that the constant growth of the General Electric Co.—and the ever-increasing diversity of the Company's needs—have necessitated the expansion of the facilities available for such work. "In addition," he says, "it is now more important than ever that the Research Laboratory's scientific understanding should be used for helping to solve any critical problems relating to materials and processes that may stand in the way of Company progress. The organization of the new Metals and Ceramics Building includes the establishment of a group of scientists to seek out and solve problems pertaining to materials and processes wherever they may appear in the Company. Thus, in the new building, amid facilities of both laboratory and industry size, the promising findings of our outstanding group of metallurgists, ceramists, physicists and chemists can be applied to the kind of problems now creating a bottleneck at the designer's level."

One field in which the Metals and Ceramics Building is expected to make significant contributions is in studies of the effect of the 'scale factor' on the properties and processing of materials. Investigation of the effect of large increases in the scale of operations during the transition from laboratory work to production previously has been among the least explored fields of metals and ceramics research. Studies in this field will include the feasibility and the probable cost of factory-size operations.

The General Electric Metals and Ceramics Building is for this reason one of the few facilities in existence which makes available to the research worker production-size equipment unrestricted by the scheduling demands of actual production. When the building was being planned, the size of the machines was to a large extent determined by the quantities of material that would have to be produced in order to make possible a realistic evaluation from the point of view of production. The size of some furnaces, for example, was determined by the smallest quantity of metal that would permit the manufacture of at least one complete product, such as a transformer, for evaluation purposes. The advice of manufacturing components of the Company was, therefore, sought in ascertaining practical limits of equipment capacity for pilot-plant production.

In order to allow the most efficient use of the variety of equipment, the building has been constructed for maximum flexibility, using what has been referred to as the 'erector set' principle. In this method of construction thousands of bolt holes are aligned throughout the structure of the building, permitting easy re-location of equipment. Consequently, as one research project is completed, another may be set up with a minimum of time and effort.

The available processing equipment includes arc-melting furnaces capable of melting highly refractory metals under vacuum and in inert atmospheres. Furnaces of this type are needed because many alloys now under investigation cannot be melted by normal commercial techniques. Vacuum arc-melted ingots of 300 lb. can be produced at the rate of three a day, while it is expected that in the future, by a continuous process, it will be possible to produce ingots weighing four thousand pounds or more. An industrial-type three-phase arc furnace for the preparation of one-ton heats of steel, and induction furnaces for melting metals and alloys in vacuum, controlled atmospheres or in air are also available.

Forming equipment includes a hydraulic extrusion press of 1,250-ton capacity, specially designed for rapid extrusion of super-alloys; a 2,500-lb. drop-hammer; 250-lb. and 2,500-lb. forging hammers; swaging equipment; and a new reversing, two-stand, rod-rolling mill. The rod mill has been designed for high-speed operation, permitting super-alloys to be formed to final size before they cool significantly from the annealing temperature.

A Sendzimir cold mill for rolling metal foils to thicknesses less than a thousandth of an inch, and a Sendzimir planetary hot mill, one of the first, have also been installed in the new building.

Much of the equipment for metal processing will also be used for the melting, heating and shaping of ceramic materials; but certain ceramic presses, furnaces and other equipment have been installed in separate areas to avoid contamination of the material.

The research staff have available throughout the building compressed air, high- and low-pressure steam, city gas, nitrogen, oxygen, standard hydrogen, dried hydrogen (– 90° C. dew point), rough vacuum, distilled water, cooling water, and hot and cold tap water.

THE TEACHING OF CHEMICAL PRINCIPLES

SECTIONS B (Chemistry) and L (Education) of the British Association held a joint discussion on September 6 on "The Teaching of Chemical Principles in School and University". In connexion with this discussion an exhibition of teaching models and demonstrations was arranged by the Chemistry Departments of the University of Bristol.

Opening the discussion, Prof. D. H. Everett (Bristol) said that in the past twenty or thirty years teachers of chemistry have been faced with new problems reminiscent of those raised at the end of the past century by the advent of physical chemistry. There is, he said, less need now to emphasize the principle that the physical basis of chemistry should form a framework for the teaching of chemistry; instead, the more important questions are concerned with the stage at which modern theoretical ideas—quantization of energy and of radiation; wave mechanics; atomic and molecular orbitals; statistical mechanics and thermodynamics—should be introduced, and with the way in which the abstractions with which they deal can be explained to the uninitiated.

The usual university honours course in chemistry has long since ceased to deal with more than a very small fraction of the total extent of chemical knowledge. However, specialization at an early stage in an honours course, with the object of achieving a detailed coverage of a small part of the subject, is undesirable in itself and obscures from the student the power of the underlying principles to unify the subject. It seems more than ever important that chemical education should not only provide the student with a basic knowledge of the facts of chemistry, but should also develop in him an intuition which will enable him to appreciate the significance of new facts as he meets them. It was argued that there should be a place in the university curriculum for a course in chemical principles which would acquaint the student with the more important features of a wide range of phenomena, and which would show how these are linked by fundamental theory. (An extended essay on this theme is to be found in "The Structure of Physical Chemistry", by Sir Cyril Hinshelwood: the treatment in this book is, however, on a more advanced plane than that foreseen by Prof. Everett.) Some more highly specialized topics would be crowded out of the undergraduate into the postgraduate curriculum, but this is not a serious disadvantage. The understanding derived from a course of this kind is more important than an encyclopædic knowledge of chemical facts.

The physical concepts upon which the principles of chemistry are based are nearly all abstract in nature. The ability to appreciate abstract thought develops slowly, and there are in consequence two opposing views concerning the method of introduction of these ideas. Either they should be deferred until the student is more mature, or they may be introduced early in the university course so that he may have time to understand their value by the end of the course. Because of mathematical difficulties, it is impossible to give a rigorous discussion, and so we must be satisfied with an introductory treatment based on models and analogies, which gives a partial understanding. All such simplifications are, however, half-truths, which if applied incautiously can lead to confusion; but if the models and analogies are carefully chosen, and presented with the right emphasis, the dangers of the 'simple introduction' can be minimized. Some ideas implanted in an early course may have to be rejected later, but the student must be prepared to develop his ideas throughout his training: this evolutionary process is characteristic of the development of science as a whole, and a realization of this fact is important to the student.

Prof. Everett expressed the opinion that many of the fundamental ideas can be explained to students at an early stage in their course (Inter. B.Sc. or first-year degree course) by means of simple mechanical models designed to illustrate macroscopic analogies of the molecular situation rather than to represent the actual atomic or molecular state of affairs. He then demonstrated a series of models illustrating, among other things, the quantization of orbits in the hydrogen atom; absorption and emission of energy in definite quanta; the development of the periodic system of elements in terms of the electronic energy-levels; atomic orbitals; molecular orbitals; the free-energy relationships in an allotropic change, and in the solution of a solid in a liquid. More detailed descriptions of these models will be published in the *Advancement of Science*.

Prof. C. A. Coulson (Oxford) read a paper on the "Teaching of Quantum Mechanics to Chemists". He said that no greater change in chemical understanding has ever taken place in modern times than that associated with the advent of quantum mechanics. As a result, to-day no chemical education is worth considering which fails to take account of this development. Yet quantum theory itself is too wide, and too complicated, to present to chemistry students at a university. For practical purposes it seems as if wave mechanics must bear the effective emphasis. This is, by comparison with other forms of quantum theory, relatively simple, and makes more use of conventional ideas such as probability.

Wave mechanics in chemistry is based on two concepts: the idea of quantization, and the description of electron properties. Neither of these is likely to be obvious, despite the efforts of the popular Press. Hence we seek some simple analogy, or model. These analogies and models seem to be of first-rate importance, since without them there is little or no chance that the student will acquire a 'feel' for these modern interpretations. But they are dangerous, and have often led to serious confusion.

Quantization can be approached via the de Broglie relation and the familiar example of standing waves in a violin string. Electron properties—for the chemist—resolve themselves chiefly into probability distributions (or, more simply, the idea of a charge-cloud) and spin. In the first of these the most important factor to stress is shape. It is unimportant in earlier stages to relate these to magnetic properties. There seems no simple model or analogy for electron spin, and all attempts to provide one seem doomed to cause great confusion later. (Physicists may be able to understand the vector model of an atom, etc., but it is doubtful if chemists should be expected to do so.) A simple version of the Pauli exclusion principle is easily written down, adequate to deal with most ground-states of atoms and molecules, and Hund's rules for incomplete shells can be stated plausibly.

Prof. Coulson expressed the view that every chemist should have some familiarity with wave functions, and suggested that the two lowest-energy states of the hydrogen atom could be worked out by students—this would give confidence that more complete treatments for more complex systems would in fact yield the correct answer.

As an example of the dangers in all elementary accounts, Prof. Coulson cited the frequent misuse of the word 'resonance'. A critique of this concept should be regarded as part of any course on wave mechanics, and leads easily and naturally to a discussion of the true status of wave mechanics, as a most valuable conceptual tool, which gives insight into chemical phenomena, but which is severely limited if accurate *ab initio* calculations are desired. No electronic computer will replace a chemical laboratory.

The third main paper was read by Mr. G. I. Brown (Eton), who gave as the duty of a science master that of understanding the developments in science and interpreting and presenting them in a simplified form to the uninitiated. He considered it important that there should be no undue delay in incorporating new advances into school teaching. This is no easy task for the teacher, and Mr. Brown urged more liaison between active teachers in universities and schools. He welcomed the opportunity for this discussion, also, because it provided a chance of emphasizing the attractions of a teaching career. The teaching of chemistry can be made both interesting and attractive by the variety of possible ways of presenting it, and by the different requirements of students. He stressed that the advanced course of chemistry at school must never be a narrow one, but should give some indication of the importance of all the aspects of chemistry. Each teacher must to some extent decide on the type of approach to be adopted. However, the recent trend towards an undue emphasis on the social and economic aspect was deprecated as one which can too easily give the impression that chemistry is solely concerned with such things as nylon underwear.

Mr. Brown considered that the basis of the course for sixth-form science students should be a theoretical one, involving a study of fundamental chemical principles. Of these the most useful as a unifying framework is modern valency theory. Chemistry is often criticized as a school subject on the grounds that it can be learnt simply by perseverance and hard work, and that it involves too little real thinking. It is true that, below sixth-form level, chemistry cannot fail to be largely a matter of routine learning of apparently unconnected facts—but young boys make no objection to learning the facts, and many have little difficulty in doing so. What is difficult, at this stage, is to exercise the mind of the student in the same way as it is exercised in the learning of, say, mathematics or Latin. There comes a time, usually while still at school, when a boy begins to ask more fundamental questions—and then his mind must be stimulated by something more than a mere catalogue. Mr. Brown expressed his belief that modern valency theory provides the necessary interest, and that despite the criticisms levelled against its introduction in school-teaching, the benefits derived from its use far outweigh the reduction in factual knowledge implied by a change in the balance of study.

Mr. Brown was critical of examining bodies who continue to set questions requiring for their answer the recollection of far too many unimportant facts, and pointed out that the quickest and most effective way of changing the character of school-teaching is to change examination syllabuses and the nature of the examination questions.

The two main contributors to the general discussion which followed were Mr. J. C. Stredder (Tonbridge) and Mr. A. C. Cavell (Uppingham). Mr. Stredder, while not rejecting the incorporation of more recent theories in teaching at school, stressed the dangers of such a policy. He was particularly concerned that an inexperienced pupil, who is unable to criticize—and perhaps unable to understand—the experimental evidence on which modern theories are based, must either allow his critical faculty to be dulled, or must accept such theories as fairy-tales in which he may one day believe. There is a danger that not only facts but also theories will be learned parrot-fashion. Furthermore, the introduction of many modern ideas must depend on the pupil having a sufficient background in physics; and often this cannot be provided adequately at school. Mr. Stredder was of the opinion that, with some exceptions, boys are scarcely ready to be introduced to subjects such as the wave nature of the electron, atomic orbitals, resonance and molecular orbitals until they enter a university.

Mr. Cavell was anxious that developments in chemistry teaching in schools should take account of the educational as well as the more specialized technical aspects. He expressed the view that both schools and universities are attempting to teach too wide a syllabus in science, and that by introducing too much detail, insufficient time is available for dealing with basic principles. While agreeing with Mr. Brown that modern valency theory helps to make sense of chemistry, and encourages thought and discussion, Mr. Cavell said that in his experience the evidence provided by school certificate scripts suggests that either this approach is not being widely used, or that candidates are averse to using it in answering examination questions. His agreement with Prof. Everett that a rational rather than a strictly historical approach is to be preferred, was qualified by the view that one of the fundamental educational weaknesses of science is that it deals more with things than with people. Consequently, he argued, no opportunity should be lost of introducing historical and biographical detail in an attempt to humanize the subject. Mr. Cavell also appealed for closer co-operation between teachers in school and university, especially in connexion with the revision of school syllabuses, the provision of courses for science teachers at universities, and on detailed techniques of science teaching.

PROPERTIES AND DISTRIBUTION PROBLEMS OF RAW COTTON

A ONE-DAY conference on "Raw Cotton, its Properties and Distribution", arranged by the Manchester and District Section of the Textile Institute, was held in Liverpool on November 23 to facilitate the participation of raw-cotton merchants in discussing current problems in the growing and marketing of raw cotton with the spinning and weaving sides of the cotton industry. It was also hoped that the conference would illustrate part of the wide field of activities undertaken by the Textile Institute and so encourage the formation of a Liverpool section. Four papers were presented for consideration and discussion: genetics, by Prof. S. C. Harland (professor of botany in the University of Manchester); cotton quality and its assessment, by E. Lord (British Cotton Industry Research Association); spinners' requirements, by A. Draper (William Birtwistle Allied Mills, Ltd., Preston); and supply and marketing, by W. B. Hutchinson (Major Cleaver and Co., Liverpool).

Partly through necessity, the cotton industry is accustomed to handling variable material, and both marketing and industrial processing are organized to minimize the effects of quality variations. Prof. Harland outlined how large differences between the main groups of commercial cottons are mainly genetical in character, but environmental factors also produce appreciable effects. Variability in the many characters of the fibres in a given cotton sample starts with marked regional variation over the surface of the seed and is progressively increased by additional variation associated with seed to seed, boll to boll and plant to plant differences. Samples of the same strain, but different origin, often show pronounced locality and seasonal effects. Yield is of paramount importance to the grower and so far has received the most attention in the breeding programmes of various research stations. Nevertheless, cotton quality can be improved appreciably by the applications of genetical methods, both by reducing the variability and increasing the average fibre quality. Some past achievements along these lines in various countries were reviewed, and Prof. Harland also pointed out that as yet we are not able to formulate or even envisage the future upper limit that it may be possible to reach by cotton breeding. A valuable development during recent years is the increasing use of spinning tests to measure directly particular yarn features in preference to the previous almost complete dependence on a range of individual fibre tests.

For many years, and still to a large extent, the various features of raw cotton have been appraised commercially by subjective methods, particularly by making assessments based on the visual appreciation of appearance and on tactile impressions noted during manual manipulation of the fibres. A high degree of skill in the classification of cotton quality may come with long experience; but it remains largely a personal matter. Mr. Lord reviewed many of the 'laboratory' methods which have been developed to furnish separate objective evaluations of the various characteristics affecting cotton quality and commented on their accuracy, ease of use, limitations and scope of application. Determination of fibre length may be effected in several ways. In some methods, complete estimation of the several aspects of the distribution of fibre length may be made by tests largely dependent on the skill of the operator. In others, special fibre arrangements may be prepared and measured by the use of photoelectric scanning devices. The cotton fibre is a hollow, flattened and twisted single cell which grows out of the epidermis of the seed. Both perimeter and the degree of wall thickening are of industrial importance; but direct rapid measurement of these features is not generally feasible because of difficulties of technique and the high inter-fibre variation. Tests based on the determination of the weight per unit length and on the microscopical classification of swollen fibres have been developed to furnish indirect estimates of fineness and thickening. These methods have found widespread application, although they are slow in the light of classers' requirements. Measurement of the air permeability of compressed plugs of cotton fibres affords a rapid and reasonably accurate method of assessing specific fibre surface. The specific surface is determined both by the fibre fineness and the cell-wall thickening, and hence the practical interpretation of flow estimates demands care. Fibre strength is of prime technical importance and is most easily measured on bundles of parallel fibres. The structure and growth of cotton are such that weak places occur at irregular intervals along each fibre, and this leads to a marked dependence of measured fibre strength on the length of test specimen, so that no single set of experimental conditions affords a means of fully assessing the separate strength characteristics. Cotton 'grade' was another feature briefly reviewed at the conference. The 'Shirley' analyser is a mechanical tester for the determination of the trash or foreign content of cotton, one quantity largely influencing the classified grade. The assessment of particular reflectance characteristics of cotton may be made on the automatic Nickerson–Hunter cotton colorimeter. Observations on this instrument correlate well with the visual grade classifications of American cotton. Commercial applications of the colorimeter are limited by the price, but its use in maintaining a regular check on the choice and formation of physical standards of grade is now established in the United States and should prove valuable in avoiding small but progressive changes which have occurred in the past.

Mr. Draper commented further on the application of fibre and spinning test methods to the choice and classification of raw cotton. Most objective tests are still too lengthy to permit their being applied to all commercial samples. Nevertheless, there is a strong need for representative scientific data to be available to the grower, merchant and spinner in order to encourage the production of more suitable material and to detect quickly those growths in which deterioration is occurring. He felt that in some instances the side of the industry concerned with growing might have exploited scientific tests to indicate how closely quality can be cut without incurring undue complaint instead of exploring more fully the possibilities of developing new strains of better general quality or with specialized characteristics for competing or blending with man-made fibres. Mr. Draper also outlined in detail some of the ways in which practices of merchanting raw cotton in Great Britain might usefully be extended in order to meet more satisfactorily the requirements of the spinner.

Mr. Hutchinson surveyed the basic principles of the organization of cotton marketing. The present pattern in Britain has been gradually developed to fill many varied needs. It must provide a selling link between the small grower and the consumer and maintain classification methods to ensure reasonable continuity in quality despite regional and seasonal fluctuations. Marketing organization on a wide scale requires a complex price-structure to cope with rapidly changing supply and demand, with intermittent government interference through monetary controls and crop limitations, and with the problems arising through price changes during the often lengthy period which elapses between harvesting the crop and the final production of textile articles. The use of scientific tests to determine cotton quality is a development of significance which cannot be ignored. Merchants must examine these methods and place them in proper perspective in the general framework of trading. Stress was laid by Mr. Hutchinson on the need for merchants and also spinners to have the fullest information available about the various characteristics of both main growths and new varieties. He said that at first it would probably be found better to superimpose any new tests on the established systems of classifications than to set up new systems. Nevertheless, marked additional sub-classification would certainly give rise to serious marketing difficulties. Selling would be made more complicated because many test results cannot be used as a basis for trading values, choice of material might be more restricted, and prices would be increased by higher classification costs, while adequate cover against price changes could not be arranged to cope with a multiplicity of qualities. There might be more scope for the use of scientific tests in normal 'spot' trading of cotton for immediate consumption than in 'futures' trading for covering price changes.

SYMPOSIUM ON THIOCTIC ACID

A SYMPOSIUM on the chemistry, biochemistry and pharmacology of thioctic acid was held during November 28 and 29 at the Institute of Pharmacology of the University of Naples. There were about a hundred participants, including Profs. Bovet, Chain, Condorelli and Rossi-Fanelli (Rome), Prof. Theorell (Stockholm) and Prof. Vannotti (Lausanne), apart from the speakers.

The symposium was introduced by Prof. D. Marotta, director of the Istituto Superiore di Sanità (Rome), and the first lecture was given by Prof. M. Calvin (California), who discussed the part played by thioctic acid in the photosynthetic cycle. Prof. Calvin reported the isolation, with the help of ^{35}S-labelled thioctic acid, of the natural active form from the plastids of algae. It is probable that, in this form, the carboxyl group of thioctic acid is bound in an ester linkage to a hydroxyl group of glycerol.

Prof. E. A. Braude (London) followed with an account of the synthesis of thioctic acid. He described a new method which affords a good overall yield in few steps and represents the first application of the Prins reaction (addition of formaldehyde to an olefin) to the synthesis of a natural product.

The pharmacology of thioctic acid was discussed in a lecture by Prof. L. Donatelli, who stated that the lethal dose in rabbits, mice and other animals lies between 100 and 220 ml. per kgm. weight. A strong antitoxic action of thioctic acid was demonstrated for acute and chronic poisoning by mercuric chloride, arsenite, arsenobenzoles, carbon tetrachloride, aniline and *iso*nicotinic acid hydrazide. A remarkable diuretic and choleretic effect was also observed in the rabbit.

The second day was devoted to the physiopathology and therapeutic applications of thioctic acid. Prof. P. Larizza (Cagliari) reviewed present knowledge on the part played by thioctic acid in biochemical processes and illustrated his experiments on phosphorus poisoning and steathogenic (Handler) diets in which thioctic acid normalizes the fat content of the liver. Prof. F. Rausch (Bad Rothenfelde) reported on the applications in human pathology, particularly in the awakening action on liver coma patients. This effect was confirmed by Prof. A. Colarusso (Naples), who also discussed the liver-protecting action in hepatic cirrhosis and various forms of hepatitis. He noticed a remarkable diuretic effect on some of his patients with liver cirrhosis and congestive heart failure. The dose used was of the order of 20–50 mgm. per day, usually injected intravenously.

From these lectures and from the lively discussion which followed, it was clear that thioctic acid, apart from playing an important part in plant metabolism, may be a useful therapeutic agent, especially in diseases of the liver.

A. Segre

WATER RESOURCES OF GREAT BRITAIN

ALONG with the news of the reconstitution of the Central Advisory Water Committee (*Nature*, October 22) comes the welcome reappearance of "The Surface Water Year Book of Great Britain"*. A complete survey of inland water resources involves details of rainfall, surface water and ground water. The "Year Book" provides information about the surface water resources of most drainage areas and their rainfalls, and rather more detailed information relating to rainfall alone is issued annually in "British Rainfall", published by the Meteorological Office. Details of ground water resources are not yet available, but active steps are being taken to acquire and issue this information.

The first three "Surface Water" volumes dealt with the periods 1935–36, 1936–37 and 1937–45, and the fourth and present volume with the eight water years 1945–53. In the first two volumes the measurements reported were collected from various public and private organizations, and the distribution of the records was very uneven. This was improved in the third volume, and a further notable increased coverage occurs in the fourth volume largely as a result of the River Boards Act of 1948.

In the present volume Great Britain is divided into 103 areas, each area corresponding to one or more river basins. Within each area there is, first, a general description of the region, the gauging stations and the records available. Monthly evaluations of the average general rainfall over the drainage area for the standard period 1881–1915 are given, and then follow tables of monthly discharges and run-off, together with monthly evaluations of the general rainfall. An indication of extreme discharges is also given.

Thus the presentation of the data, so far as the monthly flow records are concerned, closely follows the pattern of the third volume, but the new volume does not give daily discharges for each station or the tables of frequencies. The possible inclusion of these data and other relevant information is, however, under consideration for the next issue, which it is hoped will cover only one water year. Meanwhile, the issue of the fourth volume is a notable step towards the systematic collection and dissemination of the basic data necessary for the formulation of a much-needed national water policy in Great Britain.

W. G. V. Balchin

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* Ministry of Housing and Local Government: Scottish Office. The Surface Water Year Book of Great Britain, 1945–53. (Hydrometric Statistics for British Rivers, together with related Rainfalls, for the Eight Years ended 30th September, 1953.) Pp. xi+167. (London: H.M.S.O., 1955.) 35s. net.

SCIENCE IN THE UNITED STATES DURING 1954

THE third report of the British Commonwealth Scientific Office in Washington, D.C., entitled "Notes on Science in U.S.A., 1954"*, covers 1954 and is not so specifically linked with the United States fiscal year as the two previous reports. During the period under review, the only legislative activity directly affecting science was the passing of the new Atomic Energy Act, which permits an increased release of information on atomic energy to American industry and exchanges with other countries. While the possibilities of exchanging military-type information are limited, there is wide scope for co-operation on the peaceful uses of nuclear energy. The five-year nuclear power programme of the Atomic Energy Commission, which was approved in March 1954, calls for research and development at a cost of 8·5 million dollars a year and a total estimated expenditure of 199 million dollars on five specific projects on reactors of the following type: pressurized water; sodium graphite; boiling water; homogeneous; and fast breeder. Besides this, the United States Navy has expanded its programme of nuclear-powered vessels, and the Air Force is developing nuclear-powered aircraft. For the Army, a power plant, the so-called Army Package Power Reactor, is being constructed; this will develop about 2,000 kW. of electricity, and the components will be transportable by air. The Commission has replaced the previous 'study' agreements with industry by three types of participation agreements, and it was estimated that perhaps a hundred new participating agreements would be signed in 1955 in addition to the twenty study agreements by the end of 1954. In the field of particle accelerators the Commission has approved the design and construction at the Brookhaven National Laboratory of an ultra-high-energy alternating-gradient synchrotron for producing beams of protons of energies ranging up to 25,000 MeV. The value to industry of radioisotopes is now estimated at a hundred million dollars a year, and that of the ancillary industry of making instruments for the detection of radiation is expected to reach thirty-five million dollars a year by 1956. The Commission is constructing a new 200,000-dollar plant for processing radioiodine and has made available to industry the irradiation facilities of the high-intensity 30,000-kW. Materials Testing Reactor at Arco, Idaho, while a 90,000 dollar gamma-radiation plant is being constructed at Argonne primarily for use by the Army in studying food preservation. A note on nuclear developments in Canada directs attention to the valuable information which has been gained in restoring the 30,000 kW. reactor at Chalk River (called NRX). The reactor is now operating at 40,000 kW., and this greater power will reduce the time for research experiments and the production of isotopes, as well as permit tests on components for the new reactor to be made under irradiation more nearly comparable with actual conditions of exposure.

Referring to the President's Executive Order of March 1954, reiterating his support for the National Science Foundation, the report points out that the Order is important as indicating the Administration's intention that the Foundation shall be the cornerstone of the basic research effort of the United States. Federal expenditure on research and development in 1954 is estimated at 2,095 million dollars, or 3·1 per cent of the total budget, and roughly half the national expenditure on research and development. Of this, 1,530 million dollars went to the Department of Defense, and, including all the work of the Atomic Energy Commission and of the Advisory Committee for Aeronautics, the proportion concerned with defence was 90 per cent. About 250 million dollars was spent on new facilities and equipment. In view of the complexities of the relation between the National Academy of Sciences and the National Research Council and of the slight understanding of those outside the United States of the relation of the Academy to the Government, the functions of both bodies are explained at some length. During 1952–53 about three-quarters of their income of 6 million dollars came from government contracts and grants.

Academic research on solid fuels was reduced in volume during the year; but in view of the state of the coal industry a programme to develop new, and maintain existing, markets for coal has been initiated. A joint survey of the comparative economics of the electric furnace and the open-hearth furnace for the production of low-carbon steel indicated substantial advantages for the electric furnace; but a complete change-over to electric furnaces would require a 12 per cent increase in the output of electricity and 25 million tons a year increase in coal consumption. In the new programme on synthetic liquid fuels emphasis has been placed on catalyst development, while in coal hydrogenation the aim is a one-stage high-pressure process giving high yields of gasoline; the chemistry and physics of the processes are receiving more fundamental study. Little further work on the gasification of coal at atmospheric pressure is contemplated, but construction of an improved pressure-gasifier at the new research station at Morgantown continued; this may permit a two-thirds reduction in the cost of compressing synthesis gas before its use in methyl alcohol, ammonia or Fischer–Tropsch synthesis. The possibility of transporting liquid methane in ships containing tanks internally insulated by a thick layer of cemented balsa wood sections is being examined, and increasing attention is being given to atmospheric pollution, on which ninety-eight laboratories in the United States were working during 1953. In the Detroit (Michigan)–Windsor (Ontario) area an International Air Pollution Study is in progress in which an international technical advisory board co-ordinates the activities of both United States and Canadian authorities, and co-operation has also been secured in attempts to reduce smoke emitted by vessels plying the Detroit River.

Interest in solar energy is expanding, and at a conference at Madison, Wisconsin, in June 1953 graphical methods were demonstrated for analysing the economics of collector design; the basic mechanism of photosynthesis was discussed from the point of view of quantum mechanics and thermodynamics, and of photolytically induced endothermal chemical reactions, while the Bell Telephone Co., Inc., has announced a photoelectronic cell consisting of a very thin plate of metallic silicon yielding, in full sunlight, power at the rate of about 50 watts per sq. yd. The mass culture of algae is also receiving much attention, and a feature of a symposium at the Boston meeting in December 1953 of the American Association for the Advancement of Science was the disclosure that much of the present work is with algae other than *Chlorella*.

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* British Commonwealth Scientific Organization (North America). Notes on Science in U.S.A., 1954. Pp. iv+39. (London: H.M.S.O., 1955.) 2*s*. net.

Although water is an abundant resource in the United States, it can no longer be taken for granted, and the rapid increase in the use of ground water for air conditioning appears to be causing concern; but there appear to be insufficient data on water losses in all phases of the cycle of water supply and use. Active work continues on the desalting of water; but nothing yet published suggests that provision of irrigation water in quantity by this method is approaching economic possibility. In agriculture the main development during the year, especially in the western States, was the use of liquid fertilizers. Several nitrogenous solutions are on the market, and other solutions, containing nitrogen, phosphates and potash, are available for use with low-pressure spraying equipment or for insertion into irrigation water. As regards insecticides the present trend is to concentrate on substances which can be absorbed into the plant system and, by their presence in the plant cells, prevent attack by insects or infection by disease. Growth-regulating substances are being used not only for removing unwanted plants but also for controlling the rate of development of ornamental shrubs, to delay the flowering of fruit trees, and even to retard the growth of lawn grass. In animal production, the main developments on the nutrition side have been the use of antibiotics to accelerate the fattening of cattle, and the evolution of a system by which pigs can be weaned at five days old. In 1952, about 30 per cent by weight of all antibiotics produced in the United States was fed to farm animals. Further developments by industrial interests and by the official research centres during 1953 and the first half of 1954 may well make 1954 the last 'experimental' year in regard to the full-scale commercial production in the Americas of kenaf, the jute substitute. The problem of mechanical harvesting has not been solved, however, but chemical retting may go far to place the industry in a strong position.

In metals and metal physics, work on the sintering of iron ores has received considerable impetus, and many trials have been made with a high proportion of sinter in the burden. Attention is being given to the development of domestic sources of supply of titanium, and a new plant, with an annual output of a hundred thousand tons of ilmenite, is under construction in Florida; it is of the 'travelling lake' type and uses a battery of Humphrey spirals on a raft which floats in a lake of its own making and proceeds through the deposit as ore is taken in at the front of the raft and waste material discharged at the rear. Several firms have been working on the casting of titanium and titanium alloys, and the major difficulty of surface contamination appears to have been overcome. The potentialities of the Colorado Plateau as a source of uranium were emphasized during the year, and the release of the classified metallurgical work on beryllium has permitted a comprehensive view of the present state of beryllium metallurgy in the United States. Satisfactory methods are now available for the metallographic examination of beryllium and its alloys; but, apart from an aluminium casting, no beryllium-rich alloy is known to be in use, although beryllium might find extensive use in reactors if the cost were reduced to 25 dollars/lb. of pure beryllium raw metal. In fundamental research, much work is being done on single-crystal specimens, whereby grain-boundary effects and some other variables are eliminated. Interest is widespread in the development of chemical methods for the extraction of metals, in place of normal smelting procedures, to which low-grade ores, tailings and slags are often not amenable, and considerable attention has been paid to low-grade domestic sources of manganese, as well as to the extraction of copper, nickel, cobalt and uranium from low-grade ores. In 1953 the sale of synthetic detergents in the United States exceeded for the first time that of soap, and this increasing use is presenting problems of sewage disposal and water supply, particularly the growing use of non-ionic materials, which now account for 10 per cent of the production. There is also evidence that detergents may have a deleterious effect on the sewage-digesting bacteria.

Several research groups are considering the possibilities of mechanical aids to translation, and a feature of this report is a brief but excellent bibliography of recent articles and reports.

DETECTION OF ATMOSPHERIC DUST AND TEMPERATURE INVERSIONS BY TWILIGHT SCATTERING

By DR. E. K. BIGG

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THE detection of meteoritic dust and the tracing of its passage through the atmosphere is important in view of the evidence produced by Bowen[1] that rainfall (when added for many stations or many years) is correlated with the advent of meteor showers. Discontinuities in the scattered sunlight during twilight have been reported by Grandmontagne[2] and de Vaucouleurs[3], and the hope of displaying these more prominently and perhaps identifying them with regions of dust led to the experiments to be described.

During twilight, light received from a cone of 1° vertical angle was recorded by a photocell with filter at the focus of a large lens. The light was interrupted 250 times per sec. by a rotating slotted disk, and the alternating current from the photocell amplified and balanced against a fixed voltage, the difference between the fixed and varying voltages being read at 10-sec. intervals. Whenever the difference reached a certain level, it was reduced to zero by adjusting the gain of the amplifier. The rate of change of the deflexion of this meter was then approximately proportional to the ratio of the rate of change of illumination (dI/dt) to the illumination (I).

To emphasize the contribution of dust particles to the scattered light, the large forward scattering of particles comparable in size with the wave-length was utilized by looking in the vertical plane containing the sun at an angle of 20° to the horizon. Height was defined by the intersection of the grazing ray from the sun's centre with the line of sight, with a fixed allowance of 68′ for refraction. To make the shadow as sharp as possible, only light of red and infra-red wave-lengths was accepted by the equipment.

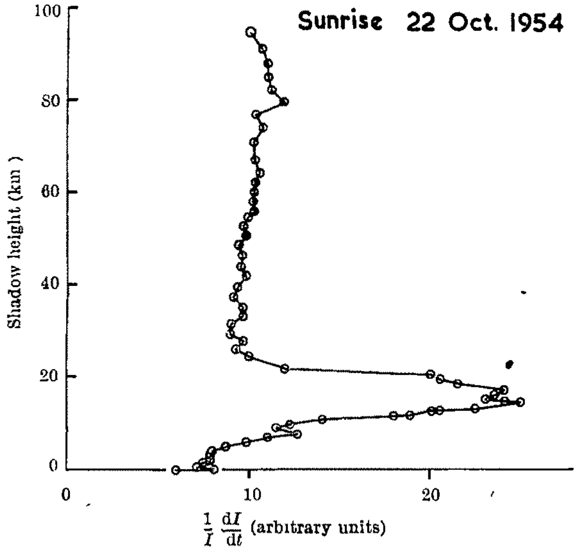

Fig. 1

The present results were obtained during October 19–November 30, 1954, near Alice Springs (lat. 23° S.) in Central Australia, a dry, cloudless climate being essential for the experiments. There was a nearby radio-sonde station from which temperature soundings were made daily shortly after noon. A fuller description of the observations at this and two other sites has been submitted for publication to the *Journal of Meteorology*.

Scattered light was detected for shadow heights exceeding 100 km., but was not recorded because of the high proportion of secondary scattering. Regular features of the twilight curve of $\frac{1}{I}\frac{dI}{dt}$ were a large maximum near 15 km., a long constant portion and second maximum near 80 km., the relative sizes in arbitrary units being 15–50, 10, 10–13 respectively. A typical example is shown in Fig. 1.

A specific example serves to illustrate the nature of the lower maximum. In Fig. 2 is shown a temperature sounding showing inversions *A–E* and the following twilight curve with maxima *A′–E′*. The interpretation of the similarity is that a maximum of $\frac{1}{I}\frac{dI}{dt}$ occurs at the boundary of regions of different dust content—a boundary usually being a temperature inversion. In cases where the only inversion was the tropopause, the peak in $\frac{1}{I}\frac{dI}{dt}$ was also usually single, and the heights of the tropopause and the peak varied from day to day in a similar way. The size of the largest maximum in the twilight curve varied greatly and was correlated remarkably with surface pressure 60 hr. later. This is thought to mean that instability in advance of cyclonic conditions led to upward transport of dust which accumulated at the tropopause. The possibility of detection of meteoritic dust by the twilight method at this level is therefore slight, because of the relatively large quantities of dust of terrestrial origin.

The long part of $\frac{1}{I}\frac{dI}{dt}$ between 25 and 75 km. was, on the average, constant but contained some short-lived irregularities which had usually disappeared by the following twilight. If these represented falling dust layers, the inference is that the dust was patchy or soon mixed vertically.

The maximum in the curve near 80 km., although smaller than that at the tropopause, was of great interest as it seemed likely to be associated with the temperature inversion known to exist there. Calculations indicate that molecular scattering alone is

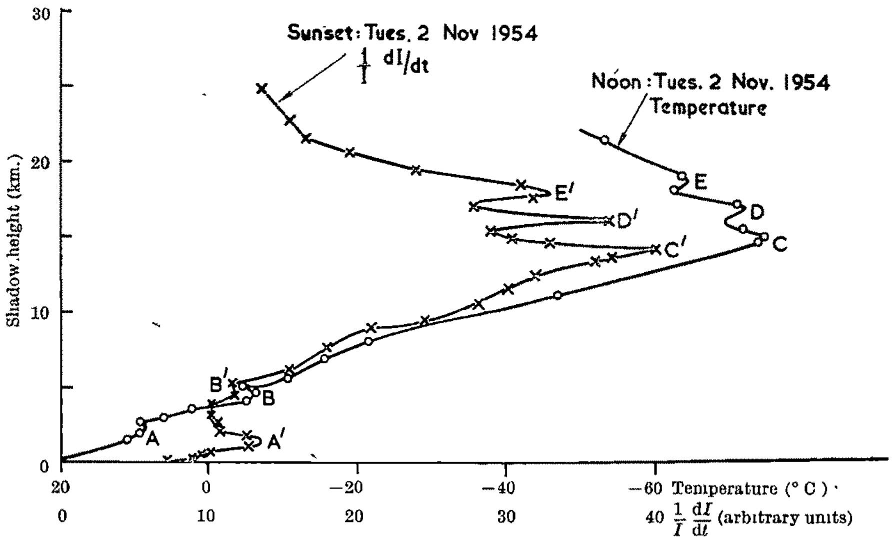

Fig. 2

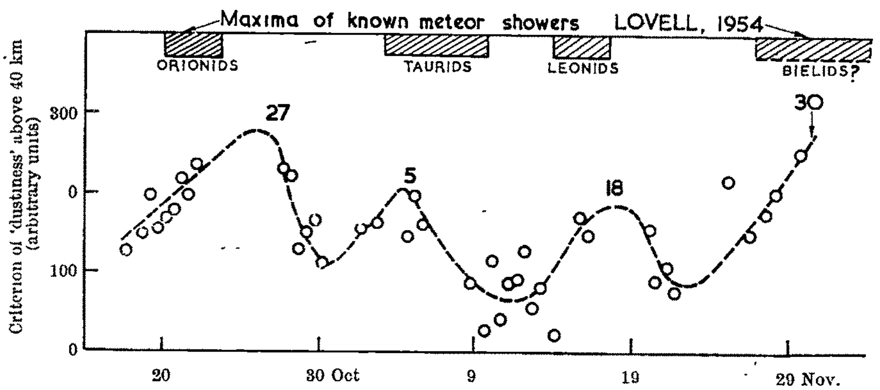

Fig. 3

unlikely to account for the day-to-day variations found at this height, so that they are due, at least partly, to scattering from larger particles. The area under each curve was therefore integrated between 90 km. and 40 km. to obtain an arbitrary criterion of 'dustiness' in the upper atmosphere, and it was found that some systematic variations existed. These are shown in Fig. 3, and it can be seen that, in spite of scatter, there seems to be a tendency to maximum values at about the time of maximum of meteor showers.

Because the meteor showers of this period have relatively broad and ill-defined maxima, they are not well suited to test Bowen's theory of the meteoritic influence on rainfall. The maxima shown in Fig. 3, though somewhat subjective, provide fairly definite dates which can be used to check the 30-day lag which Bowen found between the advent of the meteoric dust in the atmosphere and the associated rainfall peak. A compilation of fifty years rainfall from about 250 stations for this period, prepared by Bowen (private communication), has maxima on November 27, December 5 and December 29—each about thirty days after high values of 'dustiness'.

The average height of the upper maximum in the twilight scattering curve, which is believed to be associated with the temperature inversion at about that height, was found to be 81·1 km. for the thirty-two occasions in this period when it was well defined, the extreme variability being ±5 km. An interesting feature of the scattering near 80 km. was the formation of a double maximum, which occurred on days near the peaks in Fig. 3.

The experiments described offer a novel method for detecting inversions in the troposphere and for studying the height and form of the discontinuity near 80 km. The observations so far made are consistent with Bowen's rainfall–meteor dust hypothesis, but provide no conclusive evidence to support it. [July 28

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STRUCTURES AND FUNCTIONS OF THE PHENOLASE COMPLEX

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THE phenolase complex, widely distributed throughout the phylogenetic scale, consists of two enzymic activities, phenol *o*-hydroxylase ('cresolase', equation 1) and *o*-diphenol dehydrogenase ('catecholase', equation 2). These activities have

$$\text{Monophenol} + \tfrac{1}{2}O_2 = o\text{-diphenol} \qquad (1)$$

$$o\text{-Diphenol} + \tfrac{1}{2}O_2 = o\text{-quinone} + H_2O \qquad (2)$$

now been investigated for sixty years[1], and from the results which have been obtained, two interesting problems have emerged: What is the chemical basis of cresolase activity? And what is the relationship between cresolase and catecholase activity? In this communication I propose to develop a new theory of the mechanism of reactions catalysed by the phenolase complex, a theory which appears to give the most plausible solution of these two problems.

The catalytic activities comprising the phenolase complex possess the following characteristics: (*a*) they occur together[2,3], and have been found associated with the same electrophoretic and ultra-centrifugal component[4]; (*b*) in any preparation of the phenolase complex, they are inhibited to the same degree by metal-binding reagents, and substrates for one activity competitively inhibit the other[5–8]; (*c*) each activity has been found proportional to copper content[4,7–9]; (*d*) both activities are lost when copper is removed from holoenzymic preparations and reconstituted when copper is added to the inactive apoenzymic product[8,10]. Furthermore, it has not been possible to remove catecholase from cresolase activity[4,7,10–12].

While the two reactions catalysed by the phenolase complex are very dissimilar, the corresponding enzymes appear to be associated with the same active site. Since the catalysis of two types of reaction by a single catalytic configuration is a situation rare in biochemistry, the possibility of its occurrence deserves close scrutiny. Thus, it has not been possible to remove catecholase activity from cresolase, but considerable purification of catecholases themselves has been achieved[4,7,8]. During these purifications the cresolase activity is, however, destroyed rather than separated, and the ratio of the two activities in the phenolase complex can readily be altered by mild physical treatment, such as warming or adsorption, or even standing at −72° in lyophilized form. In addition, the residual cresolase in high catecholase preparations has a characteristic lag or induction period toward monophenolic substrates which is absent in crude extracts and is specifically abolished by traces of *o*-diphenolic substrates for catecholase[7,8,13]. A quantitative (inverse) relationship exists between the concentration of this *o*-diphenol and the length of the induction period[13]. Non-specific shortening of the induction period also takes place in the presence of reducing agents such as ascorbic acid and hydroquinone, which are not themselves *catalytically* oxidized by the phenolase complex[6,14].

Mechanism of Cresolase Action

A number of mechanisms have been proposed to explain these observations. The reader is referred to recent review articles for historical and bibliographic details concerning them[2,3,15]. For the present purposes, it is sufficient to recall that these hypotheses fall into enzymic and non-enzymic classes. According to the latter concept, the quinonoid product of the catecholase reaction (equation 1) is an active oxidant in the cresolase reaction, in the sense shown by equation 3:

$$\text{Monophenol} + o\text{-quinone} + H_2O = 2\ o\text{-diphenol} \qquad (3)$$

Molecular oxygen is thus consumed only to form *o*-quinone, and the oxygen of the freshly introduced hydroxyl group must arise from solvent water. In order to test this theory and to learn more of the mechanism of cresolase action, we have recently conducted the hydroxylation (of 3,4-dimethylphenol) in environments of oxygen-18 and water, and oxygen and heavy water ($H_2{}^{18}O$), and have determined the heavy-oxygen content of the 4,5-dimethylcatechol which was formed in each case[16]. The results are given in Table 1. Clearly, the oxygen of the newly introduced hydroxyl group arises from molecular oxygen. None comes from solvent water, nor is there any apparent exchange of solvent oxygen with molecular oxygen during the process. It is therefore certain that the mechanism described by equation 3 cannot operate during cresolase action. This is quite consistent with a number of other observations which make a non-enzymic basis for cresolase activity unlikely, such as the ortho-position and optical specificities of cresolase[10,13,14], the inability of quinones generated by other enzymes to hydroxylate monophenols[11,17], the high level of cresolase activity possible in the presence of strong reducing agents[6], and the changing ratios of cresolase to catecholase activity during purification[4].

Table 1. Uptake of Oxygen-18 from Oxygen-18 and from $H_2{}^{18}O$ during the Enzymic Hydroxylation of 3,4-Dimethylphenol in the Presence of Mushroom Phenolase

Experiment	Per cent of theoretically possible uptake of oxygen-18
1. ${}^{18}O_2 + H_2O$	89 88, 95
2. $O_2 + H_2{}^{18}O$	0, 0

Since, therefore, cresolase activity is an enzymic rather than a non-enzymic process, molecular oxygen must combine at some stage with enzyme or enzyme-substrate complex. There is a growing consensus of opinion[4,6,15,17–19], to which I subscribe, that the *o*-diphenol-sensitive induction period of cresolase, the changing ratios of activities and the dependence of both activities upon a copper-containing protein can best be explained in terms of a single enzyme possessing two characteristic activities. In the form proposed by Dawson and his co-workers[4], this hypothesis provides that, during the oxidation of an *o*-diphenol by the phenolase complex, a portion of the enzyme becomes momentarily activated or primed, so that it can bring about the hydroxylation of monophenols. It is for this reason that the enzyme is cresolase-active when simultaneously oxidizing *o*-diphenols[6,20,21–24]. The changing ratios of cresolase to catecholase activity during purification of the phenolase complex are ascribed to fragmentation of the phenolase complex, and to loss of copper-free portions of the enzyme which must in some way be important to cresolase activity. The molecular sizes of different preparations are thus different, but the number of copper atoms per molecule (four) presumably remains constant. Since copper forms only a portion of the cresolase-active centre according to this concept, only the catecholase activity should be proportional to the copper content of high catecholase preparations, and this is indeed the case. However, the terms 'priming', 'activation', and 'fragmentation' are vague and their physico-chemical basis is ambiguous; considering that it has not been possible to obtain cresolase preparations sufficiently homogeneous.

On the other hand, evidence concerning the number and valence of the copper atoms at the catalytic sites of the phenolase complex together with the results of the oxygen tracer study make it possible to offer a more plausible explanation of the mechanism of catecholase and cresolase reactions catalysed by the same copper protein (phenolase). Thus, in the presence of one molecule of *o*-diphenol, two cupric atoms in phenolase are reduced to cuprous atoms[8]. Since hydroxylation by phenolase cannot take place in the absence of *o*-diphenols[13,21–24] or other reducing agents[6,14,20], cresolase activity has its initial basis in reduced phenolase, that is, cuprous enzyme. *o*-Diphenols act as the heat-stable substances which Keilin and Mann[7] have suggested as a requirement for cresolase activity, and thus have a dual function as specific cresolase activators and as catecholase substrates. Furthermore, one molecule of carbon monoxide is bound per two atoms of cuprous phenolase copper[8]. It is therefore likely that the catalytic configuration involved in cresolase activity consists in two neighbouring cuprous atoms attached to protein, and that one molecule of oxygen may combine with this structure, which accordingly bears a strong analogy to that of hæmocyanin[8,25,26]. Differences in the mode of attachment of copper to protein which lead to a different distribution of electrons around the oxygenated complex may account for the reversible coupling of molecular oxygen by hæmocyanin on one hand, and hydroxylation of the benzene ring by phenolase on the other. On these grounds, the mechanism of cresolase action may be expressed by equations 4, 5 and 6. One atom of oxygen is consumed by the hydroxylation reaction during this sequence. The second atom is reduced to water, a process which requires two electrons. Two cuprous atoms supply them, and at the end of the hydroxylative phase (equation 5) this pair must then be in the cupric or inactive state, and require reactivation by the oxidation of *o*-diphenol, as depicted in equation 7. It also seems probable that steps 5, 6, and 7 occur in one stage, as shown in equation 8, the phenolic substrate displacing a water of hydration at the copper to form an activated ternary complex, which dissociates directly to *o*-quinone.

$$\text{Protein}-\text{Cu}^{+}{}_2+\text{O}_2 = \text{protein}-\text{Cu}_2-\text{O}_2 \tag{4}$$

$$\text{Protein}-\text{Cu}_2-\text{O}_2+\text{monophenol}+2\text{H}^+ = \text{Protein}-\text{Cu}^{++}{}_2+o\text{-diphenol}+\text{H}_2\text{O} \tag{5}$$

$$\text{Protein}-\text{Cu}^{++}{}_2-+2e^- = \text{protein}-\text{Cu}^{+}{}_2 \tag{6}$$

$$\text{Protein}-\text{Cu}^{++}{}_2+o\text{-diphenol} = \text{protein}-\text{Cu}^{+}{}_2+o\text{-quinone}+2\text{H}^+ \tag{7}$$

$$\text{Protein}-\text{Cu}_2-\text{O}_2+\text{monophenol}\} = \text{protein}-\text{Cu}^{+}{}_2+o\text{-quinone}+\text{H}_2\text{O} \tag{8}$$

This hypothesis explains the close association of catecholase with cresolase activity, and also provides a basis for the facile loss of cresolase activity during purification. The power of the oxygen complex, which we postulate as the cresolase-active site, to act as a locus of hydroxylation must depend upon the orientation of the electrons around the complex, and this in turn must depend upon the positions of the copper atoms relative to one another. Since the relevant valence states and bond angles are unknown, little can be said about this structure beyond the possibility that it may take one of the forms illustrated in Fig. 1, in which the positions of the copper atoms in the complex have been estimated from the structure of hydrogen peroxide[27]. Of the three configurations shown, one cis (*A*), one trans (*B*), and one containing a co-ordinated oxygen atom (*C*), the last is preferred for its asymmetry, which suggests a straightforward hydroxylation mechanism involving interaction of the oxygen atom with pi-electrons of the benzene ring. A change in the relative positions of, and the distance between, these two atoms of copper (3, 4, or 5 A.) must result not only in a change of oxygen-binding power but also of hydroxylating power, which will

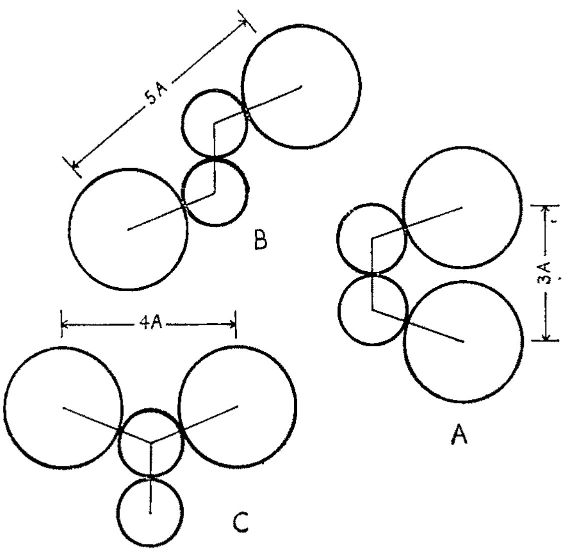

Fig. 1. Scale drawings depicting possible configurations of the cresolase-active copper–oxygen complex. The large circles represent copper atoms, the small circles, oxygen

therefore be sensitive to any small twist or spread of the protein backbone or amino-acid side-chains involved in the attachment of copper.

We designate this fixed, cresolase-active configuration 'closed phenolase'. Active enzymic sites which have been altered in respect to the positions of the copper atoms as a result of either physical or chemical influences we designate 'open phenolase'. The structural configuration of such a site may still exhibit much of its specificity towards substrate phenols, but may contain only one atom of copper either as a result of separation or loss of a mobile or loosely bound member of the pair. Since copper atoms attached to non-specific protein display pseudo-catecholase activity[28,29], there is no *a priori* reason for believing that the open configuration should have less catecholase activity than the closed structure. The ease with which the closed configuration is transformed into the open during purification may vary with the protein and its associated copper bonds, which are apparently of low stability in mushroom phenolase, of intermediate stability in potato phenolase, and are stable or protected in highly organized macrostructures such as mammalian melanin granules. The stability of cresolase activity must therefore bear a relationship to the characteristics of the aggregate upon which it occurs. Because of this sensitivity toward environmental changes, cresolase activity has resisted purification, and high-cresolase preparations resemble original extracts and differ from high-catecholase preparations in respect to solubility, copper content, behaviour towards adsorbents, and isoelectric *p*H, as well as in enzymic character.

Structure and Function

Elsewhere, oxygen transfer and electron transport by the phenolase complex have been related to the formation of the *o*-diphenolic precursors of the flavonoids, lignins, cuticulation diphenols of arthropods, etc.[30]. Although students of plant respiration have tended to lay emphasis on the catecholase aspect of the function of the phenolase complex, it follows from the present hypothesis that preparations of the high-catecholase type may be artificial in the sense that they bear a catalytic configuration which is produced in the process of isolation of the enzyme and which differs from that of the enzyme present within the cell. The high-cresolase (closed) form is the more nearly natural state of the enzyme. In this state a prevailing oxidation potential sufficiently high to keep the enzyme in the cupric form will prevent hydroxylation even in the presence of appropriate substrate and oxygen, but this inhibited phenolase complex may be activated by reduction. Thus, closed phenolase may occur *in vivo* as a reduced enzyme active towards both mono- and di-phenols, or as an oxidized form inert but activatable towards monophenols although already active towards *o*-diphenols. The open phenolase which is produced as a result of processes of purification is active towards *o*-diphenols but relatively inactive towards monophenols, which may act as substrate only owing to the residual closed form present in the enzyme preparation.

Finally, it is interesting to observe that the two series of metalloproteins involving hæm on one hand and copper on the other have striking similarities in their range of function. Each series contains an oxygen carrier dependent upon reduced metal (hæmoglobin and hæmocyanin), an electron carrier (cytochrome and catecholase), and an oxidizing enzyme (peroxidase and cresolase)

I wish to thank Sir Alexander Todd for the hospitality of his Department while this paper was being written. The United States Public Health Service and the American Cancer Society have supported this work.

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LETTERS TO THE EDITORS

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Measurements of Natural Freezing Nuclei at High Altitudes

A NUMBER of determinations of freezing nuclei has been made in aircraft. These form part of a programme of investigation into (*a*) the distribution and properties of freezing nuclei at high altitudes (where they are thought to play a part in the formation of rain by the Bergeron process), and (*b*) the question of whether the rainfall singularities reported by Bowen[1], and attributed by him to the arrival in the lower atmosphere of meteoritic dust, are accompanied by corresponding fluctuations in the concentration of freezing nuclei. Daily measurements were made near Sydney, Australia, during January 1954 and January 1955, and near Tucson, Arizona, United States, in January 1955. In addition, in January 1955 measurements using a somewhat similar method were carried out on a mountain top in the Hawaiian Islands. The results to date are summarized below. The month of January was chosen because the meteor dust – rainfall hypothesis was based on statistics for that month.

The airborne measurements at Sydney and Tucson were carried out as described by Smith and Heffernan[2], using cold chambers of 100-litres capacity. These were filled with air from outside the aircraft and cooled at 4 deg. C. per min., water vapour being added to form a fog. The concentration of ice crystals was observed at various temperatures, the threshold of detection being 0·1 crystal per litre. Samples were taken at various altitudes, but in this communication only results at altitudes exceeding 3,000 metres are given. On some days, two readings at the same altitude were made, and the mean is given.

Fig. 1 shows the daily variation in the warmest temperature at which one ice crystal per litre was observed, the three curves representing Sydney 1954 (full), Sydney 1955 (dashed) and Tucson 1955 (dotted). It can be seen that in both years this temperature varied markedly at Sydney, but much less at Tucson. The consistency of several readings on the same day is such that, while the temperature variation recorded at Tucson may not be significant, that recorded at Sydney is. If similar variations occur in the temperature of formation of ice crystals in natural supercooled clouds, then substantial differences in cloud behaviour should be observed on the corresponding days near Sydney but not near Tucson. The range of values recorded, from −16° C. to −33° C., appears to be consistent with the temperatures at which cumulus clouds are observed to glaciate.

Measurements in the Hawaiian Islands were taken at the top of the extinct volcano Haleakala on the island of Maui. It is 3,000 m. high and the top is nearly always above the trade wind inversion. Readings were taken at night in order to reduce the chance of sampling aerosols of local origin. A cloud chamber was used of a different design from those in the aircraft, and the measurements are not directly comparable. Its capacity was 50 litres. However, on certain days, namely, January 10, 23 and 29, the number of ice crystals observed at temperatures greater than − 25° C. was far larger than was the case on other days in January. These days are indicated on Fig. 1 by the letter *H*, all times being given as G.M.T.

Cwilong[3] has reported independent determinations of freezing nucleus in Panama using a small expansion chamber. Increases in the temperature at which effective nuclei were observed occurred on January 13, 18 and 31. These dates are indicated on Fig. 1 by the letter *P*. The dates on which fifty years total rainfall is abnormally high in Sydney are given by Bowen[1] as January 12–13, 22–23 and 31. These are indicated on Fig. 1 by the letter *R*.

If the rainfall singularities are associated with increases in concentration of freezing nuclei of cosmic origin, it might be expected that these various determinations of such nuclei would exhibit peaks at about the same time, and that the peaks would recur from year to year. It is therefore of interest to examine Fig. 1 from this point of view.

It can be seen that the two years measurements in Sydney do not agree well in the early part of January; but in the latter part of the month there are several features in common. The first rainfall peak, on January 12–13, coincides with peaks in the Sydney 1954 and 1955 curves, and with a peak at Panama. There is also a peak in Sydney (1954) on January 14. The second rainfall peak on January 22–23 again coincides with peaks in the Sydney 1954 and 1955 curves, and with a peak at Haleakala. The third rainfall peak, on January 31, coincides with a peak in Sydney (1954) and Panama, but peaks in Sydney (1955) and Haleakala occur two days before. The Panama peak of January 18 appears to be isolated.

It is not yet known what degree of consistency is to be expected from year to year and from place to place; and the present measurements, although not sufficient to confirm the theory, do show certain coincidences between rainfall singularities and peaks in the concentration of freezing nuclei at different geographical locations and at different times. It is hoped that the measurements can be continued in later years and in more places in order to help clarify

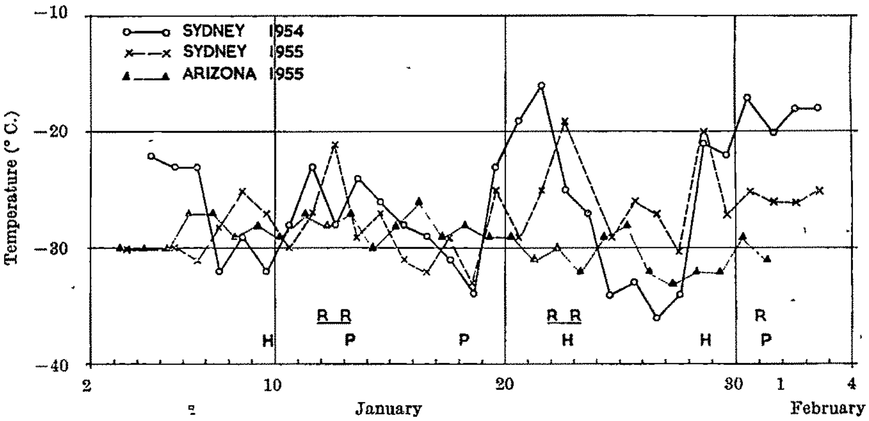

Fig. 1 Freezing nucleus measurements. Temperature at which one ice crystal per litre was observed

the question of whether there is a relationship between the concentration of freezing nuclei, meteor dust and the weather.

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Electrolytic Desalting with Ion-Exchange Membranes

Separation of amino-acids and other substances by paper chromatography must often be preceded by the removal of inorganic salts. The common methods[1] require careful supervision, and under optimal conditions a loss of 10–20 per cent of many amino-acids may occur with 50 per cent loss of arginine by conversion to ornithine[2]. A simplified form of desalter, employing ion-exchange membranes, as suggested by Astrup and Stage[3], has been used in this Department for the routine preparation of plasma, urine and cerebrospinal fluid for paper chromatography. The apparatus consists of a small 'Perspex' container separated into three compartments by ion-exchange membranes (Fig. 1). The solution to be desalted in the centre compartment (3 ml.) is separated from the anode by an anion exchange membrane ('Permaplex' A.10) and from the cathode by a cation membrane ('Permaplex' C.10, both obtainable from Permutit, Ltd., London, W.4). The anode and cathode chambers are filled with 0·2 *N* sodium hydroxide and sulphuric acid respectively.

When a current is passed, the anion exchange membrane allows anions to move out of the centre compartment while preventing the ingress of cations, and the cation membrane permits the passage of cations, but retains anions. The net result is a loss of electrolyte from the centre compartment with an increase in the salt concentration in the outer compartments. The current is supplied by a 6-V. accumulator, and a variable resistance (0–500 ohms) regulates the initial current to 50 m.amp.

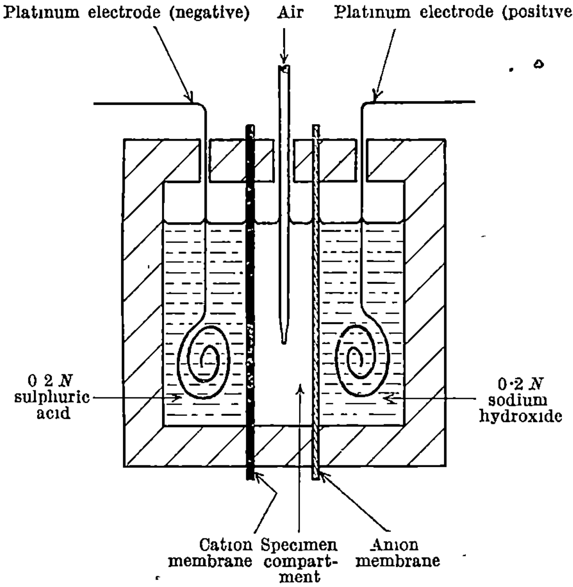

Fig. 1. Apparatus for electrolytic desalting with ion-exchange membranes

Table 1. Recoveries of Electrolytes and Amino-Nitrogen from Various Solutions after Desalting for 6 and 10 Minutes

Solution	Initial *p*H	Concentrations								
		Sodium (m.eq./litre)			Chloride (m.eq./litre)			Amino nitrogen (mgm. per cent)		
		0 (min.)	6	10	0 (min.)	6	10	0 (min.)	6	10
A. Salts + Glycine Alanine Phenylalanine Valine	7·2	126	55	37	100	52	29	5·6	5·3	4·8
B. Salts + Glycine Alanine Glutamic acid Arginine	7·3	124	56	22	103	49	31	6·0	5·8	4·6
C. Salts + Glutamic acid	7·2	127	49	30	100	50	27	6·2	4·2	4·3
Aspartic acid	4·4	125	53	28	100	45	30	6·2	4·9	4·4
D. Salts + Arginine	7·3	130	65	25	105	47	33	6·3	4·4	4·0
Lysine	8·8	130	60	20	105	53	30	6·3	5·3	5·0
Serum ultrafiltrate	7·1	139	40	19	—			10·9	9·0	7·0

Some loss of amino-acid is inevitable, and depends upon the dissociation of the various acids and also on the relative mobility of their ions. The rates of loss of the principal electrolytes of serum and of amino-acids were measured under standard conditions. A double-strength solution of plasma electrolytes was mixed with equal volumes of 0·01 *M* solutions of amino-acids, and desalted for 6 and 10 min.; the analytical results are shown in Table 1. The loss of neutral amino-acids was slight with an initial *p*H of 7·2 in the desalted solution. The greater losses of acidic and basic amino-acids could be reduced by bringing the initial *p*H nearer the *iso*electric point of the amino-acids concerned. Desalting of serum ultrafiltrates and casein hydrolysate solutions gave similar results.

A steep fall in current occurred after 6 min., when the salt concentration fell to about 30 per cent of its initial value; this level permits satisfactory separation on paper of amino-acids in serum, cerebrospinal fluid and concentrated urine samples. A fall in the *p*H of the solution during desalting occurs which increases the loss of basic amino-acids. This can be largely overcome by the addition of 0·1 *N* potassium carbonate to adjust the initial *p*H of the solution to 8·0. For routine chromatography of biological material for diagnostic purposes, neutralization of the samples is all that is necessary, since 25 per cent differences in concentration are the least that can be detected on paper.

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Destruction of Thyroxine by Electrolytic Desalting

It is well known that artefacts and serious distortion can be caused during paper chromatography if acids are present in the solution being chromatographed, and that they can be eliminated by initial electrolytic desalting. In a recent communication[1], Acland confirmed that trichloracetic acid can be "largely" removed by desalting the solution electrolytically; as an example, he showed that the chromatographic picture from a mixture of thyroxine and trichloracetic acid was very distorted, whereas that from a mixture of thyroxine and 'desalted' trichloracetic acid was relatively undistorted.

It might therefore be supposed that electrolytic desalting of thyroxine extracts containing trichloracetic acid would improve their chromatographic investigation. We wish to point out that this is not the case, as the electrolytic desalting of thyroxine solutions leads to rapid reductive deiodination. After 10 mgm. of thyroxine, dissolved in 1 ml. of aqueous methanol containing trichloracetic acid or any other acid, had been subjected to electrolytic desalting at 500–250 m.amp. for 10 min., paper chromatography showed only thyronine to be present (ninhydrin reagent), with no detectable organically bound iodine (ceric sulphate – arsenite reagent, which would have shown as little as 1 per cent remaining[2]). Desalting for shorter periods (1 min.) gave intermediate products identified as various iodo-thyronines. When an aqueous solution of trichloracetic acid (1 ml. containing 10 mgm.) was desalted at 500–100 m.amp. for 7 min. its *p*H rose to 5·5, indicating virtually complete removal of the acid.

Further work on the stepwise dehalogenation of polyhalogen derivatives of tyrosine and thyronine will be reported elsewhere[3].

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Use of Gas–Liquid Partition Chromatography as a Preparative Method

The sharp separations obtainable by gas–liquid partition chomatography[1] would make it a useful alternative to distillation as a method for the purification of volatile compounds if the quality of the separations could be maintained on large columns. Evans and Tatlow[2] have described a column, 16 ft. long by 3 cm. internal diameter, which is suitable for the separation of 2–8 gm. of fluorocarbons. It is not yet clear, however, how much further the increase in size can be carried; but in any event, as so far developed, chromatography remains a batch process. Hence another line of approach to the problem of processing large amounts of material would be the automatic repetition of the cycle of batch operations, that is, injection of the charge and isolation of the pure material as it emerges from the column. This approach would be applicable whatever size columns are finally adopted.

Under fixed column conditions, each substance emerges at a constant time after injection, and this suggested that a clock might be used for controlling the cyclic process. We have constructed such a clock and used it successfully in the separation of C_4 hydrocarbon gases. In itself, the chromatographic apparatus is similar to those previously described, except that the column is somewhat larger (1 m. long by 15 mm. internal diameter) and two solenoid-operated valves are incorporated in the flow line. The gaseous sample is admitted to the column through one valve and the outlet gas can be deflected from one to another of two collecting traps by means of the other valve, which is located immediately after the detector[3]. The clock comprises a 'Londex' *PR/S* timer and a 50-position uniselector arranged to give a cycle of variable length divided into fifty equal intervals. At the beginning of each cycle, the inlet valve opens and a charge of the hydrocarbon gas is admitted to the column inlet, the amount depending on the pressure and the length of time the valve is open. The recorder trace for the detector is observed, and those positions of the uniselector corresponding to the peak required are wired together to operate the outlet valve and divert the flow of gas; in this way the wanted material is separated from the remainder. At a given column temperature the times of emergence of the component peaks can be varied by altering the rate of flow of the carrier gas which, together with the length of cycle, is arranged so that all the remaining components are eluted from the column before the next appearance of the peak required. So far, we have used cycles of 15–20 min. duration, (nitrogen) carrier-gas rates of about 30 l./hr. and a charge of somewhat less than 1 gm. (giving a daily throughput of between 70 and 80 gm.). Low-boiling materials prove difficult to remove from the carrier-gas stream, and it has been found most satisfactory to fill the collecting traps with activated alumina gel. In use they are immersed in a Dewar vessel containing solid carbon dioxide, and the gas can easily be recovered on warming.

The success of the method depends upon the pattern produced on the recorder remaining in phase with the clock. Such constancy in the times of emergence of the components of a mixture has been achieved in the trials so far carried out by attention to three factors: the temperature of the column (which was packed on ice), the rate of flow of the carrier gas, and its presaturation with the solvent used. In these conditions successful runs, lasting several days, have resulted in the expected separation and no adjustments to the clock have been required.

The work described has been carried out as part of the programme of the Chemical Research Laboratory, by permission of the Director of which this communication is published.

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Determination of Chromium, Vanadium and Tungsten by Activation Analysis using Low-Level Neutron Sources

A RADIOCHEMICAL method for the determination of chromium, vanadium and tungsten by means of radioactive silver was suggested by J. Govaerts[1]. Insoluble silver salts can be prepared by means of these elements. Using a solution of radioactive silver nitrate, a standard curve is obtained indicating the activity of the precipitate as a function of the quantity of metal present. The purpose of the present work was to use the same silver salts in order to determine the amount of element present by means of thermal neutron activation of silver ($T_{\frac{1}{2}} = 22$ sec. and 2·3 min.), which quantity is proportional to that of the unknown element.

Preliminary investigations indicated that chromium and tungsten are not activated by a thermal neutron source of 270 mgm. radium–beryllium when exposed during 10 min. Under the same conditions, vanadium is fairly well activated ($T_{\frac{1}{2}} = 4·5$ min.) and this activity adds to that of silver. Up to 25 mgm./cm.², no corrections for self-absorption are required for either of the three insoluble silver salts.

By means of a neutral solution of silver nitrate, chromium is precipitated as silver chromate[2], vanadium as silver vanadate[3] and tungsten as silver tungstate[4]. A Geiger–Müller tube with thin mica window is used for the measurements of radioactivity. The compounds are collected in a uniform and reproducible manner. One of the techniques used is similar to that described by R. H. Hendricks *et al.*[5] for mounting barium-14 carbonate on a flat circular disk of aluminium by gravity settling, except that we have used 'Plexiglas' plates, which are not activated by neutrons. A demountable centrifuge tube can also be used[6]. With certain precautions the precipitate can be collected quantitatively. Using different amounts of silver salts, standard curves are obtained indicating the activity of the precipitate as a function of the quantity of the metal present (Fig. 1). The procedure to determine an unknown concentration is to collect the precipitate on a fritted-glass filter; the precipitate is dried and weighed. The total precipitate, or a known aliquot part, is then collected on a 'Plexiglas' plate and activated; the same geometrical conditions are used for all radioactivity measurements. The amount of the element present on the plate is read on the standard curve.

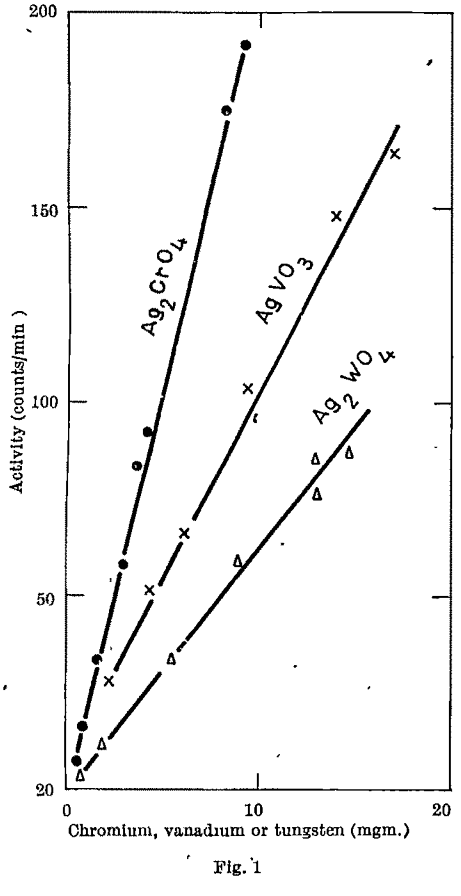

Fig. 1

The method described is very quick, sensitive and well suited to routine use.

I wish to thank Prof. G. Gueben for the opportunity of working in the Institute of Nuclear Studies, Liège, and Prof. J. Govaerts for his interest.

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Infra-Red Absorption Spectra and Protein-Sugar Interactions

BIOLOGICAL materials consisting largely of protein and carbohydrate give rise to infra-red absorption spectra which show the main characteristic absorption bands of the protein and carbohydrate structures. A more detailed study of the spectra of such biological materials reveals a number of important differences from the spectra expected by the direct addition of the typical protein and carbohydrate spectra, and these differences confirm the suggested interaction of the protein with the carbohydrate.

The infra-red spectra of most sugars show a series of sharp absorption bands in the 1,050 cm.$^{-1}$ region[1], similar to those shown in spectrum *A* (Fig. 1). In biological materials containing sugar these sharp bands are replaced by bands of much broader structure, similar to those shown in spectrum *B*. Such broad bands can be observed in the published infra-red spectra of bacteria[2] and tissues[3], and also in unpublished spectra obtained from dried milk and freeze-dried bovine uterine cervical secretions.

This protein–sugar interaction and its effects upon the infra-red spectra can be demonstrated by the spectra of casein and lactose shown in Fig. 1. Spectrum *A* was obtained from a dry intimate mixture of casein (soluble, commercial product) and lactose (freeze-dried monohydrate) made up in the same proportions as are present in cow's milk, that is, approximately 3 parts by weight of casein to 5 parts of lactose. Spectrum *B* was obtained by dissolving the same mixture in water at room temperature and then freeze-drying. Similar results have been obtained for casein–glucose and casein–sucrose mixtures.

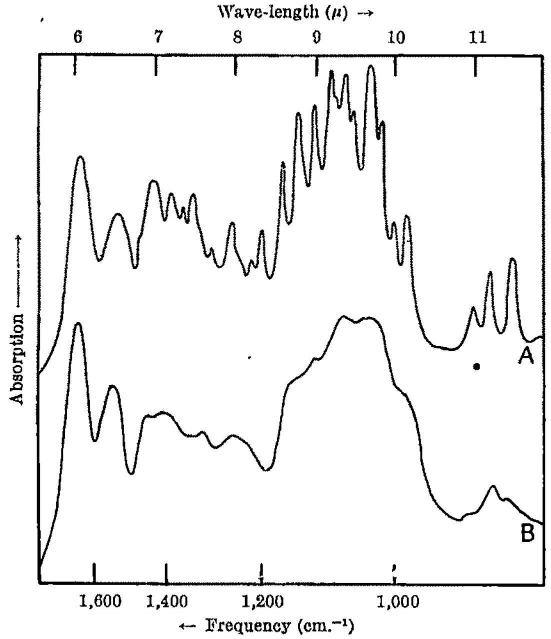

Fig. 1. *A*, lactose–casein dry mixture; *B*, lactose–casein, freeze dried from aqueous solution

It is probable that this interaction of casein with sugars forms the first stage in the series of reactions studied by Lea and his co-workers[4] in relation to the browning of milk.

Since the carbohydrate absorption bands in the 1,050 cm.$^{-1}$ region are generally associated with the C—O stretching and the O—H bending vibrations, it seems likely that the carbohydrate and protein molecules are held together by a hydrogen-bonding mechanism. Such interaction would be expected to affect the carbohydrate bands in this region of the spectrum as well as in the more usually studied 3μ region.

The spectra were obtained with a double-beam Grubb Parsons *S3A* infra-red spectrometer fitted with a rocksalt prism. Samples were examined in potassium bromide disks, and similar results were also obtained using the 'Nujol' mull technique with the same samples.

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Separation of the Isomers of Benzene Hexachloride by Reversed-Phase Paper-Partition Chromatography

A simple and rapid paper chromatographic method was required for separating mixtures of isomers of benzene hexachloride. The paper chromatographic method of Moynihan and O'Colla[1], further developed by O'Colla[2] and Mitchell[3], gives a satisfactory separation, but the acetic anhydride, used as the stationary phase, is an unpleasant reagent to handle. The use of 'Vaseline'-impregnated strips has been previously described for the separation of DDT derivatives[4], and there was some evidence that separation of isomers of benzene hexachloride could be achieved by the application of a similar technique[5]. The method has been adapted as follows.

Whatman No. 1 filter paper strips were washed overnight by allowing distilled water to travel down the strips as in chromatography in order to remove an inorganic halide contaminant present in the paper. The strips were then dried, dipped in a 5 per cent ethereal solution (w/v) of Paraffinum Molle Album, drained and dried. The mixture of the isomers in acetone solution was applied as a small spot near the top of a strip. The mobile phase, consisting, by volume, of 70 per cent methanol and 30 per cent distilled water, was allowed to descend the strip in the normal way. The strip was left at laboratory temperature for 18 hr., during which time the solvent had travelled approximately 40 cm.

The strip was dried and the positions of the isomers detected by dipping it in redistilled monoethanolamine, heating at 100° for ½ hr. and then dipping in a $0 \cdot 1\,N$ solution of silver nitrate acidified with concentrated nitric acid (10 vol. silver nitrate solution : 1 vol. acid). On exposure to ultra-violet light (*c.* 254 mμ) brown spots appeared corresponding to the positions of the isomers. It was essential to remove all the monoethanolamine before dipping in silver nitrate solution, otherwise a background colour developed which masked the spots. The alpha-, beta-, gamma- and delta-isomers moved with mean R_F values of 0·33, 0·00, 0·40 and 0·58 respectively. The method of detection was sensitive to less than 5 μgm. of the alpha-, gamma- and delta-isomers, but was less sensitive in the case of the beta-isomer, 5 μgm. of which was only just detectable.

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η-Tocopherol (7-Methyltocol): a New Tocopherol in Rice

Recent publications have confirmed the existence of two previously unknown natural tocopherols in the lipid fractions of cereal grains (ε- and ζ-tocopherols) and have described methods for their separation by paper chromatography[1-3]. Thus six of the seven possible tocol structures produced by methylation of the tocopherol chroman nucleus have been identified, and it was of interest to search for the remaining tocopherol (7-methyltocol) among natural sources. In a comprehensive study of the vitamin E content of various foodstuffs, Harris, Quaife and Swanson[4] reported some years ago that 50 per cent of the total tocopherols in rice were γ- and δ-tocopherols. These authors used the diazo-coupling method of analysis[5] for this identification. Since this observation conflicted with our own observations on tocopherol patterns in cereal products, we have re-investigated the vitamin E content of rice.

The lipid fraction was extracted with ether from ground whole Japanese rice. After the usual purification by alkaline saponification and treatment with floridin earth, the vitamin E complex was analysed by two-dimensional chromatography[2]. The papers, after spraying with ferric chloride – dipyridyl reagent in ethanol, showed three well-defined spots in the α-, ε- and ζ-positions; γ- and δ-tocopherols were absent. However, the spot in the ε-position, on spraying with diazotized *o*-dianisidine in alkaline solution, showed a strong positive reaction, given only with tocopherols having a free, non-methylated 5-position. The known ε-tocopherol does not react with this reagent, and, by methods of separation to be described elsewhere, it was shown that rice contains little or no ε-tocopherol. From its chromatographic behaviour (which assigns it the structure of a monomethylated tocopherol) and reaction with the *o*-dianisidine reagent, therefore, the new spot was considered to be due to 7-methyltocol, which, according to custom, has been named η-tocopherol. Rice contains α-, ζ- and η-tocopherols in the proportion 47 : 26 : 27.

Extraction of 200 gm. of whole rice followed by saponification of the oil, chromatography and isolation by two-dimensional paper chromatography on multiple papers by methods already described[2] gave nearly 3 mgm. of almost pure η-tocopherol. The new tocopherol could be assayed normally with the Emmerie–Engel reagent and coupled immediately with the *o*-dianisidine reagent. It had an absorption maximum at 293 mμ (E(1 per cent, 1 cm.), 78) and gave a yellow nitroso derivative with nitrous acid. Oxidation with nitric acid, according to Smith *et al.*[6], gave the red *o*-quinone, with absorption maximum at 477 mμ (E(1 per cent, 1 cm.), 56). The identity of η-tocopherol with 7-methyltocol was finally confirmed by direct methylation on 1 mgm. of the substance by reaction with formaldehyde, hydrochloric acid and stannous chloride[7]. The methylated product, on two-dimensional paper chromatography, gave two new spots, identified by R and R_F values and chemical tests as α- and ζ-tocopherols.

All seven possible tocopherols with methyl groups in the chroman nucleus have now been shown to occur in Nature.

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---

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Thermodynamic Aspects of the Action of Phosphohexoseisomerase

The isomerization of glucose-6-phosphate ⇄ fructose-6-phosphate is catalysed by the enzyme phosphohexoseisomerase[1], and at equilibrium a mixture of aldose and ketose in the proportion of 6/4 is present[2,3]. Although Bruns and Hinsberg[2] have investigated the kinetics of this isomerase system by the method which was also employed in the present experiments, the thermodynamic properties of this reaction have not been studied.

The free-energy change and activation-energy change of the isomerization process can be calculated from earlier data concerning the effect of temperature on reaction velocity. From the equilibrium constant K calculated from the molar concentration of the reactants,

$$K = \frac{[\text{Glucose-6-phosphate}]}{[\text{Fructose-6-phosphate}]} \qquad (1)$$

the free-energy change of − 84 cal. mole⁻¹ was obtained based on the equation

$$\Delta F^{\circ} = -RT \ln K \qquad (2)$$

The reaction kinetics are of pseudo zero order in the presence of an excess of glucose-6-phosphate and may be formulated in the following way,

$$v_i = k_1 E S_0 \qquad (3)$$

where v_i is initial reaction velocity, S_0 is initial concentration of substrate, E is enzyme concentration and k_1 is reaction constant.

If k_1 is expressed in terms of the Arrhenius equation[4,5],

$$k_1 = PZ \exp(-\Delta E/RT) \qquad (4)$$

then, from earlier results[1] when v_i was studied as a function of T over the range 23°–40° C., log v_i is proportional to $1/T$, and the activation energy, ΔE, can be evaluated as − 11·3 kcal./mole⁻¹.

When Eyring's equation[5],

$$k_1 = \frac{kT}{h} \exp\left(-\frac{\Delta H^*}{RT}\right) \exp\left(\frac{\Delta S^*}{R}\right) \qquad (5)$$

is applied, ΔH^*, the heat of activation, can be estimated. From the proportionality of log v_i/T to $1/T$, ΔH^* (10·4 kcal./mole) also can be evaluated using the slope of a plot of log v_i/T versus $1/T$. A diagram demonstrating the energy relationship of this reaction is shown in Fig. 1.

The activation energy can be estimated from bond energies. If we assume the following 'activated

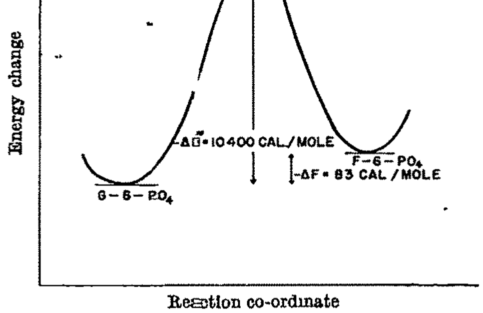
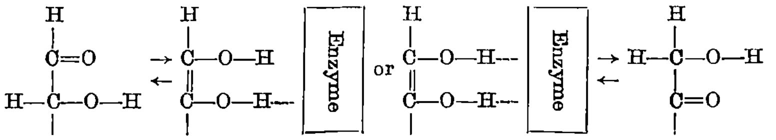


Fig. 1

complexes' of the hypothetical intermediary ene–diols with the isomerase,



the differences of the bond energies[6] in the activated complexes as compared with glucose-6-phosphate or fructose-6-phosphate are about – 9 kcal./mole or – 14 kcal./mole, respectively. In this estimate the energy of formation of the hydrogen bond is assumed to be 5 kcal./mole. Although the exact structure of the 'activated complex' is unknown, the activation energy estimated on the basis of the above structure is in reasonably good agreement with the values calculated from kinetic experiments. Since the activation energies based on other possible structures of the activated complexes deviate considerably from those obtained from the experimental observations, the structure of the 'activated complex' proposed above does not seem unreasonable. Such a postulated complex in the isomerase system should have an activation energy of about 10 kcal./mole. This excludes complexes with a saturated C—C bond or those involving electrostatic forces between oxygen and the enzyme.

The linear relationship of log v_i to $1/T$ holds at higher temperature, and therefore ΔE of denaturation by heat may be calculated from equation (4). As a result, a value of 26·8 kcal./mole is obtained, which is of an order comparable with that reported for heat denaturation of other enzymes[7].

This investigation was supported in part by the U.S. Atomic Energy Commission.

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Bacterial Degradation of Heparin

A SOIL bacterium has been isolated in pure form by repeated transfers on a liquid medium which contained 0·1 per cent heparin, 0·1 per cent ammonium sulphate, and trace amounts of magnesium, calcium, manganese, ferrous iron and molybdate in 0·1 *M* phosphate buffer (*p*H 7·4) and on silica gel plates with a similar medium evaporated on the surface. The organism is an aerobic, Gram-negative, non-spore forming, very small, motile rod which had been identified as a *Flavobacterium*. It is able to use heparin as its sole source of carbon, nitrogen and sulphur, although its growth is enhanced by the addition of small amounts of glucose and ammonium sulphate. Optimum growth occurs at *p*H 6·5 and 24°; the bacterium will not grow at 37° and its growth is inhibited by carbon dioxide and agar (when grown on heparin). When grown on heparin silica gel plates the bacteria form clear, lemon-yellow, round, microscopic colonies; on trypticase–phytone agar plates the colonies are larger and dark orange-yellow in colour.

Due to its high cost, heparin cannot be used as substrate for large-scale bacterial preparations. In order to obtain cells in large quantity, the bacteria were cultured on a medium which consisted of 1·7 per cent trypticase, 0·3 per cent phytone, 0·25 per cent glucose, 0·5 per cent sodium chloride and 0·25 per cent dipotassium hydrogen phosphate in tap water. The cells were harvested after two weeks and washed free of medium with 0·1 *M* phosphate buffer (*p*H 7·4). They were then adapted to heparin by the following procedure. A thick suspension of washed cells was aerated at 24° for a starvation period of 2 hr Heparin (35 mgm. per 100 ml.), casein hydrolysate (50 mgm. per 100 ml.) and yeast extract (5 mgm. per 100 ml.) were added and the aeration continued. Adaptation occurred within three hours (the adaptation period was halted when 50 per cent of the heparin had disappeared). The cells were collected, washed with distilled water, lyophilized and stored in a vacuum desiccator at – 20°.

Dried cells prepared in this manner metabolized heparin both aerobically and anaerobically. In both instances, as was also the case for growth and adaptation of the organism, the reaction proceeded optimally at 24° and not at all at 37°. The disappearance of heparin was more rapid under anaerobic conditions. The dried cells appear able to degrade heparin by

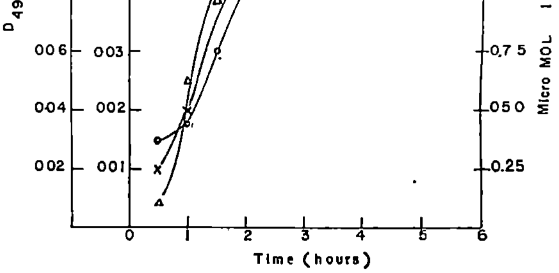

Fig. 1. Accumulation of reaction products during the degradation of heparin by dried cells. The incubation vessels contained 2 mgm. of heparin and 5 mgm. of dried cells in 2·5 ml. of 0·1 *M* phosphate buffer, *p*H 7·4. The vessels were incubated at 24° in an atmosphere of nitrogen–carbon dioxide (95 : 5). At each of the times indicated one vessel was removed and analysed for heparin (ref. 1) ●, reducing groups (ref. 2) ×, periodate titratable groups (ref. 3) △, and glucosamine (ref. 4) ○. Heparin determinations were performed on aliquots of 0·02 ml., reducing groups on aliquots of 0·10 ml., periodate titrations on aliquots of 0·1 ml., and glucosamine on aliquots of 0·2 ml. Values obtained in control vessels in which dried cells were incubated without heparin have been subtracted in all cases

two different mechanisms. Thus, aerobically, heparin was degraded more rapidly at *p*H 6·5 than at 8·5, whereas anaerobically the reverse was true. In preliminary experiments with borate buffer under aerobic conditions, heparin was degraded more rapidly at *p*H 8·5 than at 6·5. There may, then, be one reaction sequence (with optimum *p*H 6·5) which requires both oxygen and phosphate, and another (with optimum *p*H 8·5) which functions in the absence of either oxygen or phosphate.

In preliminary experiments with wet cell suspensions of the adapted bacteria, it was found that neither acids nor carbon dioxide are formed during the anaerobic metabolism of heparin. When heparin was incubated anaerobically with dried cells, reducing groups, periodate titratable groups and glucosamine were formed (Fig. 1). The appearance of these reaction products before detectable disappearance of metachromasia indicates the accumulation of intermediates which, while no longer identical with 'native' heparin, are still metachromatic. The isolation and identification of such intermediates should help elucidate the fine structure of heparin.

We are indebted to Dr. C. B. Anfinsen, who suggested this approach. Sodium heparin (117 units/mgm.) was obtained through the kindness of Dr. L. L. Coleman, of the Upjohn Company, Kalamazoo, Michigan. One of us (A. N. P.) is a participant in the Foreign Research Science Program of the Foreign Operations Administration.

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Uptake of Adenine-8-^{14}C by Whole and Fractional Amœbæ

RECENTLY, Goldstein and Plaut[1] have obtained direct evidence for the synthesis of cytoplasmic ribonucleic acid by the nucleus in *Amoeba proteus*. The demonstration by Brachet and Szafarz[2] that enucleate fragments of the unicellular alga *Acetabularia mediterranea* exhibit a distinct turnover of a precursor of ribonucleic acid (orotic acid) has been interpreted by Brachet[3] as indicative of cytoplasmic synthesis of ribonucleic acid in the absence of a nucleus. If these two findings are both applicable to cells in general, we could conclude that there are two basic systems of synthesis of cytoplasmic ribonucleic acid : one centred in the nucleus, and the other a cytoplasmic system which is independent of the nucleus. In order to investigate this possibility, we have undertaken a study of the incorporation of the ribonucleic acid precursor adenine-8-^{14}C into whole and fractional amœbæ. For a valid comparison of the rates of synthesis of cellular constituents it is necessary, first of all, to ascertain the intracellular availability for synthesis of a labelled precursor in whole and nucleate and enucleate half-cells[4]; otherwise an impaired ability to transfer a material across the cell membrane might be mistaken for a reduction or loss of synthetic capacity.

Table 1. UPTAKE OF ADENINE-8-^{14}C BY WHOLE (*W*), NUCLEATE HALF (*N*) AND ENUCLEATE HALF (*E*) AMŒBÆ

		Incubation time (hr.)		
		18	43	51
Counts/min./amœba (No. of cells in sample in parenthesis)	*W*	1·06 (25) 1·02 (24)	2·66 (50) 2·71 (60)	3·24 (25)
	N	0·69 (25) 0·88 (17)	2·12 (50) 2·03 (43)	2·58 (22)
	E	0·38 (19) 0·35 (24)	1·10 (50) 0·90 (60)	1·65 (11)
Ratios	*W/N*	1·32	1·30	1·26
	N/E	2·15	2·08	1·56

Counts are corrected for a background based on samples of the last wash-water, which never differed significantly from the general background : 11–12 counts per min.

Amœbæ (*A. proteus*) were cultured for 24-hr. in food-free medium. Some of them were then cut, free-hand, with a fine glass needle into nucleate and enucleate halves. After separation of the nucleate and enucleate halves, the cells, including a sample of whole amœbæ, were washed twice to remove possible debris and transferred to a food-free medium containing 1·7 μc. of adenine-8-^{14}C per ml. (0·13 mgm. per ml.). This ribonucleic acid precursor was chosen since experience in our laboratory has shown that it is readily incorporated into ribonucleic acid by amœbæ[5]. During the incubation period, samples of all three experimental groups were withdrawn at different times, dried on planchets after sufficient washing in inactive medium to remove external isotope, and assayed in a windowless gas-flow counter.

Taking the volume of an average whole amœba[6] as $8 \times 10^5\ \mu^3$ and that of a half amœba as $4 \times 10^5\ \mu^3$, we obtain, for equivalent volumes of labelled medium, an activity of about one count per minute corresponding to the whole cell and 0·5 count per minute for the half-cell. It can be seen from Table 1 that the measured activity of the cells and the half-cells reaches a higher level. From this comparison and from the evident linearity of the curves in Fig. 1,

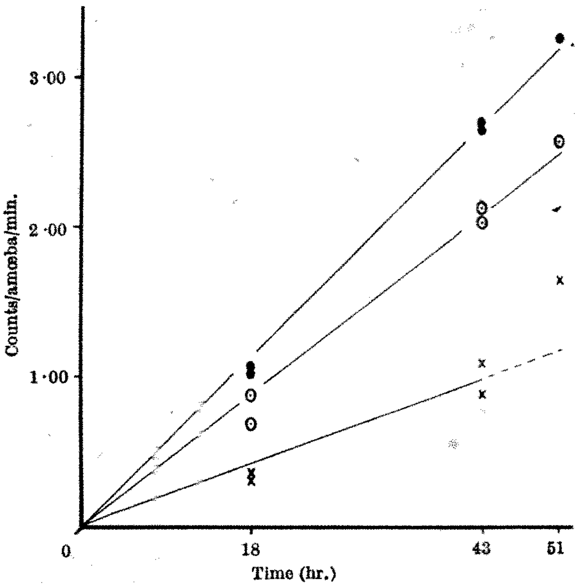

Fig. 1. ● Whole cells; ○ nucleate halves; × enucleate halves

we conclude that there is a continuous uptake of adenine-8-^{14}C and not a passive equilibration of cells with the medium.

Our results indicate that, as with other substances[7], the presence of the nucleus is not essential for the uptake of adenine. However, the ratio of 1·3 : 1 between whole amœbæ and nucleate halves shows that a doubling of the amount of cytoplasm increases the uptake by only 30 per cent. This fact, together with the distinctly higher ratio of 2·1 : 1 between nucleate halves and enucleate halves, demonstrates the importance of the nucleus in adenine uptake during the early incubation period. The value of the 51-hr. point for enucleate half amœbæ is questionable, because of the small size of the sample; but it is being rechecked in a series of experiments designed to elucidate the uptake and incorporation pattern of adenine over a longer period of time.

There are at least two possible interpretations for the higher activity within the cell than outside it; a mechanism may be in operation for the active uptake of adenine against a concentration gradient, or the intracellular adenine may be converted into other products. Whatever the reason, the fact that adenine enters the enucleate half-cell demonstrates its intracellular availability for incorporation or conversion processes if such processes take place.

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A Virus in Chronic Respiratory Disease of Turkeys

IN the chronic respiratory disease syndrome of chickens and ducks, both a virus and pleuropneumonia-like organisms have been etiologically implicated[1]. Serological studies on infectious sinusitis of turkeys, utilizing a hæmagglutination-inhibition test, indicated that there is a relationship between presence of antibodies against the pleuropneumonia-like organisms and a clinical sinusitis[2]. However, in some birds, infection with the pleuropneumonia-like organisms did not result in development of a sinusitis. Observations on field-outbreaks of chronic respiratory disease and their relation to the onset and severity of sinusitis in turkey flocks seemed to indicate that the pleuropneumonia-like organisms did not serve to define the etiology of these syndromes. This became apparent in two outbreaks when it was demonstrated that a large percentage of the birds were serologically positive to the pleuropneumonia-like organisms prior to the onset of respiratory symptoms, and furthermore that sinusitis was observed in only 2–5 per cent of the birds. Within two weeks after the onset of the respiratory symptoms, 40 per cent of the birds in one flock and 60 per cent of the birds in the other flock developed sinusitis.

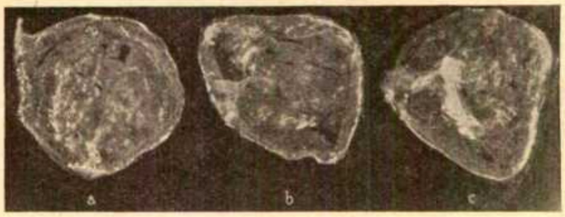

Fig. 1. Pocks on eleven-day old chorioallantoic membranes produced by viruses isolated from (*a*) chickens, (*b*) ducks and (*c*) turkeys infected with chronic respiratory disease

During the acute stage of the respiratory disease, turkeys from both outbreaks were killed, and attempts to isolate a virus were made by procedures which have proved practical for isolating viruses from similar clinical conditions in other fowl[1]. An agent which showed filterability, resistance to antibiotics and inability to be demonstrated with a variety of stains under the light microscope was isolated from both outbreaks. This agent, which is tentatively presumed to be a virus, grew in the yolk sac and chorioallantoic sac of chicken embryos and produced pocks on the chorioallantoic membrane. Specific embryo deaths followed inoculation into the chorioallantoic sac in 24–48 hr. and maximal pock production was observed on the chorioallantoic membrane in 72 hr. Fig. 1 compares the pocks produced by one of the turkey strains with those of chicken and duck strains of a virus with similar properties. It should be emphasized that this agent was not a pleuropneumonia-like organism, although these organisms were also isolated from the infected flocks. Another strain of the virus was isolated from a flock of turkeys experiencing a mild and transient respiratory disease. This isolation was of interest since the turkeys were free of infection with the pleuropneumonia-like organism, and infection with the virus did not result in sinusitis in any of the birds.

In an effort to identify this virus, serum neutralization tests were carried out in either the chorioallantoic sac or on the chorioallantoic membrane, using sera containing antibodies against infectious bronchitis, Newcastle disease and infectious laryngotracheitis viruses. No neutralization of the turkey virus could be demonstrated in any case, nor would sera from birds inoculated with the turkey virus neutralize any of the above viruses. This would seem to exclude the possibility that this new virus bears a *P–Q* relationship to infectious laryngotracheitis, since in Pulsford's work the *Q* variant produced antibodies fully active against laryngotracheitis virus[3].

The findings of a virus in chronic respiratory disease of turkeys with characteristics identical with those isolated from chickens and ducks would seem to indicate a common etiological factor in these syndromes. Proof of this contention, however, must await serological and cross-infection studies. The exact relation of this virus to the onset and incidence of sinusitis in turkeys infected with the pleuropneumonia-like organism similarly remains to be determined.

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Abnormal Colour Responses of the Minnow resulting from Inhibition of Movement

WHEN a minnow (*Phoxinus phoxinus* L.) is allowed to swim freely on an illuminated white or black background, it becomes correspondingly pale or dark in colour and remains so indefinitely. However, if the fish is kept stationary by confining it on a white or black background in a glass tube containing running aerated water, its colour responses become abnormal[1].

During the first hour or so of confinement, the fish struggles; but later, escape reactions cease and the fish remains quiescent on the floor of the tube. Under these conditions on either a white or a black background the fish fails to become fully white- or black-adapted; it assumes an intermediate tint and maintains this indefinitely. However, if the fish confined on black is subjected to an extraneous stimulus, for example, a movement in its field of vision, sudden alteration of the rate of flow of water in the tube or change in hydrostatic pressure, it will suddenly become fully dark in tint and then in the following 15 min. slowly revert to the intermediate colour. In other words, an extraneous stimulus momentarily converts an abnormal black background response to a normal one. No response to an extraneous stimulus in a fish confined on white has been observed; the fish remains an intermediate tint.

The minnow melanophores are under the control of both nerves and pituitary hormones, and spinal section anterior to the fifteenth vertebra eliminates central nervous control, resulting in very slow background responses effected by hormones[2]. Confinement on black does not interfere with the slow darkening of such a spinal fish, and an extraneous stimulus never results in a momentary darkening. Similarly, when central nervous control is eliminated only from the anterior region of the body by sympathectomy and the fish confined on black, this region slowly becomes fully dark, while the posterior region remains intermediate in colour. In this case an extraneous stimulus results in a momentary darkening of the posterior body region, but has no effect on the anterior region. On the other hand, hypophysectomized fish confined on black maintain an intermediate tint and show a darkening response to an extraneous stimulus. Therefore, the abnormal tint caused by confinement appears to be due to interference with the nervous rather than the hormonal chromatic mechanism.

In an unrestricted environment the minnow is an extremely active fish. Confinement thus abolishes continuous somatic motor activities, imposing a learnt inhibition on the central nervous system. It seems probable that this inhibition becomes generalized and affects the brain centres controlling colour change. An extraneous stimulus appears to remove temporarily the central inhibition, permitting for a time a normal black-background response.

The abnormal response resulting from confinement on white is less easy to explain. Under these conditions normal, spinal and hypophysectomized fish alike remain intermediate in colour and show no reaction to an extraneous stimulus. Both nervous and hormonal mechanisms appear to become abnormal under these conditions, and the absence of a sudden paling in response to an extraneous stimulus in the case of normal or hypophysectomized fish remains at present unexplained.

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Role of Ergothioneine and Catalase in Infection by Ergot Fungus (*Claviceps purpurea* Tul.)

I HAVE already shown that the activity of peroxidase and catalase in rye is altered by ergot infection[1]. It seems to be very probable that this circumstance indicates formation of peroxide in the host-plant. The present communication deals with the effect of hydrogen peroxide on germination of ergot conidia.

Ergot was cultivated on malt agar. Conidia of a culture 3–5 weeks old were germinated at 20–22° C. in hanging drops on a culture medium of the composition: KH_2PO_4 1·0 gm., $MgSO_4.7H_2O$ 0·6 gm., $CaCl_2$ 0·5 gm., asparagine 2·0 gm., saccharose 30·0 gm., distilled water 1 litre. To this culture medium was added hydrogen peroxide, ergothioneine and the centrifuged conidia-free substances of honey-dew.

We have found that hydrogen peroxide in a concentration of 5×10^{-3} *M* entirely inhibits the germination of conidia. This inhibition can be removed by 5×10^{-3} *M* ergothioneine. Ergothioneine by itself has no effect on germination. We were unable to demonstrate ergothioneine in saprophytic conidia by the Hunter diazo-reaction[2].

It is known that conidia of parasitic origin (honey-dew) are more aggressive than saprophytic ones[3]. Honey-dew was gathered from Petkus rye; it was diluted with water in the ratio of 1 : 50, then centrifuged and examined for ergothioneine. We were able to prove that the conidia do not contain ergothioneine; on the other hand, ergothioneine was present in the conidia-free substances of honey-dew. The conidia-free sap from 50 million conidia (about 0·1 ml. honey-dew) contains 0·2–0·5 mgm. ergothioneine. It should be noted that another substance present also gives the diazo-reaction; this substance shows a maximum absorption at 6300–7000 A. At the same time, we have also found that the catalase activity of washed honey-dew conidia and saprophytic conidia was weak. During 5 min., 0·27–0·85 mgm. hydrogen peroxide was decomposed *in vitro*. Honey-dew sap shows a high catalase activity; during 5 min., 4·54 mgm. hydrogen peroxide was destroyed.

When honey-dew sap was added to saprophytic conidia, a weak stimulation of germination and an

Table 1. INHIBITING EFFECT OF HYDROGEN PEROXIDE ON GERMINATION OF ERGOT CONIDIA OF SAPROPHYTIC ORIGIN (PER CENT) AND ON GROWTH OF GERM HYPHÆ (MICRA); ELIMINATION OF INHIBITING EFFECTS BY ERGOTHIONEINE AND BY HONEY-DEW SAP

Culture medium + inhibitor and protector	Conidia germinated during 24 hr.	
	No. (per cent)	Length (μ)
5×10^{-3} *M* hydrogen peroxide	0	0
5×10^{-3} *M* ergothioneine	15	110
5×10^{-3} *M* ergothioneine + 5×10^{-3} *M* hydrogen peroxide	13	90
1 : 50 diluted honey-dew sap	24	325
1 : 50 diluted honey-dew sap + 5×10^{-3} *M* hydrogen peroxide	22	325
Control	17	105

intense stimulation of growth was observed. No toxic effect of hydrogen peroxide was found in the presence of honey-dew sap (see Table 1).

These results indicate that honey-dew contains certain substances which are stimulating and certain which are protective against hydrogen peroxide. Among the protective substances there are ergothioneine and catalase, which may at least partially account for the fact that honey-dew conidia are more aggressive than conidia of saprophytic origin[3].

I am indebted to Prof. G. Hunter for help in this investigation. It is proposed to publish fuller results elsewhere.

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A Lysogenic Strain of *Rhizobium trifolii*

DURING the course of routine examination of strain *SU*298 (Sydney University strain) of *Rhizobium trifolii*, it was suspected that the strain was carrying a bacteriophage. Subsequent investigation proved strain *SU*298 to be lysogenic, and the closely related strain *SU*297 to be a susceptible indicator strain. The field-performances and relationships of these strains have recently been reviewed by Vincent[1]. The occurrence of lysogeny in *SU*298 was demonstrated by seeding yeast mannitol agar (0·4 per cent agar) with appropriate proportions of each strain and incubating the plates at 26° C. After 24–48 hr., plaques could be observed in the otherwise confluent growth of *SU*297. At the centre of each plaque was a colony of the lysogenic strain. The lysogenic nature of strain *SU*298 was confirmed by the fact that it proved to be resistant to the purified phage; strain *SU*297, on the other hand, was fully susceptible.

A series of colonial variants of strain *SU*298, the characteristics of which have been described in detail by Vincent[1], were examined to determine whether they were lysogenic. Only one variant, namely, *SU*298/536, was found to be non-lysogenic. Somewhat unexpectedly, this colony type was found to be resistant to the phage obtained from the lysogenic cultures. As the somatic antigenic constitution of *SU*298/536 was found by Vincent to differ considerably from that of the original strain *SU*298, the resistance to the phage could possibly be explained in terms of the suggestion by Marshall and Vincent[2] that the possession of a particular antigen is an essential prerequisite to the action of some strains of bacteriophage on *R. trifolii*.

On present evidence, the practical significance of *Rhizobium* – bacteriophage interaction in soils is somewhat questionable. Similarly, lysogenic strains of root-nodule bacteria may be of questionable significance in soils, although it is felt that the inherent resistance of a lysogenic strain to a particular phage would be to its advantage in soils containing such a phage. The occurrence of lysogeny may be of more practical significance where mixtures of strains are used in the preparation of peat cultures for legume inoculation. Both the lysogenic strain *SU*298 and the susceptible indicator strain *SU*297 have been used in mixed cultures in Australia. I have recently demonstrated (unpublished results) that strain *SU*298 dominates strain *SU*297 when they are mixed in peat. Investigations are in progress to determine whether this is due to the susceptibility of *SU*297 to the phage of the lysogenic *SU*298.

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Deoxyribonucleic Acid Deficiency in the Mature Egg Nucleus of *Aloe davyana* in South Africa

RECENTLY, there have been two or three accounts of deoxyribonucleic acid deficiency in the egg nucleus of both angiosperms and algae. Delay, for example[1], states that the egg nucleus in the oogonium of *Chara* was found to be Feulgen-negative, whereas the antherozoids were Feulgen-positive right up to the commencement of fusion. Rowlands[2] makes a similar observation on the embryo sac of *Vicia* and puts forward a reason for the deficiency. It was felt that it might prove useful to report a like deficiency in *Aloe davyana*.

The material used in the investigation was collected at Mondeor in the vicinity of Johannesburg in August 1954 by Miss D. Dimovic. The time of collection was one of extremely low mean night temperatures.

The development of the embryo sac of *Aloe davyana* has proved to be of the eight-nucleated type in which the antipodals disintegrate very early.

Previously all stages of the young embryo sac had been stained with crystal violet and had stained well, showing good deoxyribonucleic acid content. The mature embryo sacs over three seasons, however, showed only very faint coloration or none, particularly in the case of the egg nuclei. The synergids and central nuclei were darker, but still did not compare with the deep violet of nucellus nuclei. The optimal thickness for sections was found to be 18μ, and crystal violet stained equally well after Navashin and formalin–acetic–alcohol fixatives. After formalin–acetic–alcohol, using hæmatoxylin, which is not specific for deoxyribonucleic acid, the egg nucleus stained well.

Next the Feulgen method was applied, using cold hydrolysis in 5 *N* hydrochloric acid for forty minutes to one hour at room temperature[3]. The same gradation of colour in the embryo sac as mentioned above was observed in each case. Since leuco-basic fuchsin is specific for deoxyribonucleic acid, the pale pink of the mature egg nucleus against the deep red nucellus nuclei may be taken as proof of deficiency. Feulgen-light green staining was used with the same result.

The Feulgen staining was particularly good after Navashin fixative but also strong after formalin–acetic–alcohol.

The Feulgen stain may also be used for the quantitative determination of deoxyribonucleic acid; but this method was not employed during the above investigation.

It was found that the dividing zygote, even in early prophase, showed deep red chromonemata, evidence that deficiency disappears on fertilization.

With both crystal violet and Feulgen staining, the male nuclei lying free in the embryo sac stained very strongly, quite equal to the nucellus in intensity even when in contact with the egg. Actual fusion was not observed. The male nuclei proved to be exceptionally large and were vermiform or spirally curved. No nucleolus was observed.

In an attempt to gain further proof of deoxyribonucleic acid deficiency, methyl green – pyronin staining was applied after acetic alcohol fixation. Methyl green from Grübler (Leipzig) and pyronin from Gurr (London) was used. Unna's mixture, as tried by Darlington and La Cour, and various modifications suggested by Kurnick[4], Taft and Brachet[5], were tried, together with several differentiation media[6]. The dyes were purified by the methods of Sibatani[6].

Unfortunately, although the methyl green (specific for deoxyribonucleic acid) proved satisfactory, the pyronin available was of unknown type and results on the whole were disappointing. With Kurnick's and Brachet's methods, using a differentiating mixture of absolute alcohol 1/*iso*propyl alcohol 1 for as short a time as possible, it was found that egg nuclei stained pale green compared with nucellus nuclei, whereas the male nuclei were very green indeed. The results bear out the supposition of deoxyribonucleic acid deficiency in the egg nucleus, while the male nucleus shows none of these tendencies.

Quite often during methyl green – pyronin staining the synergid cytoplasm, which should have gone red, gave a green stain instead. The same phenomenon was seen using crystal violet, hæmatoxylin and leuco-basic fuchsin, when the synergids stained violet, black and red respectively. Evidence of deoxyribonucleic acid in the cytoplasm was taken to mean that disintegration of the synergid nuclei had resulted in deoxyribonucleic acid escaping into the cytoplasm. Occasionally, using methyl green – pyronin, the egg nucleus stained red.

The evidence for supposed deoxyribonucleic acid deficiency in the mature egg nucleus of *Aloe davyana* can be attributed to: (*a*) masking by some unknown substance; (*b*) conditions at the time of collection; (*c*) actual deficiency.

So far as (*a*) is concerned, it is difficult to reconcile this argument with the fact that semi-specific crystal violet, as well as leuco-basic fuchsin and methyl green, gives evidence of faint staining only, whereas hæmatoxylin shows full staining of the egg nucleus.

If the severe change from day to night temperature during the collecting period affects the egg nucleus, why is the nucellus, subjected to exactly the same conditions, not changed as well? Possibly the egg nucleus and, indeed, the embryo sac in general, is more sensitive than the nucellus nuclei; but one would expect the male nucleus to have the same tendencies.

Neither (*a*) nor (*b*) is an entirely satisfactory answer to the question, and actual deficiency seems more probable at this stage, especially since the Feulgen reaction can be used for the quantitative determination of deoxyribonucleic acid.

Crystal violet staining in this Department of the embryo sac of *Ornithogalum virense* by J. Gafin (unpublished) has shown no deficiency in the egg nucleus of this plant. If *Aloe davyana* is indeed deficient in deoxyribonucleic acid, it is a rare case and certainly merits further investigation.

It should be noted that *Aloe davyana* is a plant which sets seed easily and abundantly.

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Influence of Day-length on Nodule Formation in *Soja hispida* by a Specific *Rhizobium* Strain

Experiments have been carried out upon the action of day-length on the formation of nodules by a specific *Rhizobium* strain. Two different varieties of *Soja hispida* (Capitole and Kouban 0375) were used. In each case, four series were made: two were exposed to an 8-hr. day, and the other two to a 16-hr. day. Both for the 8- and the 16-hr. day, one group was sown with the specific *Rhizobium*, the other being sown without the *Rhizobium* (control). The temperature of the room was maintained at 20° C. during the whole experiment in the phytotron installation at Liège. Artificial light was given by six fluorescent 'Phytor' lamps at 65 cm. from the soil (4,500 lux at the soil surface).

It was observed that the *Rhizobium* was able to colonize perfectly the roots of plants in the case of the 16-hr. day, whereas for an 8-hr. day colonization remained very feeble.

With a 16-hr. day, heavy and numerous nodules functionally effective, developing a dark red colour in the internal tissue, were obtained. On the contrary, for an 8-hr. day, nodules were rare and very small; the colour of the inside tissue was pink only for the largest of them; in one experiment, there was total absence of nodules with an 8-hr. day (Fig. 1).

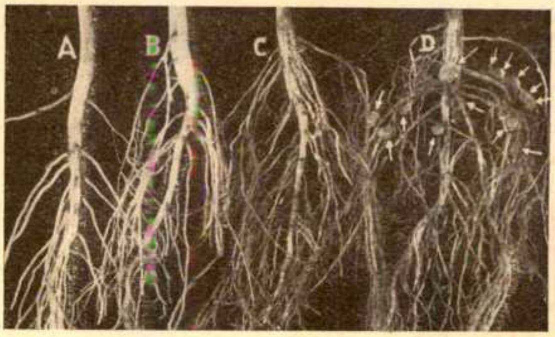

Fig. 1. (*A*) Roots of plants in 8-hr. day, without *Rhizobium*. (*B*) Roots of plants in 8-hr. day, with *Rhizobium* (no nodules are formed). (*C*) Roots of plants in 16-hr. day, without *Rhizobium*. (*D*) Roots of plants in 16-hr. day, with *Rhizobium* (heavy and numerous nodules are formed; indicated by the arrows)

It appears that the day-length to which the leaves of the plants are exposed—in other words, the functioning of the leaves—has an influence on nodule formation by a specific *Rhizobium* and specially on the functional effectiveness of the nodules.

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A Biologically Active Fatty-acid in Malvaceae

It has been known for many years that the ingestion by hens of malvaceous plants or crude fats derived from such plants gives rise to pink 'whites' in stored eggs[1]. Schaible and Bandemer[2] showed that the pink discoloration was caused by iron diffusing from the yolk and chelating with the conalbumin of the white. The disorder is accompanied by a putty-like condition of the yolks when the eggs are cold, and affected yolks have a higher water content than normal. The pH values of the yolk and white, normally 6·5 and 9·0 respectively, tend to converge. Schaible and Bandemer[2] suggested that the effects of a diet containing malvaceous products could be explained by an increased permeability of the vitelline membrane surrounding the yolk.

Since the active principle in Malvaceae has not hitherto been identified, chemical studies have been carried out on the oils extracted from the leaves and seeds of *Malva verticillata* and *M. parviflora* and from cotton seed (*Gossypium hirsutum*). As oils of malvaceous plants are known to give a positive reaction to the Halphen test[3], attempts were made to isolate the constituent giving rise to this reaction. The biological activity of several fractions of the oil has also been studied. The results show that the factor in malvaceous oils promoting the development of pink whites is an unsaturated fatty-acid, which may be identical with the acid giving the Halphen test.

In each oil tested, the Halphen test was invariably given by the saponifiable fraction. Low-temperature crystallization of the mixed fatty-acids from acetone solutions yielded fractions giving increasingly intense Halphen tests as the saturated and part of the unsaturated acids were removed. Since the acid giving the Halphen test (referred to here as 'Halphen acid') is heat-labile and readily oxidized, separation by fractional distillation of the methyl esters is not feasible. Reversed-phase partition chromatography[4] has been used for separation. After passing the fractions rich in Halphen acid twice through the partition column, further purification was effected by six to ten crystallizations from cold acetone and petroleum ether. The concentration of the Halphen acid in the mixed fatty-acids of *Malva* spp. probably does not exceed 3 per cent.

While it is doubtful whether pure Halphen acid has yet been isolated, the richest fractions have yielded material with the following characteristics: Halphen colour reaction is just detectable at 10 p.p.m.; gentle heating of the acid, with or without alkali, rapidly abolishes the colour reaction; melting point, 10·3–10·5° C.; analysis, C, 77·4; H, 11·9 and O, 11·0 per cent (oleic acid, C, 76·5; H, 12·1; O, 11·3 per cent); iodine value[5], 110·3; apparent molecular weight 283 (oleic acid 282). The infra-red absorption spectra of the liquid acid showed a prominent band at 1,008 cm.$^{-1}$, which is believed to be characteristic of the *cyclo*propane ring[6]. Dijkstra and Duin[7] found that some oils giving the Halphen reaction also showed strong absorption at 1,009 cm.$^{-1}$.

In order to test whether fractions giving the Halphen test contained the biologically active component, 0·2 ml. of a chromatographic fraction rich in Halphen acid (more than 20 per cent) was fed every day for fifteen days to each of four laying hens. Similar amounts of pure oleic acid were fed daily to four control hens. All eggs from the control (oleic acid) pen were normal, whereas 71 per cent of the eggs from hens fed the Halphen acid showed typical pink-white disorder. Some typical results of chemical analyses are given in Table 1.

Table 1. Chemical Analyses of Control and Affected Eggs

Group of hens	pH		Yolk moisture content (per cent)	Iron (μgm./gm. white)	Non-protein nitrogen (mgm./gm. white)
	White	Yolk			
Before feeding					
1	8·72	6·70	51·5	0·31	0·071
2	8·71	6·66	51·6	0·33	0·076
During feeding					
1 Control eggs	8·57	6·46	51·7	0·22	0·078
2 Pink-white eggs	7·52	7·43	54·3	1·38	0·283

For the affected eggs, the results in Table 1 show increased moisture content of yolks, increased iron and non-protein nitrogen content of whites and convergence of the pH values of the whites and yolks. It was found that much higher concentrations of amino-acids occurred in the whites of affected eggs than in the controls. Halphen tests on yolk fat extracted from eggs with pink white were strongly positive in 1 : 10 dilutions and slightly positive in 1 : 100, whereas the control yolk fats were negative.

The rate of hæmolysis of sheep erythrocytes by the potassium soap of Halphen acid (concentration 100 p.p.m.) is three times faster than that produced by a similar concentration of potassium oleate. The Halphen acid may therefore have strong surface-active properties.

A fuller account of these investigations will be published elsewhere. They form part of the research programme of the Division of Food Preservation, Commonwealth Scientific and Industrial Research Organization.

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Chromatographic Detection of Free Amino-acids in Normal and Iron-deficient Plants of *Hibiscus esculentus* L.

It has been reported that in iron-deficient plants there is observed an increase of the soluble forms of nitrogen, with a simultaneous decrease of its protein forms[1-3]. This observation was confirmed in the present work, on *Hibiscus esculentus* L., using the standard methods of chemical analysis. However, we have endeavoured to carry out a qualitative examination of the soluble fraction of nitrogen in normal and iron-deficient plants of this species by the application of paper chromatography.

For that purpose, 3–4 gm. of fresh material taken from 35-day old plants was carefully broken up in 80 per cent ethyl alcohol and the crude extract centrifuged for 15 min. at 4,000 r.p.m. The supernatant liquid was then separated by decantation and concentrated by evaporation until its volume was reduced to 1 c.c. From that concentrated extract 0·005 c.c. was used for each chromatogram. Two-dimensional ascending chromatography on Whatman No. 1 paper, 25 cm. × 25 cm. sheets, was adopted, with phenol as solvent for one direction and *n*-butanol/acetic acid/water (4 : 1 : 5) for the other. The position of amino-acids was located by spraying with ninhydrin reagent (0·1 per cent in acetone). The amino-acids were identified by comparing the spots appearing on the chromatograms with those produced by authentic compounds.

In Fig. 1 are shown two chromatograms : (*A*) from an iron-deficient plant ; (*B*) from a normal plant. With regard to the quantity of amino-acids involved, the greater concentration of these acids is clearly observed in the alcoholic extract of the iron-deficient plants, from the size as well as the intensity of the colour shown by the spots. The higher concentration of asparagine is especially remarkable. From the qualitative point of view, the iron-deficient plants contain phenylalanine, serine and probably glycine. Normal plants do not contain detectable amounts of these amino-acids. From the undetermined spots, two were common on both chromatograms, but were more intense on those prepared from iron-deficient plants. One spot appeared only on the chromatogram from iron-deficient plants, while three appeared on those from normal plants only. The location and colour of one of the last three spots coincide with those produced by cysteinic acid.

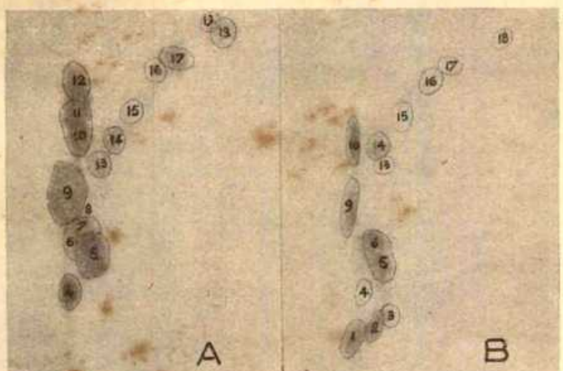

Fig. 1. Two-dimensional ascending paper chromatographs of alcoholic extracts of *Hibiscus esculentus* L. tissue. (*A*) From an iron-deficient plant ; (*B*) from a normal plant.
1, 2, 3, 4, 12, 13, Unidentified spots ; 5, aspartic acid ; 6, glutamic acid ; 7, serine ; 8, glycine (?) ; 9, asparagine ; 10, arginine ; 11, glutamine ; 14, α-alanine ; 15, β-alanine ; 16, tyrosine ; 17, valine ; 18, leucine(s) ; 19, phenylalanine

From these observations, it becomes evident that the difference in the amino-acid content of normal and iron-deficient plants is not only quantitative but also qualitative.

Further details of this work will be published elsewhere.

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Chemical Nature of Nucleic Acids in Cyanophyceae

The available information regarding the chemical nature of nucleic acids in Cyanophyceae is very meagre, and deoxyribonucleic acid and ribonucleic acid have not been isolated chemically from this group. As the blue-green cell is peculiar in its nuclear structure, the chemical nature of its nucleic acids may be different in kind or degree from that of other sources. With this in view, the nucleic acids were isolated from *Nostoc muscorum* using the conventional method of Schmidt and Thannhauser as modified by Heinrich *et al.*[1].

The deoxyribonucleic acid separated from *Nostoc muscorum* gives a positive test with the Dische reagent, indicating the presence of deoxypentose-sugar. Chromatographic analysis of the hydrolysate according to the procedure of Wyatt[2] revealed only three spots of bases, corresponding to guanine, adenine and cytosine, but thymine could not be detected. Magee and Burris[3] showed in experiments on nitrogen fixation by *Nostoc muscorum* that incorporation of nitrogen-15 in thymine is much less than that of other nitrogenous compounds. It is possible that the thymine in deoxyribonucleic acid is present in too small an amount to be detected on the chromatogram, and hence application of carbon-14 as a tracer might help its detection. Carbon-14 dioxide was therefore passed through a *Nostoc* suspension in phosphate buffer at *p*H 7 for 6 hr. in presence of light. After the experiment, the suspension was extracted with 80 per cent ethanol, alcohol–ether (3 : 1) and finally with ether only, and deoxyribonucleic acid was precipitated by the procedure referred to above. A radioautograph revealed the spot corresponding to thymine. Added thymine co-chromatographed with the thymine eluted from the radioactive spot. Thus deoxyribonucleic acid in Cyanophyceae is similar in kind to that from other sources, which also support the earlier observations from cyto-chemical work[4] and with the electron-microscope (Singh, R. N., personal communication).

Ribonucleic acid which was precipitated from the deoxyribonucleic acid filtrate by alcohol gave a positive reaction in the orcinol test, indicating the presence of pentose sugar. Chromatographic analysis following the method of Smith and Markham[5] gave four spots corresponding to guanine, adenine, cytidylic acid and uridylic acid. Thus the ribonucleic acid of Cyanophyceae shows no qualitative deviation from the normal type.

Further studies, with carbon-14 and phosphorus-32, on the turnover of nucleic acids in Cyanophyceae are now in progress.

Thanks are due to Dr. D. M. Bose, director of the Bose Institute, for his interest in this work and to Dr. S. K. Roy and Dr. S. P. Sen for suggestions and criticisms.

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Culture of Tubal Mouse Ova

TUBAL mouse ova at the eight-cell stage developed consistently to blastulæ, when cultured in the egg white – saline mixture used by Hammond[1] for the actual collection of ova. This fluid was freshly prepared each day and kept in tightly stoppered vessels. Unlike that of Hammond, the *p*H was about 7·0; but this rapidly rose to 7·8 during measurement with a glass electrode or when exposed in shallow vessels, and the change was attributed to loss of carbon dioxide contained in the egg white. Since ova failed to differentiate at a *p*H greater than 7·7, Krebs–Ringer bicarbonate[2] (*p*H 7·4), with 10 γ/ml. penicillin and streptomycin, was adopted as the standard saline medium. With the addition of 1 per cent fresh thin egg white, this proved an excellent culture medium for the ova, but no growth was obtained in the Krebs–Ringer bicarbonate alone.

The essential factor or factors in egg white were shown to be non-dialysable, but an attempt to identify them with one or more of the protein fractions of egg white was unsuccessful. However, normal growth was obtained with Krebs–Ringer bicarbonate plus crystalline bovine albumin (Armour and Armour) in concentrations ranging from 0·03 to 6 per cent, and this preparation was used in all subsequent observations.

Mice were killed on the third day after mating and the ova obtained by inserting a 28-gauge hypodermic needle at the uterine end of the oviducts, and flushing them out into a cavity slide with about 0·5 ml. of the medium. The ova were then collected in about 0·3 µml. of fluid, with as little tubal debris as possible, in a mechanically controlled pipette. They were transferred to a second cavity slide containing 1 ml. of medium, the contents agitated, and the ova again collected with a fresh pipette and transferred to an agglutination tube containing 1 ml. of fluid. This was tightly stoppered and incubated in a water bath at 37° C. After 48 hr. the contents were tipped on to a cavity slide and examined.

Using this technique, only three out of 148 ova failed to develop into blastulæ when cultured in 0·4 per cent bovine albumin in batches of 10–14, and 86 out of 87 developed when the concentration was 0·1 per cent. These blastulæ appeared normal and produced characteristic growth when inserted under the kidney capsule of mice.

It is unlikely that tubal cells or secretions transferred to the culture tubes with the ova played any part in growth, since development continued even if the washing procedure described above was repeated ten times.

The mode of action of the albumin is not clear. It did not appear to function by preventing extraction of any component of the ova, since they failed to grow in Krebs–Ringer bicarbonate containing 200 ova/ml. which had been ruptured by alternate freezing and thawing. However, it did alter the physical properties of the medium and greatly facilitated the manipulation of the ova with a pipette, as those in Krebs–Ringer bicarbonate alone adhered to the glass. So far it has been shown that the omission of calcium, magnesium, potassium or glucose from the Krebs–Ringer bicarbonate prevented growth, and development was delayed without phosphate. Growth occurred only between *p*H 6·9 and 7·7 and continued when the molarity was reduced to 0·09.

I acknowledge the generous help given by members of the Department of Biochemistry of this University.

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Microbiology of Silage

ALTHOUGH several investigators have studied the micro-organisms present in silage, the various types of organisms and the number of each found in different qualities of silage are rarely given. Preliminary results of a study of the micro-organisms present in grass silage made in four different ways may therefore be of interest.

The silage was made in glass tubes in a manner similar to that described by Allen *et al.*[1], 40 gm. of the grass mixture—perennial ryegrass and white clover—being mown and after treatment being packed into tubes 6 in. × 1 in., care being taken that all the implements used had been previously sterilized. Each tube was immediately closed with an air-tight stopper, and stored at ordinary laboratory temperature for seven weeks, after which the tubes were opened and their contents examined for colour and smell as well as bacteriologically.

Four contrasting treatments were adopted as follows: (*A*) the grass was packed without chopping and without the addition of any water or preservative; (*B*) the grass was chopped into inch lengths but packed without the addition of any water or preservative; (*C*) the grass was left unchopped but sprinkled with sterile water before packing; (*D*) the grass was left unchopped but was well mixed with 0·2 gm. of sodium metabisulphite in powdered form before being packed into the tube.

The silage from treatment (*A*), though made without the addition of any preservative, was still green and had kept well. A slight aroma of a pleasant nature had developed; otherwise the condition of the grass appeared almost identical with what was originally put in. In fact, it was considered the best-preserved of all the four methods. In treatment (*B*) the silage was fairly similar in appearance to that in treatment (*A*), but it had a slightly objectionable smell. In treatment (*C*), the silage turned slightly brown after a few days and when opened it smelt strongly of butyric acid; it was deemed the poorest of all the four silages. In treatment (*D*) the grass had kept well and had a pleasant aroma, but it had developed an unnatural shade of green—a bright

Table 1. *p*H AND LOGARITHM OF THE NUMBER OF BACTERIA PER TUBE* IN THE GRASS WHEN FRESH AND AFTER SEVEN WEEKS IN EACH OF THE FOUR TREATMENTS

	Treatment of grass	*p*H	Total bacteria	Lacto-bacilli	Coli-forms	Anaerobic spore formers
	Fresh	6·2	8·9	0·5	4	3
A	Packed as mown	4·5	7·9	7·4	0	0
B	Packed after chopping	4·1	9·8	7·7	0	0
C	Packed after being sprinkled with sterile water	5·6	7·2	6·2	7	6
D	Packed after addition of sodium metabisulphite	5·4	4·0	1·7	3	0

* Each tube contained 40 gm. of fresh grass.

green as compared with treatment (*A*), which had retained the normal fresh green.

In the bacteriological examination the contents of each tube were ground up with sterile sand, and, by dilution, counts were made of the following: the total number of bacteria growing at 30° C. on tryptone glucose-yeast extract agar[2]; lactobacilli on Rugosa's medium at 37° C.[3]; anaerobic spore-forming bacteria in Robertson's cooked meat medium at 30° C.; and coliforms in MacConkey's bile salt broth at 30° C.

Table 1 shows that, comparing the four silages with the fresh grass, there has been a distinct change in the pattern of distribution of the bacterial flora, much more so than in the total number of organisms. The total number of bacteria and the number of lactobacilli were considerably lower in the metabisulphite treatment than in any of the other treatments. The number of coliform bacteria, however, had not been reduced to the same extent. Excess of water (treatment *C*) tends to encourage the coliforms and also the anaerobic spore formers—both undesirable developments. On the other hand, treatments (*A*) and (*B*)—packing without surplus water—have reduced both these developments while at the same time they have favoured the development of the lactobacilli.

Two features stand out here in connexion with the lactobacilli. In the first place, the low number of lactobacilli present in the fresh grass; this is typical of all samples of fresh grass encountered in this work. Secondly, it will be seen that the acidity had developed to a further degree where neither water nor sodium metabisulphite had been added. In these two treatments (*A* and *B*) the lactobacillus had not only increased very considerably but also had become the dominant organism.

These and other results on the microbiology of different silages will be reported in a future publication, when it is hoped to relate the figures found in tube silage to those obtained from similarly treated silage made in ordinary silos. This work is being carried out during the tenure of a Sir James Knott Fellowship; I wish to thank Prof. Martin Jones for his interest and advice.

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'Solubilized' Chemicals for the Control of Plant Nematodes

Staniland and Stone[1] have described the use of 'solubilized' chemicals as nematicides. Laboratory work has been continued by Miss J. K. Bartlett with the aid of a grant from the Agricultural Research Council, and some other aspects of the problem are being studied by Mr. L. E. W. Stone. I have given particular attention to the control of potato eelworm in glasshouse soils. Control of potato root eelworm of a high order has been obtained by watering infested soil with a large volume of various 'solubilized' chemicals. Volumes to the extent of one gallon per square foot are necessary, and care is required in application in order to avoid 'ponding', with consequent uneven wetting of the soil and contained eelworm cysts. Cysts not killed are mainly to be found at the lower depths where soil and cysts are wetter. 'Solubilized' chemicals work best in the higher and dryer levels of the soil, where fumigants are least effective since the drier and more aerated soil does not permit a sufficient concentration of vapour to be retained.

It occurred to me that an efficient economic control of potato root eelworm under glass could probably be achieved by a combination of both methods. It has been found that an injection with DD (dichloropropylene dichloropropane) at the usual rate of 400 lb. an acre can be followed by application of a sufficient volume of 'solubilized' chemical to wet the top 2–3 in. of soil, the amount of liquid for this purpose being 2 gallons a square yard. This treatment has now been tested under commercial glasshouse conditions and has given excellent results.

Dr. B. G. Peters, then head of the Department of Nematology, Rothamsted Experimental Station, very kindly undertook a laboratory experiment whereby the effects of nematicides could be studied in separate 2-in. layers of soil to a depth of 12 in. In this way it was possible to investigate the effects of the two chemicals separately and together. Dr. Peters has shown that the two treatments behave independently and that in combination they are effective. A paper describing this work has been published[2].

The combined DD injection, followed by the application of a nematicidal 'seal', is simple and quick in practice and compares favourably with steam sterilization in efficiency, time and cost. The chemical which has been found most suitable for solubilization, with due regard to nematicidal efficiency and low cost, is a commercial xylenol fraction. The most suitable detergent for effecting solubilization is a commercial brand of the long-chain alkyl sulphate type. It is clear that there is much scope in the use of a variety of tar-distillates; and the finding of even cheaper materials, particularly if cheaper detergents were forthcoming, might well extend the use of the method to open land, particularly in connexion with some of the more profitable crops.

A full account of this work will be published elsewhere.

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Arresting *Paramecium*

VARIOUS devices are employed in an effort to slow down the movements of *Paramecium* for the benefit of first-year students. It seemed worth while to report that the so-called cellulose adhesives are very successful indeed.

The material was prepared from 'Stadex C.A.', a commercial product intended for the use of decorators. Movement was slowed to a convenient rate in a 0·15 per cent solution, and one twice this strength was also useful for demonstrating the twisting and turning movements of which the animal is capable. The animals look perfectly normal in the solutions and their movement is normal though slowed; they are apparently unharmed and have survived for more than two months.

I am given to understand that 'Stadex C.A.' is sodium carboxy methyl cellulose. The results should therefore not have been unexpected, for methyl cellulose has already been used successfully[1]; but as its use does not appear to be widely known, it was thought that the present observations would be of value.

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Use of Gold Sols as an Aid to focusing in High-Resolution Electron Microscopy

ALTHOUGH electron microscope contrast may be increased by the use of objective apertures, accurate focusing in thin-section work is still difficult and, in order to obtain an in-focus picture of a particular field, it is very helpful to find a small dense particle, or a hole in the membrane, on which to focus. An obvious solution to this problem is to distribute small dense particles on the specimen.

Birch-Andersen *et al.*[1] have tried using carbon black, but the method is open to two objections: (1) large masses must be deposited on the specimen, and (2) even if only single particles are present, it is necessary to focus slightly off the particle to get an in-focus picture of the section, since the diameter, or edge, of the particle is at a different focal level. This effect is of importance, however, only towards the limit of resolution.

We decided that a gold sol might provide particles of useful size and density. Fortunately, it is easy to make gold sols in a wide range of particle sizes. We have found that particles of 130–150 A. diameter are very useful for focusing at a magnification of 9,000; for higher magnifications, smaller particles would be useful.

Turkevich, Stevenson and Hillier[2] described a method of making gold sols in a range of particle sizes. The method (reduction of acid gold chloride, 95 ml. of which contained 5 mgm. of gold, with 1 per cent sodium citrate at 60–100° C. depending on the particle size required) is easy, and yields sols with a very small scatter of particle diameter—the standard deviation of the distribution is about 10 per cent. We diluted the sol 1 in 10 and put drops on mounted sections, left them for 10 min., and then drained off as much as possible. The particles were rather more evenly spread over the specimen if the sol was put on the 'Formvar' membranes before mounting the sections.

We have found that gold sols, prepared in this way, have several advantages: (1) they are extremely dense and give very good images when in focus; (2) they are so uniform in size and their density is so great that they are unlikely to be confused with any tissue components; (3) the size of the particles and their number on the specimen can be varied to suit any particular purpose.

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Quotation of Titles of Papers in Review Articles

As one of the contributors to the "International Review of Cytology", vol. 3, reviewed in *Nature* of October 8 (p. 664) by Dr. D. R. Newth, I should like to direct attention to certain facts. Dr. Newth concludes his review with the words: "The reviewer of Vol. 1 pleaded for titles of papers to be given in the lists of references. If a reminder will strengthen the editors' hands in forcing this reform upon unwilling authors, it is gladly given".

My review was submitted with a bibliography including full titles, and I strenuously urged the publishers to include them. The following is a quotation from a letter from me to the publishers, dated March 29, 1954: "In a letter to Dr. Bourne [one of the editors] last year, I quoted the review of Dr. E. N. Willmer in 'Nature', in which he strongly deplored the omission of titles of papers referred to in the IRC. A very great deal of the value of any review article is lost if the full bibliography is omitted, and I would have wished to place this review elsewhere had I thought that this grave and short-sighted defect was to be repeated in vol. III. I feel most strongly that the main use of most reviews lies in the bibliography; many of the references I quote are of little use to the reader if he cannot refer to their titles easily, and would not have been included had I known that the titles were to be cut out".

The publishers replied on April 7, 1954: "With respect to the omission of titles of papers, we regret that we will be unable to insert them. It is our house style and also the style of this series, and we have found that on the rare occasions when we have made exceptions we have had unfavorable comments from reviewers concerning the inconsistency. We hope that you will not find this unreasonable".

The editors' hands indeed need strengthening; but not against unwilling authors.

CHARITY WAYMOUTH

Roscoe B. Jackson Memorial Laboratory,
Bar Harbor, Maine.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, January 16

Bone and Tooth Society (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (joint meeting with the Institution of Civil Engineers and the Institution of Mechanical Engineers, at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5 30 p.m.—Meeting on "Advanced Courses for Engineers in Industry".

Manchester Literary and Philosophical Society (in the Lesser Free Trade Hall, Manchester), at 5.45 p.m.—Mr. Max Beloff: "Benjamin Franklin: International Statesman" (Franklin Memorial Lecture).

Institute of Metal Finishing (joint meeting with the Institute of Sewage Purification, at Imperial College, South Kensington, London, S.W.7), at 6.15 p.m.—Mr. A. E. J. Pettet: "The Effects of Metal Finishing Wastes on Sewage Purification".

British Psychological Society (in the Psychology Department, Birkbeck College, Malet Street. London, W.C.1), at 8 p.m.—Mr. N. S. Sutherland: "Visual Discrimination in Octopus".

Tuesday, January 17

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. Kalmus: "A Biologist's Impressions of Brazil".*

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. B. Folkow (Gothenburg): "Quantitative Aspects of some Mechanical, Nervous and Humoral Factors Controlling the Cardiovascular System".*

Scientific Film Association (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Mr. R. Ollerenshaw: "The Use and Abuse of Film in Medical Illustration".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. W. Deck: "Crack Detection in Aircraft Structures".

Wednesday, January 18

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Benjamin Franklin in London" (Trueman Wood Lecture).

Physical Society, Colour Group (at Imperial College, Prince Consort Road, London, S.W.7), at 3.30 p.m.—Mr. J. M. Adams: "Colour Half-Tone Printing".

British Glaciological Society (joint meeting with the Royal Meteorological Society, at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Meeting on "Snow Accumulation and Ablation".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. E. S. Pearson, C.B.E.: "Some Aspects of the Geometry of Statistics: The Use of Visual Presentation in Understanding the Theory and Application of Mathematical Statistics" (Presidential Address).

British Nuclear Energy Conference (in the Great Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. B. Hall and Mr. T. I. M. Crofts: "The Use of Sodium and Sodium Potassium Alloy as a Heat-Transfer Medium".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Symposium on "The Personality Characteristics of Parents of Promising Children". Speakers: Miss Elizabeth Tylden, Miss Mildred Creak and Mr. S. G. Singleton.*

Institute of Fuel (joint meeting with the Coke Oven Managers' Association (Southern Section), at the Waldorf Hotel, Aldwych, London, W.C.2), at 5.30 p.m.—Mr. L. J. Clark: "Steam and Power in the Gas and Coking Industry".*

Royal Institute of Chemistry, London Section (joint meeting with the London Section of the Society of Chemical Industry, at the Institute of Metals, 4 Grosvenor Gardens, London, S.W.1), at 6 30 p.m.—Dr. H. J. Plenderleith: "Science in the Service of Archæology".

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. M. R. Mills: "The Selective Hydrogenation of Tung Oil".

Thursday, January 19

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. J. Stenning: "Following the Clouds: Sudanese Nomadism".*

Physical Society, Optical Group (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. A. Graves: "A Decade of Progress in Canadian Mining (1945–1954)—Part 2".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. R. W. Butcher: "Marine Microflagellates—a Long Overlooked Ecological Group"; Miss P. Lamplugh Robinson: "The Mesozoic Fissures of the Bristol Channel Area and Their Vertebrate Faunas".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. K. F. Roth: "Rational Approximations to Algebraic Numbers".

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall, Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 6 p m.—Meeting on "The Use of Pulverised-Fuel Ash". Mr. B. Butterworth: "Brick Making"; Mr. W. Kinniburgh: "Light-Weight Aggregate".

Chemical Society (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Dr. G. W. Kenner: "Recent Progress in the Chemistry of Peptides" (Tilden Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "The Treatment of Human Amoebiasis". Opening Speakers: Prof. A. W. Woodruff and Dr. A. R. D. Adams. Chairman: Prof. R. M. Gordon.

Friday, January 20

British Society of Rheology (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 9.45 a.m.—Symposium on "Rheology of Proteins".

British Society for Research on Ageing (in the Littlewood Hall, The General Infirmary, Leeds), at 2.30 p.m.—Meeting on "Connective Tissue and its Changes With Age".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion—"Irregular Changes in the Rotation of the Earth". Chairman: Sir Harold Spencer Jones, F.R.S. Speakers: Mr. T. Gold, Dr. W. H. Munk and Prof. S. K. Runcorn.

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—"Some Meteorological Aspects of High-Level Navigation". (1) Captain B. C. Frost: "Jet Streams in Flight"; Mr. J. K. Bannon and Mr. T. H. Kirk: "Forecasting Jet Streams".

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. W. Davis: "Marine Reduction Gearing" (Thomas Lowe Gray Lecture).

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Mr. E. Chadwick: "Solvents in the Chemical Industry".

Saturday, January 21

Biochemical Society (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer in Mechanical or Production Engineering, Assistant Lecturer in Mathematics, Demonstrator in Mechanical Engineering, and a Demonstrator in Electrical Engineering—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (January 18).

Scientific Officer (with a first- or second-class honours degree or equivalent in physics or chemical engineering) with the Ministry of Supply at Waltham Abbey, Essex, for research on heat transfer phenomena at high temperatures—The Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S W.1, quoting A.458/5A/VD (January 21).

British Coke Research Association Fellow (honours graduate in chemistry, physics or applied science relating to fuel technology) to work on the physical chemistry of carbon under the direction of the Professor of Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Chair of Education—The Registrar, University College, Singleton Park, Swansea (January 31).

George Angus Student (graduate of an approved university or holder of approved qualifications) for research in the Department of either Chemistry, Physics or Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Lecturer (with qualifications in theoretical physics) in Physics—The Secretary, Queen's University, Belfast (January 31).

Professor of Heat Engines—The Dean, Faculty of Engineering, Cairo University, Giza, Egypt (February 1).

Senior Lecturer in Education at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 4).

Assistant Lecturer in Histology in the Department of Physiology and Histology—The Registrar, The University, Liverpool (February 6).

Lecturer in Fuel Technology in the Department of Chemical Engineering—Head of the Chemical Engineering Department, Imperial College, London, S.W.7 (February 6).

Lecturer or Assistant Lecturer (with some experience in any of the branches of electrical engineering) in the Department of Electrical Engineering—The Registrar, The University, Manchester (February 11).

Director of Research—The Secretary, British Scientific Instrument Research Association, Sira, South Hill, Chislehurst, Kent (February 14).

Assistant Lecturer (honours graduate) in Zoology—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (February 15).

Reader in Aeronautics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 16).

Lecturer in the Department of Aeronautical Engineering—The Registrar Queen Mary College (University of London), Mile End Road, London, E.1 (February 21).

Lecturer in Astronomy—The Registrar, The University, Manchester 13 (February 28).

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—Secretary of University Court, The University, Glasgow (February 29).

Lecturer in Anatomy—The Secretary, The University, Aberdeen (March 1).

Assistant Director (with a good science degree and a knowledge of research in nutrition, and preferably proficient in foreign languages, and experience overseas) of the Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Aberdeenshire—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (May 31).

Aerodynamicist (with a first- or second-class honours degree in physics, mathematics or engineering) at the Ministry of Supply Headquarters, London, for assessment of civil aircraft projects for commercial operations, including estimation of aircraft performance during take-off, landing and in flight—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.952/5/AA.

Assistant (preferably with a biological degree and bibliographical experience, and with some knowledge of German) to prepare a journal comprising an annual record of the contents of entomological publications—Commonwealth Institute of Entomology, 56 Queen's Gate, London, S.W.7.

Associate Professor of Mathematics—Dean W. H. Johns, Faculty of Arts and Science, University of Alberta, Edmonton, Alberta, Canada.

Engineer or Physicist (with a first- or second-class honours degree or equivalent, and keen on practical as well as theoretical work) in the Instrumentation and Photographic Department of the Royal Aircraft Establishment, Farnborough, Hants, for work on development of new and adaptation of existing aircraft automatic pilots—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.620/5A/AA.

Head of the Science Department, Grade II—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts.

Master to teach Chemistry up to "A" level—The Headmaster, Worksop College, Notts.

Principal Scientific Officer (with a first- or second-class honours degree in physics and considerable experience in electronic techniques), to co-operate with Nuclear Physicists in the design of specialized equipment and circuitry required in nuclear physics experiments with particle accelerators, and to supervise its construction—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 857/34.

Scientific Officer (with a first- or second-class honours degree or equivalent in electrical engineering or physics with a bias towards electronics, and preferably with previous experience of airborne radar systems) at a Royal Air Force Establishment in Norfolk, for development and adaptation of radio equipment pulse techniques, including aerials, power supplies and displays—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.598/5A/AA.

Senior Technician to take charge of Aerobic Vaccine Production and Media Making—The Head, Bayer Biological Institute, Beechwood House, 44 Church Street, Exning, near Newmarket, Suffolk.

Technician (with experience in clinical biochemistry or in biochemical research) in the Clinical Research Laboratory—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. A Brief Review of Science and Technology in Western Germany. Pp. viii+103. (London: H.M. Stationery Office, 1955.) 4*s*. net. [811

Ministry of Fuel and Power. Safety in Mines Research Establishment. Thirty-third Annual Report on Safety in Mines Research, 1954. Pp. 93+4 plates. (London: H.M. Stationery Office, 1955.) 4*s*. net. [811

Department of Scientific and Industrial Research. Bulletin of the Geological Survey of Great Britain, No. 9. Pp. iv+58+3 plates. (London: H.M. Stationery Office, 1955.) 6*s*. net. [911

Birkbeck College (University of London). Calendar for 1955–1956 (133rd Session). Pp. 132+xxviii. (London: Birkbeck College (University of London), 1955.) [911

Ministry of Agriculture and Fisheries. Bulletin No. 146: Poultry Breeding—Genetics and System of Breeding. By G. E. Mann. Pp. vi+150. (London: H.M. Stationery Office, 1955.) 4*s*. 6*d*. net. [911

Other Countries

Museum of Applied Science of Victoria. Report of Activities for the year ended 30th June, 1954. Pp. 15. (Melbourne: Museum of Applied Science of Victoria, 1955.) [411

South Australia. Institute of Medical and Veterinary Science. Sixteenth Annual Report of the Council, July 1953–June 1954. Pp. 107. (Adelaide: Institute of Medical and Veterinary Science, 1955.) [411

Defence Research Board, Canada. Publication T53J: Daily Disturbance Variation of Earth Currents at Kakioka. By Kazuo Yanagihara. (Translated by E. R. Hope, with Translator's Comments.) Pp. ii+12. Publication T190R: Earth Currents. By V. A. Troyickaya. (Translated by E. R. Hope.) Pp. 8. Publication T174R: The Ivanov–Troyickaya Earth Current Oscillations. Three papers by A. G. Ivanov and Troyickaya. (Translated by E. R. Hope, with Translator's Comments.) Pp. i+31. (Ottawa: Defence Scientific Information Service, Defence Research Board, 1955.) [411

British Guiana. Geological Survey Bulletin No. 26: The Bauxite Resources of British Guiana and Their Development. Compiled by D. W. Bishopp from reports by E. E. Winter, Sir John Harrison, and from other sources. Pp. i+123+9 figures. (Georgetown: Geological Survey, 1955.) 12*s*. 6*d*. [511

United States Department of Agriculture. Index-Catalogue of Medical and Veterinary Zoology. Part 1: Authors—Aall to Azzolina. Pp. 1–142. Part 2: Authors—B to Bychkov. Pp. 143–612. Part 3: Authors—C to Czygan. Pp. 613–962. 40 cents. Part 4: Authors—D to Dzunkovski. Pp. 963–1176. 30 cents. Part 5: Authors—E to Fynney. Pp. 1177–1458. 45 cents. Part 6: Authors—G to Gyser. Pp. 1459–1754. 40 cents. Part 7: Authors—H to Juzuki. Pp. 1755–2272. 1.25 dollars. Part 8: Authors—K to Kyzer Pp. 2273–2582. 55 cents. Part 9: Authors—L to Lyutkevich. Pp. 2583–2966. 70 cents. Part 10: Authors—M to Myoh. Pp. 2967–3482. 1.50 dollars. Part 11: Authors—N to Ozzard. Pp 3483–3720. 75 cents. Part 12: Authors—P to Quortrup. Pp. 3721–4054. 1 dollar. Part 13: Authors—R to Rzoska. Pp. 4055–4348. 1 dollar. Part 14: Authors—S to Shweig. Pp. 4349–4676. 1.25 dollars. Part 15: Authors—Si to Szyszowski. Pp. 4677–4986. 1.25 dollars. Part 16: Authors—T to Tsykalas. Pp. 4987–5210. 1 dollar. Part 17: Authors—U to Wyville. Pp. 5211–5608. 1.25 dollars. Part 18: Authors—X to Zyukov. Pp. 5609–5711. 40 cents. Supplement 1: Authors A–B. Pp. 1–317. 1 dollar. Supplement 2: Authors A–C. Pp. 318–458. 50 cents. Supplement 3: Authors A–I. Pp. 459–844. 1.25 dollars. Supplement 4: Authors A–K. Pp. 845–970. 45 cents. (Washington, D.C.: Government Printing Office, 1932–1955.) [511

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36, No. 9: Gains in Longevity Are Countrywide. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [811

Department of Agriculture, Mysore State. Entomology Series—Bulletin No. 16: A List of the Insects of Mysore including the Mites. By S. Usman and Dr. M. Puttarudraiah. Pp. vi+194. (Bangalore: Government Press, 1955.) Rs. 1/9/-. [811

Rensselaer Polytechnic Institute. Bulletin, Vol. 54, No. 3: The Writings of David Barnard Steinman relating to the Design, Construction and History of Bridges, including Contributions to the Development of the Engineering Profession, 1909–1954—a Bibliography. Prepared by the Staff of Rensselaer Polytechnic Institute Library. (Engineering and Science Series, No. 67.) Pp. 28. (Troy, N.Y.: Rensselaer Polytechnic Institute, 1955.) [911

Université de Thessaloniki: Laboratoire de Zoologie. Observations suivies sur la Montée en Grece. 2: Pendant les années 1940–41 jusgu à 1948–49. (Montée, Anguilliculture, Inanition.) Par Prof. G. D. Athanassopoulos. Pp. i+80. 3: Pendant les années 1949–50 jusgu à 1954–55. (Montée, Arguilliculture, Inanition.) Par Prof. G. D. Athanassopoulos. Pp. 80. (Thessaloniki: Université de Thessaloniki, 1955.) [911

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 113, No. 7: The Fossil Salamanders of the Family Sirenidae. By Coleman G. Goin and Walter Auffenberg. Pp. i+497–514. Title Page and Index to Vol. 113. Pp. 3. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [911

United States Department of Agriculture. Leaflet No. 389: Cantaloup Insects in the Southwest: How to Control Them. Pp. 8. 5 cents. Leaflet No. 392: Fleas: How to Control Them. Pp. 6. 5 cents. (Washington, D.C.: Government Printing Office, 1955.) [911

Museum of Comparative Zoology at Harvard College. Breviora. No. 47 (July 12, 1955): A New Species of Whiptailed Lizard (Genus *Cnemidophorus*) from the Colorado Plateau of Mexico, New Mexico, Colorado, and Utah. By Charles H. Lowe, Jr. Pp. 9. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [911

United States Department of Commerce: Weather Bureau. Research Paper No. 38: Evaporation from Pans and Lakes. By M. A. Kohler, T. J. Nordenson and W. E. Fox. Pp. iv+21. (Washington, D.C.: Government Printing Office, 1955.) 20 cents. [911

International Survey of Programmes of Social Development. Prepared by the Bureau of Social Affairs, United Nations Secretariat, in co-operation with the International Labour Office; the Food and Agriculture Organization; the United Nations Educational, Scientific and Cultural Organization; and the World Health Organization. Pp. iv+220. (New York: United Nations; London: H.M. Stationery Office, 1955.) 2 dollars; 15*s*.; 8 Swiss francs. [911

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BROADCASTING, TELEVISION AND CURRENT AFFAIRS

THE directive issued by the Postmaster-General on July 27, 1955, to the British Broadcasting Corporation, and also to the Independent Television Authority, restraining either body from arranging to broadcast discussions or *ex parte* statements on issues within a fortnight of their debate in the Houses of Parliament, or while the issue is being debated, has been the subject of repeated questions in Parliament during the past few months. This directive, known as the fourteen-day rule, also vetoes broadcasts by any member of Parliament on any subject of legislation in the period between the introduction of the legislation and the time when it either receives the Royal Assent or is previously withdrawn or dropped. It has also been much discussed in the Press prior to the full debate on broadcasting anticipation of Parliamentary debates which, in deference to growing pressure, the Government arranged on November 30.

It was stated by the Prime Minister on October 25 that the directive imposes no new restrictions upon broadcast discussion, but requires conformity to a practice followed, in its present form, by agreement between the British Broadcasting Corporation and the major political parties since 1948. As explained, however, by the Postmaster-General in opening the debate, by 1953 the Corporation was dissatisfied with the situation and suggested that it alone should assume responsibility for deciding what subjects should be discussed. It did not, as the Corporation's annual report for 1954–55 shows, challenge the principle that broadcasting should not be allowed to encroach on the position of Parliament as the supreme forum for the discussion of public issues. It did, however, insist that if the rule was to be continued, it should be in the form of a directive on the Government's responsibility.

It was clear from the speech of the Postmaster-General that what most concerns the Government is the immense power of broadcasting, including television, over the minds of men. The fear that this power to influence public opinion may undermine or discount that of a political party inclines those in power to overlook the importance of examining the potentialities of such a new medium, of welcoming the opportunities of educating public opinion which it offers and determining the ways in which those opportunities can be most wisely and effectively used to widen the boundaries of public discussion, argument, knowledge and criticism. The Postmaster-General, it is true, admitted that broadcast discussion differs from discussion in Parliament or in public meetings generally. It differs also from discussion in the Press, and these differences in the technique required have more influence than most speakers in the debate were inclined to admit on the selection of broadcasters, whether or not they be members of Parliament. If the full advantages of broadcast discussion are to be realized, the choice of speakers must depend on their broadcasting ability and not primarily on their Parliamentary reputation or their standing with a party caucus.

The most disappointing feature of the debate was, however, the failure of any of the Government spokesmen to show any appreciation of those factors in the situation to which Sir William Haley, for example, directed attention in his Clayton Memorial Lecture in Manchester in March 1954. There was no evidence that broadcasting and television are regarded as in any sense instruments of education (at least by a majority of listeners), or of the urgent need for positive measures to counteract their erosion, for example, of standards of literacy. It is not the slender reporting of Parliamentary debates in the Press or the prior broadcasting discussion of the subjects of debate that undermines the prestige and authority of Parliament; there has always been such public discussion of live issues in the Press and in the streets and clubs and other places where people meet; rather the political party machine has reduced the significance of Parliamentary debate by making its issue a foregone conclusion.

One of the gravest blows struck at the dignity and prestige of Parliament is the disappearance of the independent member, and Sir Robert Boothby rightly reminded the House that it is its own actions rather than those of any other body that can detract from or uphold its dignity. So far from public discussion on parliamentary issues outside the House destroying the reality of Parliamentary debates, members down the centuries have relied on the cut and thrust of such debates to give vitality to their own arguments. It is true that there are occasions when restraint is called for and when broadcast discussion may be inexpedient, just as there are occasions when discussion in the Press is undesirable. If, however, sections of the Press fail to exercise the restraint which decency and the public interest dictate, the remedy lies rather with the public itself than in the imposition of a censorship.

Quoting Lord Beveridge's words, "No argument of merit can justify stifling the discussion of public issues at the moment when discussion is most opportune", Sir Robert Boothby said that Parliament should welcome free discussion as a guide to what people are thinking and how they feel. It is true that there is not quite the same alertness in broadcast debate as in a public meeting, but only the most superficial observer can fail to notice how quickly errors are noticed and how firmly opinions are challenged. There is little doubt that Sir Robert is right in suggesting that 'front bench' politicians over-estimate the power and influence of the medium.

Although the debate ended with the adoption of the Postmaster-General's motion, accepting the principle of some limitation to the anticipation of Parliamentary debates by broadcasting, and welcoming the appointment of a Select Committee to consider whether any changes are desirable in the ways in which effect is given to this principle, it became quite clear that many members of all parties feel strongly that party leaders are attempting to keep far too tight a hand on public discussion out of Parliament. At least it was recognized that fourteen days is much too long a period for any such restraint to be maintained, and from all sides the absurdities into which the present rule might lead were freely emphasized. It was indeed contended by Mr. M. Edelman that the motion was in effect an admission that the rule is unworkable. It is to be hoped that the Select Committee will speedily arrive at some sensible proposals which, while indicating where restraint or reticence is appropriate, will safeguard the vital principle of free public discussion and the right of members of Parliament to speak their minds outside as well as within the House of Commons.

These matters concern all who are interested in seeing that the full potentialities for good of broadcasting and television are utilized, in education, in science, and elsewhere. The debate on November 30 should perhaps dispose of the idea that Parliament is, or ever was, the main forum of public discussion. It also indicated the danger of any attempt to curb controversy by some mathematical adjustment to the composition of the House of Commons, a danger which is brought out vividly in the lively attack on monopoly and the political party caucus which Mr. John Irwin has launched in his witty but provocative little book, "My Time is My Own"*. In an outspoken plea for free speech and for alternative broadcasting programmes, he shows clearly how fatal to entertainment and to public education alike subservience to the susceptibilities of the political party machines can be. If democracy means anything at all, he argues, it means trusting the people to think and decide for themselves; and if television and broadcasting are to be effective and present all major public issues competently, the deciding factor must be the appropriateness and efficiency of the programme and broadcaster for the task to be done.

Mr. Irwin's rather slight little book is worth reading for the evidence it supplies of the importance of securing vitality in broadcasting. It should be obvious that if the full opportunities which open discussion affords of enabling people to understand the real issues involved in matters of public policy are to be used, it can only be while the matter is of live interest and engaging the attention of Parliament. When it has been settled by Parliament, it may no longer hold the attention of the public, and the opportunity of explaining some of the factors that have determined government action may have been missed. This can be particularly important in respect of the technical and scientific factors involved in public policy. Even with the aid of the Parliamentary and Scientific Committee, we cannot assume that the exposition in Parliament is at present, or will be in future, such that members of Parliament fully appreciate the significance of such factors or are able to bring them out in debate.

Under the present fourteen-day rule, however, a valuable means of correcting this weakness and enlightening public opinion is lost. Atmospheric pollution, the development of nuclear energy, the hydrogen bomb and the hazards from test explosions, water supply, the preservation of the countryside, transport—on all these and many other topics expert opinion is more likely to be found outside Parliament than within, and it might be difficult for effective warning of the dangers of some proposed action to be given until too late, for we have to reckon with the possibility of the Press reaching a diminishing audience. Much more use in fact should be made of broadcasting and television as a means of raising the standard of public understanding of scientific and technical matters, and more thought and experiment are required as to the appropriate techniques to be used for this purpose. These will obviously differ according to the type of audience or viewer to be approached. The House of Commons debate showed, indeed, that several members appreciate how the fourteen-day rule could operate to discourage or prevent the education of the public in this way.

On the Government side at least, there was no attempt to distinguish between propaganda and educational broadcasting. Yet even in the political field, the distinction can be drawn; and in fact it must be made if broadcasting is to be used as an educational instrument. What must be recognized, however, is that the choice of broadcasters and the nature of the broadcast should be determined objectively solely in relation to the purpose to be served. Any attempt to subject the content of the broadcast or the choice of broadcaster to the predilection of a particular political party would be fatal.

In one respect the observations on the influence of broadcasting on the modern child, made in the study of the influences affecting the upbringing of young people recently conducted by the Council of King George's Jubilee Trust, are reassuring. Indeed, despite the growth of radio and television, the working party which inquired into the period of full-time attendance at school thought that the printed word remains the most widespread and influential medium affecting the child of school age and was more concerned with the raising of standards in the Press. In view of the inquiry into the influence of television on children and young people generally, now being conducted by the Nuffield Trust, the working party concerned with the influences of leisure time after leaving school did not consider television specifically; nevertheless, the report suggests that, hitherto, radio and television in Great Britain have maintained a good standard. While, however, the influence on juveniles of adult films, newspapers and radio programmes is often exaggerated, there is much evidence that their cumulative effect on standards of taste and values is considerable. It will be remembered that Sir William Haley stressed the dominant influence of British broadcasting on manners, but he was equally concerned as to the effect of television upon the very possibility of educational broadcasting.

The function of broadcasting as an incidental result of the maintenance of high standards, or pursued as a definite objective in the Third Programme or in other ways, was strongly emphasized by the Beveridge Committee. It may be recalled that the majority itself was convinced that the group listening scheme had considerable educational potentialities, and that—through the Third Programme at least—a more determined effort should be made to encourage the participation of the audience and so increase the citizen's understanding of the world around; but a minority held that the B.B.C. had already put up powerful resistance to the attrition of standards in a democracy. In particular, it urged that the B.B.C. is to some extent supplying the unifying force required to make a democracy a real community, and that the pursuit and practice by the B.B.C. of the democratic values of truth and fairness, as well as of quality, are specially important in this respect.

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* My Time is My Own: An Irishman at the B.B.C. By John Irwin. Pp. 111. (London: Max Parrish and Co., Ltd., 1955.) 8s. 6d. net.

This function is hindered, if not endangered, by the fourteen-day rule. If it is the function of radio and television in a democracy to ventilate views, the B.B.C. cannot continue to accept a restriction which any newspaper editor would reject forthwith. The Beveridge Committee, for example, observed that "if broadcasting can find a serious audience it is an unrivalled means of bringing vital issues to wider understanding". It can only do so if it is allowed to function freely while the issues are alive; but the attitude of the political party leaders hitherto almost suggests that they are not anxious for a wider and fuller understanding. None the less, the security and welfare of the nation depend increasingly on policy being based on the facts of the situation and not on particular political theories or prejudices. Equally they frequently demand action calling for public co-operation in ways that can only be assured if there is full understanding of what is involved. As Mr. M. L. Jacks wrote in his recent book, "Education of Good Men": "The man in the street needs to be set free from the forces which would mechanise his mind . . . and it is for education to set him free".

Broadcasting, as well as television, could and should be one of the forces which promote such education. The Beveridge Committee rejected the idea of an advisory council on adult education; but had such a council been in existence it would have been well placed to point out authoritatively the real dangers which attend the continuance of the fourteen-day rule, and how it can hinder the fostering of the awareness not only of society, but also still more of the relations which membership of a society involves, and in particular of its far-reaching duties and obligations—duties and obligations of which the rule itself is essentially the negation. Still more effective, however, might well be a determined attempt on the part of the Workers' Educational Association and professional bodies to use to the full the opportunities which broadcasting offers for bringing to the public understanding the essential factors in some problem of national importance whether or not it is currently engaging the attention of Parliament.

The limitations of broadcasting were emphasized by Sir William Haley in the Clayton Memorial Lecture already noted, and because of those inherent limitations, broadcasting needs supplementing if its educational possibilities are to be realized. It is to the development of the appropriate techniques, both in respect of adult education generally and in relation to those needs of a technological society to which Mr. M. L. Jacks and the King George's Jubilee Trust direct attention, that the Workers' Educational Association and professional institutions should be giving much thought and experiment. The techniques must be developed which will enable us to seize the opportunities which the unique power of broadcasting to stimulate public interest presents, provided it is allowed to choose its topics when they are alive and to entrust their handling to men and women chosen, not for their political party loyalties, but for their technical competence in broadcasting, their personal integrity and their vision and sense of public responsibility.

GENETIC PROBLEMS OF THE ATOMIC AGE

With an editorial and three articles, by M. Westergaard, H. J. Muller and R. E. Lapp, respectively, the *Bulletin of the Atomic Scientists* (11, No. 9; November 1955) begins a systematic discussion of the genetic aspects of the atomic age. M. Westergaard, professor of genetics in the University of Copenhagen, writes on "Man's Responsibility to his Genetic Heritage"; this article had already appeared in Unesco's review, *Impact* (6, No. 2; June 1955). It is an exceedingly clear exposition of the principles of genetics, of the effects that changes in environment, on one hand, and in mutation-rates, on the other, may have on the genetic constitution of future generations and of the responsibility that we have towards them from these two aspects. It is probably the best general account for the public of what the genetic problems of the atomic age are, and what kinds of ethical and practical issues they raise.

H. J. Muller writes on "How Radiation Changes the Genetic Constitution". This is the paper which Prof. Muller would have delivered at the Geneva Conference on the Peaceful Uses of Atomic Energy had he not been prevented at the last moment by decision of some cautious administrator. The editorial, "Genetics in Geneva", deals extensively with this remarkable episode and its implications.

If it had been read, Muller's article would certainly not have made headlines as some of the less competent pronouncements at that Conference did. It is a profound appraisal of the present knowledge of the genetic effects of ionizing radiations. Its interest is in two directions. First, it gives new estimates for human populations: (*a*) of the increase in the rate of deleterious mutations expected from increased radioactivity; (*b*) of the present 'load', that is, the level of deleterious mutant alleles already present; and (*c*) of the natural mutation-rates. All three estimates are, of course, in part conjectural, and Muller stresses the urgent need for far more research. But they are the best that can be done with what is available.

Secondly, at each step in these calculations Muller expounds very fully every aspect of the argument. The estimates may not go on being acceptable for long, as more reliable data come in; but Muller's arguments and treatment will remain very useful for a long time. Here probably lies the outstanding value of this article.

The three estimates are: (*a*) for the increase in the mutation-rate following irradiation: at least one mutation per germ cell per about 450 r., considering only lethal mutations and those reducing the fitness of the homozygote by not less than 10 per cent; (*b*) for the present 'load' of such mutations: 6·5–8 per individual; and (*c*) for the rate at which such mutations arise 'spontaneously' in man: about 8 per hundred germ cells.

There are a number of interesting consequences which Muller deduces from these estimates. One is that only about 40 r. applied to a population would be sufficient to double its natural mutation-rate: this is a dose which, spread over some fifteen years, some radiologists may already be receiving. Another deduction is that natural radioactivity may account for about one-sixth of the spontaneous mutation-rate in man. A third deduction is that the loss of fitness in the first generation after Hiroshima cannot be perceptible. Over an existing load of 6·5–8 mutations per individual, an extra one due to parents *both* irradiated with as much as 225 r. would not be detectable under the crude conditions of collection of data. Yet the serious genetic damage is there: some of it is being paid for by the first generation, and the bulk will be spread thinly over innumerable future ones. Muller's article sets out very clearly the apparent contradiction between the amounts of serious genetic damage done and the fact that its consequences are not evident: "even though the induced mutations may be many times the number that would arise naturally in only one generation, they are nevertheless few in relation to the accumulated natural 'load'. Hence they can raise by only a rather small percentage the number of genetic shortcomings already present in the population". It would, of course, be impossible for a population to "tolerate generation after generation an exposure which, given to only one generation, would cause no perceptible deterioration". It is precisely this condition that we have to appraise when considering the genetic consequences of the industrial use of atomic energy, as distinct from those of the military use.

The article by Lapp—"Global Fall-out"—makes very interesting reading for the non-physicist. It deals, however, with fall-out after super-bomb tests, and international agreements to stop these tests should not be far away. As to fall-out in war, the immediate consequences would be final enough for the whole of mankind: it does not seem to be worth while thinking about the genetic consequences.

The editorial, "Genetics at Geneva", deals with the facts and the implications of the 'muzzling' of Prof. H. J. Muller at the Geneva Conference. Prof. Muller is unquestionably the foremost authority in the world on radiation genetics. The rather pitiful series of episodes—already reported in the daily Press, and given again in detail in this editorial—has had, of course, a very beneficial effect: many more will carefully read Muller's paper. It is, however, another example of the threat to the integrity of science recently analysed by Piel (see *Nature*, 176, 1134; 1955). It also shows how dangerous it is to have research on the long-term effects of radiations—a matter of supreme concern for the industrial uses of atomic energy—carried out in the same laboratories and under the same administration as research with an essentially military outlook.

CHALLENGE OF AUTOMATION

The Practice of Management

By Peter F. Drucker. Pp. viii+355. (London: William Heinemann, Ltd., 1955.) 25*s*. net.

Any review of the British edition of this book must begin by echoing many of the praises that have been sung in the intervening few months since the American original first appeared. The praises are deserved—in the sense that the book is dynamic, stimulating and challenging. The echo is right, too, in the invitation to every manager and official in British industry to read the book. But, at least in the mind of the present reviewer, there is a limit to which the fervent adulation should go.

To appreciate the tone and tenor of these tumultuous three hundred and fifty pages, it needs to be recalled that the author, Mr. Peter F. Drucker, is a sociologist by interest, and an industrial investigator by adoption. He has looked at American industry from the top down and has had the fortune—good or bad, according to one's point of view—to look from the top of very big heights. One of his best-sellers was called "Big Business", and the aura of bigness rather than greatness surrounds his latest accomplishment.

Lest this cool comment be taken unfairly as criticism, let it be said that Drucker starts off his volume by disclaiming any intention of writing on the techniques of management; but he did set out to produce a practical book. The reader, as the product turns out, gets a great deal of guidance and help on how not to do things in management, but it is by implication that he is expected to learn what to do and how. The informed reader will come away with a vivid impression of having seen all this before, perhaps not with so invigorating a degree of excitement and incitement. The newcomer to the subject will hug the book to his breast as an indispensable vade-mecum in the toilsome journey through the tasks of executive management.

"The obstacles to the 'automation revolution' are great—above all, the lack of men properly trained in the new concepts and skills." This sentence is perhaps the bedrock of the study: but the skills concerned are not thoroughly technical and intricate, in the vein of electronic brains, elaborate computations and complex mechanisms. They are, instead, the age-old simple skills of motivation and the promotion of morale—not just a re-hash of old personnel management and human relations but the deeper and more vital process of making management a leading force of all efficient operating. "Managing managers is the central concern of every manager" is a recurrent theme throughout Drucker's thought, and it is in this regard that the responsible reader feels most keenly the lack of practical approach: a whole Part of the book is devoted to the theme, but one comes away from it with little more than the inspiration contained in the theme itself.

The fifty pages devoted in Part 3 to "The Structure of Management" are among the most valuable of all. Again, the knowledge is nowhere new; but sound teaching is realistically conveyed, and the notion of 'federal decentralization' is a helpful concept in these days of large and complex organizations. Clearer understanding of Drucker's thesis in this direction would be of immense practical value to the managers and officers of many a British undertaking, including those in the nationalized industries.

Here and there occur items which leave the serious reader much puzzled as to why they are given the degree of emphasis in treatment—unless these are the instances where the author's own lack of practical insight have led him astray. For example, a whole chapter in Part 1 is devoted to considering the objectives of the business, and in the event it says little more than the paragraph of half a century ago wherein F. W. Taylor pleaded that all management decisions should be based on facts and the due analysis of what such facts reveal. Or again, much later in the book the position of the supervisor is surveyed, and recommendations are made about enlarging his responsibilities and the scope of tasks entrusted to him. One is left wondering what sort of a role the representative supervisor has in American industry if the enlargement here called for is so revolutionary: "If the supervisor has a genuine manager's job, if he is adequately supported by his own staff, if he has real authority, and if his unit is big enough—then his job will have become manageable again".

The chapters inquiring "Is Personnel Management Bankrupt ?" will also excite considerable interest among British readers, especially those whose own recognition of the need for specialist personnel assistance has been grudging, if existent at all. But they will be disappointed, for Drucker's answer is in the negative, and his two chapters (22 and 23) on how it can best make its mark are indeed valuable.

It would be a pity to let criticisms of detail hinder the widespread acceptance of an important work, and the foregoing comments have been made in the interests of maintaining a correct perspective. The book is long—in fact, too long for the type of contents that it offers. Yet it is easily readable and has a facile style that makes for ready absorption. Its title, however, can be misleading, and, at a time when reliable information about management action is being avidly sought in Britain, it seems dangerous to let a possibly disappointing source pass by unmarked—disappointing, of course, only in the sense in which the author himself avers that his book does not intend to teach the techniques. To some readers it may, perchance, be disappointing in other directions: for example, the emphatic restriction of 'management' to the business world (that is, the making and marketing of products), whereas in Britain we accept management as equally pertinent in service spheres, in government and in a multitude of non-commercial activities; and did not Mooney and Reiley a quarter of a century ago in the United States claim that the major factor about management was its universality ?

To me the main disappointment lies in the basic acceptance of the superficially popular cliché that "managers are born, not made". Leadership is, indeed, as Drucker says, "important and has no substitute". But to go further, as he does (". . . cannot be created or promoted . . . taught or learned . . ."), is to fly in the face of experience and to run counter to the mature thought of several highly respected thinkers going as far back as Mary Follett in the early 1920's, or Henri Fayol at the turn of the century.

E. F. L. BRECH

HUMAN FACTORS IN UNDERSEA WARFARE

A Survey Report on Human Factors in Undersea Warfare

Prepared by the Panel on Psychology and Physiology. Pp. x+541. Supplement. Pp. ii+92. (Washington, D.C.: National Academy of Sciences—National Research Council, 1949 and 1954.) n.p.

IN 1946 the United States National Research Council appointed a Committee on Undersea Warfare at the request of the Office of Naval Research. This Committee set up a Panel on Psychology and Physiology, and asked the Panel to "draw up an outline for a survey of basic and applied research on problems related to the human factor in undersea warfare". This the Panel did, and then selected a number of authors who were known for their scientific work in the various fields to be covered, and asked them to produce written reports on topics indicated. Few, if any, of these experts had had direct experience of submarine problems, but it was thought that this would be an advantage rather than a handicap since "a fresh and somewhat detached point of view might prove valuable in pointing up new problems".

Most of the reports were prepared during 1947–48, and the volume now under review was first published in 1949. At that time four of the papers—the night lookout; the design and use of optical instruments; visual display of complex information; and arrangement of equipment—were considered to contain material which should be treated as secret. These studies have now been declassified and are issued for public circulation as a supplement to the main volume.

The topics dealt with are: general visual problems; design and arrangement of operating equipment; auditory problems; communication; habitability, physiological and psychological; emotional stability and adjustment; selection and training; and personnel resources. Practically everybody who is actively concerned with human aspects of submarine and related operations should already be familiar with nearly everything that is reported and discussed in this book. Moreover, an immense amount more of experimental work has been carried out during the past six or seven years on all the matters raised and on many others. In numerous ways also, the nature and probable tactics of undersea warfare have changed somewhat radically, with the result that new problems have developed and some of the old ones have changed direction and practical importance.

Nevertheless, this remains an outstandingly valuable source and reference book for the submarine expert, and for many other types of reader it may well come as a revelation of what well-planned physiological and psychological research can accomplish. A great many of the problems considered are of enormous importance in current industrial organization: for example, how to arrange maps and charts and measuring devices on all kinds of optical and other instruments; how to design machine controls and to arrange instrument panels and equipment generally; how to study intelligibility and range of communication, visual and auditory; and how to find out the effects of extremes of temperature, humidity, noise and other forms of stress.

The fact that the whole book has been seriously written by scientists whose principal interests are in fundamental research means that, although the reports now need much supplementing in detail, the data that are reported are almost all thoroughly well accredited, and the methods and procedures described are of wide and permanent interest.

Considering the range of topics covered, and that thirty-four authors have contributed papers, the consistently high level maintained is remarkable. If, however, I had—rather unfairly—to choose one discussion as being of outstanding interest at the present time, I think I should select Dr. J. W. Gebhard's article on visual display of complex information (Supplement, pp. 39–66). His particular concern is with "the problems of an information centre which must handle and interpret diverse ever-changing data collected from many sources". There is no better brief account anywhere of what was known about such problems up to the beginning of 1949, and many of the critical problems which were then pressing have become still more urgent since. All the displays dealt with necessarily present the information to be communicated in coded form. Obviously the human sense organs and brain must also, in their own ways, code observed information for storage and recall. It is of great general interest, therefore, that some of the codings used in radar, sonar and other systems of display should be more fully and immediately accessible to the normal operator than others. Further, the question, which in this article is critically considered and very clearly illustrated, of how many dimensions of change can be simultaneously dealt with in the coded visual display remains still one of great practical importance and fundamental significance.

F. C. BARTLETT

AUTOMATIC FEEDBACK CONTROL

Automatic Feedback Control System Synthesis

By Prof. John G. Truxal. (McGraw-Hill Electrical and Electronic Series.) Pp. xiii+675. (London: McGraw-Hill Publishing Co., Ltd., 1955.) 89*s*. 6*d*.

YOUNG American professors of electrical engineering, especially those who have studied at the Massachusetts Institute of Technology, often write books about automatic control, and the number of re-hashes of 'Brown and Campbell' is now considerable. It is a pleasure to find that Prof. J. G. Truxal's book, although it does not stray far beyond what is recognizable as 'M.I.T. thinking', is an advance on existing books. It presumes acquaintance with one or other of the introductory text-books, and gives an account of the many developments of the theory of feedback systems that have been made in recent years. Accounts are given, for example, of the 'root locus' method of Evans, of the 'pole-zero configuration' approach, associated with Guillemin, the statistical approach that was initiated by N. Weiner, and the 'describing function' and 'phase-plane' techniques for dealing with non-linear systems. There is also a chapter on sampled-data systems.

These and other facets of the subject are clearly presented and intelligently discussed, and although the book is largely a presentation of mathematical procedures that have been described elsewhere, there are many sections in which significant new contributions can be found. A book that brings the knowledge of its readers up to date in this way will be of great value.

The approach is mathematical and based throughout on the use of the Laplace transformation. The book is not intended for beginners, but as a supplement to introductory text-books on feedback systems and on the functions of a complex variable. Regarded as a presentation of the mathematical procedures now available, it is excellent, and will be valuable to advanced students and to designers. References to the literature could with advantage have been more complete. They are given, rather thinly, as footnotes, and confined mainly to American sources.

The value and high quality of this book being granted, it may nevertheless be questioned whether Prof. Truxal has quite justified the use in his title of the word 'synthesis'. It is true that analysis and synthesis are not separable, and that in contriving a control system to meet a specification it may be useful to consider such things as the patterns of poles and zeros of a linear transfer function. But true synthesis would imply a definite numerical procedure, without trial and error, starting from quantities given in the specification and ending with quantities defining the physical construction. It is probably impossible for progress in methods of synthesis to be made, as long as the discussion insists on the excessive generality of being applicable to feedback systems in general. It is possible to go much further if such systems are first classified. For well-defined classes of feedback system—say, for example, large positioning servo systems or automatically controlled distillation columns—one may make progress with the problem of synthesis or 'design for controllability', the parameters of the apparatus controlled being regarded as variables, as well as those of the controller.

The tacit assumption that some 'system to be controlled' is given, and that the only problem is the synthesis of separate control elements to be added thereto, has always been a shortcoming of the Massachusetts contribution in this field, and Prof. Truxal, in so admirably consolidating and even advancing this contribution, has tended to retain the restriction. Perhaps he would consider what the implications would have been if his title had been "The Synthesis of Controlled Systems" instead of "Control System Synthesis". But to suggest that an author might have written a different book is one of the vices of reviewers, and we may be grateful for this comprehensive, clear and well-produced book that will contribute to the further advancement of the development of automatic controls.

A. TUSTIN

Rapport Europées Congrès Toegepaste Electronenmicroscopie, Gent, 7–10 April, 1954

Edited by G. Vandermeersscho. Pp. 359. (Gent: Rijksuniversiteit, 1954.) 500 Belg. francs.

THE Centre for Electron Microscopy of the University of Ghent organized in April 1954 the first congress devoted solely to the applications, as opposed to the fundamentals, of the subject. Previous meetings of an international nature had covered all aspects, but the rapid advance in the uses of the electron microscope justified a conference with a somewhat narrower scope. The proceedings of the congress, published with commendable speed within six months of its termination, shows that the range of topic was still very wide, while the list of authors substantiates the title "European".

Eleven papers are concerned with the electron microscope itself and special methods of operation, such as the reflexion and emission techniques and electron diffraction. Another eleven papers cover medical and biological applications: ultra-microtomy, bacteria, viruses and fibrillar structures. Only five contributions deal with metallurgical problems, confirming the general observation that this field has been the slowest to find uses for a higher resolution than the optical microscope provides. On the other hand, a new trend of the past few years is strengthened by the amount of attention paid to chemical and industrial applications. Ten papers in this group cover a wide range of materials: ceramics, greases, textile fibres, metal oxides, clays and fluorescent powders.

The volume thus presents a useful picture of the present state of applied electron microscopy. It remains only to say that speed of publication has not led to any sacrifice in quality of production; the printing, binding, and reproduction of micrographs are alike excellent. The editor, who was also in charge of the organization of the congress, must be congratulated on the fruits of his efforts.

V. E. COSSLETT

An Illustrated History of Science

By Dr. F. Sherwood Taylor. Pp. xii+178. (London: William Heinemann, Ltd., 1955.) 25*s*. net.

AS a history of science this book increases our indebtedness to the late Dr. F. Sherwood Taylor, who did so much to present the results of intensive research in language that the ordinary reader can appreciate.

As an illustrated history of science it is unique. Based upon the 1953 Christmas Lectures at the Royal Institution, London, in which the author dealt with some of the historic experiments in natural science, it has, among others, illustrations relating to the apparatus and conduct of the experiments. These, from sketches drawn by A. R. Thompson, are built up around what could be discovered about the way of life in the times when the experiments were first made, and are not merely substitutes for photographs which might have been taken had photography been possible. They have a liveliness that makes the reader feel that he is an eye-witness of what was going on, when, for example, the Abbé Nollet felt the shock from a Leyden jar, or Sir Humphry Davy demonstrated the electric arc in 1808.

Beginning with the observations of the Egyptian priest-astronomers and the Greeks who studied science for its interest rather than its use, the author surveys the early days of experimental science and its remarkable progress during the eighteenth century, the work of men like Faraday, Kelvin, Edison and Crookes in the nineteenth, and the past fifty years during which "so much knowledge and power have come into men's heads and hands that they cease to think of science as some specialised occupation, but are coming to regard it as a way of understanding and organising any job of work".

F. J. NORTH

General Microbiology

By Prof. William G. Walter and Prof. Richard H. McBee. (Based on the original text by Prof. D. B. Swingle.) Pp. ix+345. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 35*s*. net.

IN 1940 a book was published by the late Prof. D. B. Swingle, of Montana State College. It was entitled "General Bacteriology" and, as an introduction to the lower forms of life, was so well received that it was revised and issued in a second edition in 1947. Two of Swingle's successors at Montana, Profs. W. G. Walter and Prof. H. McBee, have now made a thorough revision of the earlier work and, as the title implies, have adopted a broader approach.

Some of the more recent aspects of bacterial cytology, genetics and nutrition are described to illustrate the growing importance of the study of bacteria as a means of illuminating some of the newer disciplines. A new section describes the mutual relations of micro-organisms, while chapters on pathogenic bacteria and viruses have been expanded. The book is extremely well illustrated and would form an admirable introduction to the study of microbiology for professional and lay readers. Its weakness is in the chapters dealing with applied bacteriology. The few pages on industrial microbiology, for example, are so scanty that they could profitably have been omitted to allow a wider treatment of a topic like the microbiology of milk products.

T. H. HAWKINS

Hydro-Electricity and Nature Protection

Stating the Case. Prepared by the Rt. Hon. Lord Hurcomb. (Pro Natura, Vol. 2.) Pp. 224. (Bruxelles: Union Internationale pour la Protection de la Nature, 1955.) n.p.

IN the summer of 1952 the International Union for the Protection of Nature held its third General Statutory Assembly at Caracas. A technical meeting was held at the same time which brought together two hundred experts representing thirty-two countries and five continents. One of the items discussed was "Hydro-electricity and the Protection of Nature". A volume of 550 pages containing the proceedings and the papers of the Caracas meeting appeared in 1954; but it comprised several subjects and it had also to be reproduced in three languages and principally in Spanish. As a result, the remarkable documentation on hydro-electricity that had been gathered from sixty preliminary reports, submitted to the Caracas Conference by specialists from all over the world, could not be used to the full extent of its worth.

A volume has now been prepared by the Right Hon. Lord Hurcomb, vice-president of the Union, with the aim of placing within the reach of the public as much as possible of the more important points of this documentation in an abbreviated form. Some of the papers are in French and some in English; a French summary is given of the papers published in English, and vice versa.

NEW UNDERWATER HYDRODYNAMIC RESEARCH LABORATORIES

By F. S. BURT
Admiralty Research Laboratory

THE Admiralty recently released information on the new Underwater Hydrodynamic Research Laboratories completed just over a year ago. These new facilities, which form part of the Admiralty Research Laboratory, Teddington, are to carry out fundamental research into the behaviour and characteristics of underwater bodies with the view of investigating the possibilities of making major advances in this comparatively unexplored field of hydrodynamics. The total cost of these facilities was just over one million pounds. The present article is published by permission of the Admiralty.

The most spectacular item of the equipment is the 60-ton rotating beam and annular channel which have been designed to investigate the behaviour of bodies moving at high speed under water. In addition, there are two water tunnels which are analogous to the wind tunnels used in aeronautical research. There is also a glass-sided water entry tank for investigating, on a model scale, the problem of the entry of missiles from the air into the water.

Rotating Beam Channel

The rotating beam channel, which is housed under a 160-ft. diameter dome, is used for the measurement of stability and control characteristics and also for the investigation of bodies of various forms moving at high speeds under water. The 122-ft. span rotating beam spins over the annular channel of rectangular section, 34 ft. wide and 15 ft. deep. The radius of the inner wall of the channel is 34 ft. and that of the outer wall 68 ft. The models, which may be up to 20 ft. in length, are normally run at a depth of 5 ft. and may be attached to the beam at alternative radii. The maximum speed of the beam is approximately 30 revolutions per minute, giving a speed of 150 ft./sec. at the 50-ft. radius or nearly 100 knots at the 55-ft. radius. The beam is driven by a 1,510-h.p. 600-V. D.C. motor controlled by a Ward Leonard set, and its speed can be controlled either manually or automatically to any speed to within 0·1 per cent of the top speed. For some of the tests it is necessary to obtain speed very rapidly and this is achieved by

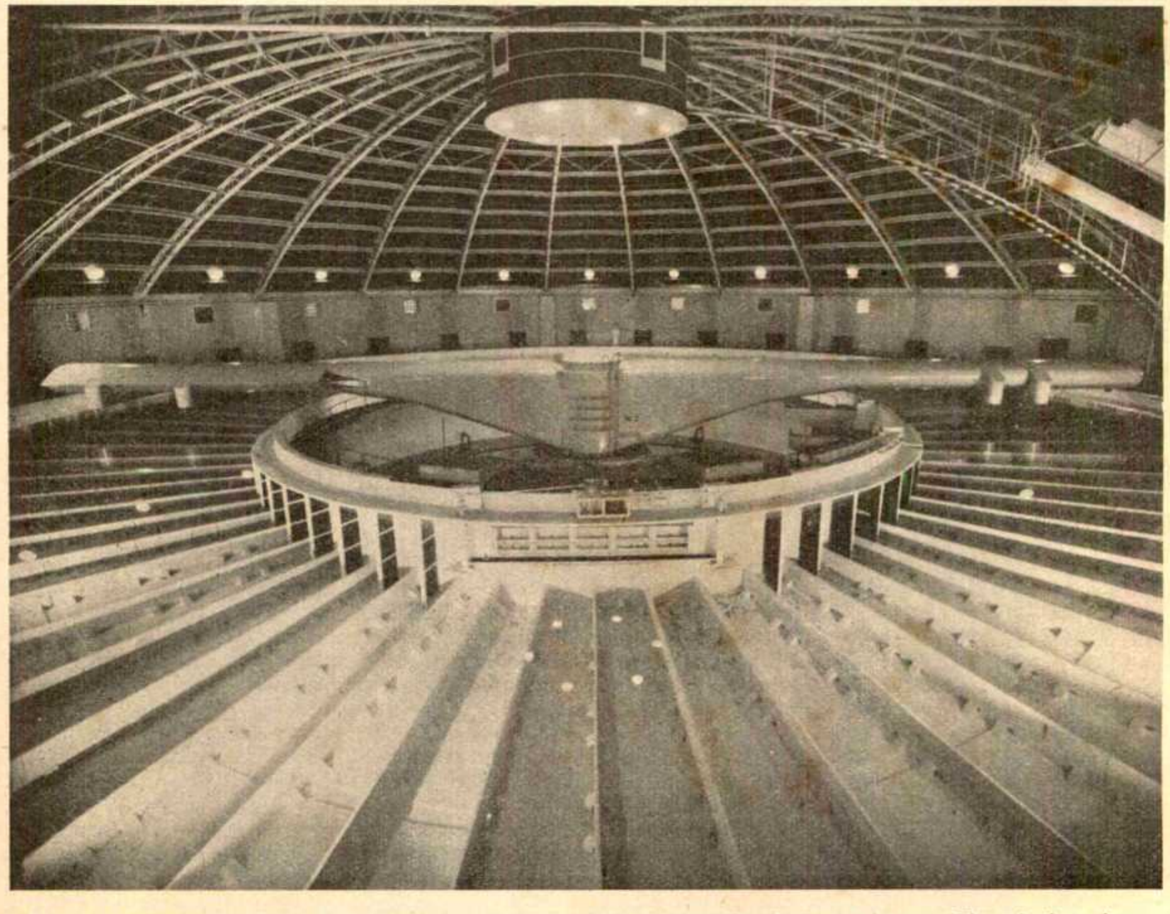


Fig. 1. The annular channel and rotating beam. The windows of the inner observation chamber can be seen. The water is so clear that it is difficult to see it even in the original photograph

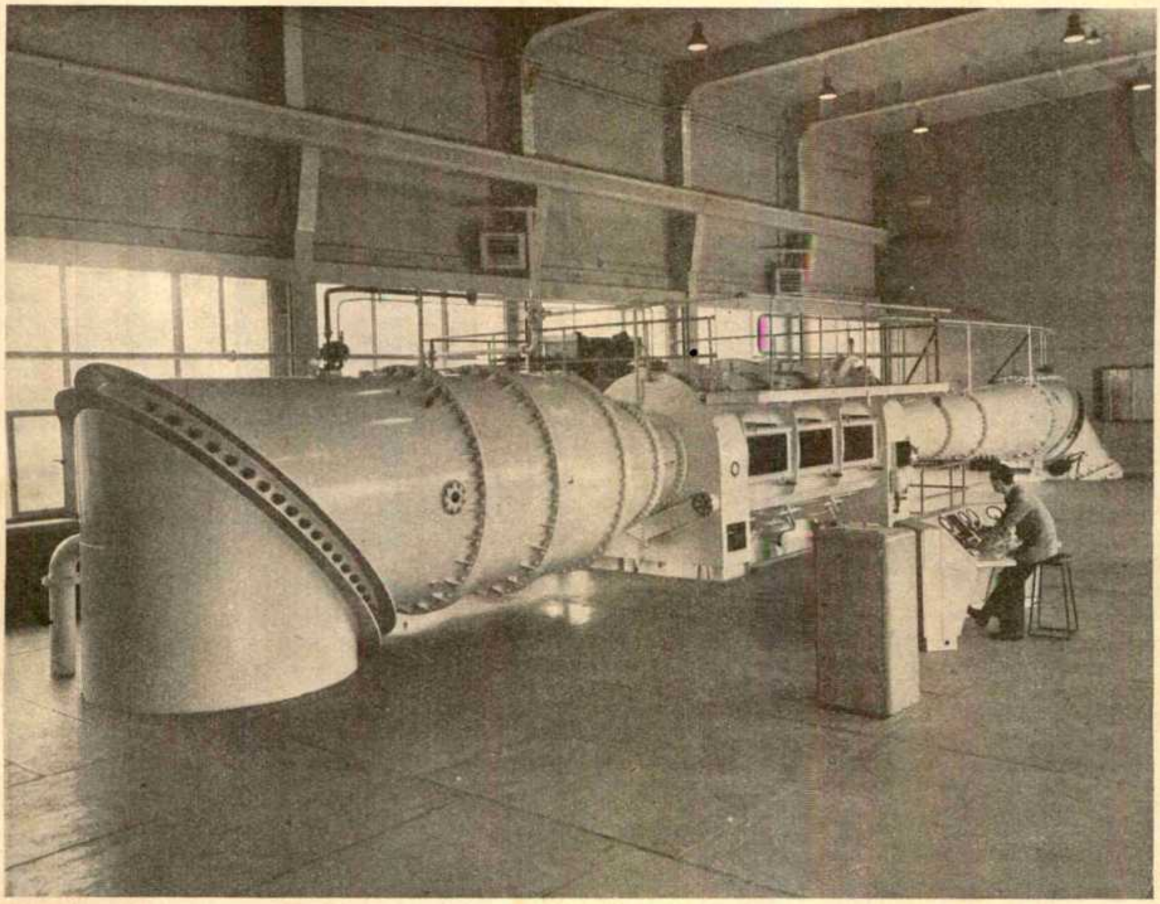


Fig. 2. The 30-in. water tunnel, showing the working section and the control console

over-running the electrical plant for short periods, enabling the beam to be got up to maximum speed in only fifteen revolutions.

At one section of the channel large windows are provided in both the inner and outer walls. The windows are made up of large 1¼-in. thick 'Triplex' panels through which the models can be observed. To enable high-speed photographs of the experiments to be taken, the million gallons of water in the channel is specially treated and filtered. By careful control the optical transmission of light in the channel is as high as 90 per cent per metre compared with air.

The models which are run in the channel and also those used in the larger water tunnel may be powered, and always contain within themselves the necessary instrumentation to measure any forces, moments or pressures that may be required. The resistance strain gauge, used in an A.C. bridge, is the standard transducer for all measurements.

The Water Tunnels

The first of the new major pieces of hydrodynamic equipment to be built was the water tunnel having a working section diameter of 12 in. This tunnel was designed to be as versatile as possible and has a variety of alternative working sections. The water speed can be continuously varied up to some 82 ft./sec. in the closed jet and up to about 62 ft./sec. in the slotted-wall working section.

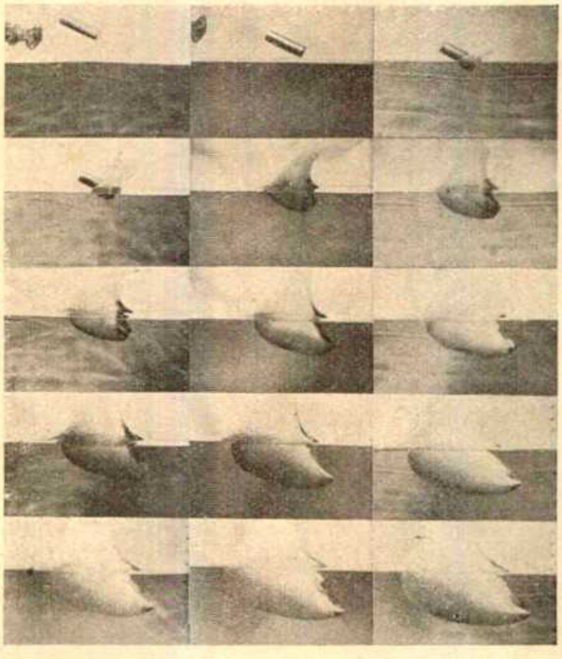


Fig. 3. Multiflash photographs (2 μsec., 110 joules) of a typical water-entry trajectory

The larger of the two water tunnels has a jet diameter of 30 in. and the speed is continuously variable up to 60 ft./sec. (35 knots). In both tunnels the pressure at the model can be varied between 2 lb. per sq. in. and 45 lb. per sq. in. absolute. Powered models cannot be made much less than about 8 in. in diameter, and much thought was therefore given to the design of a suitable working section. This resulted in the concept of a slotted-wall working section partially open and partially closed. The philosophy behind this idea is that the wall corrections of an open jet are very much less and of opposite sign to those of a closed jet, and by enclosing the open jet by a cage of bars one can in fact get the virtues of an open jet tunnel and a very much longer working section.

A considerable amount of development was done on the optimum layout of such a working section, and as a result of this it has been found possible to double the effective size of the working section, at any rate so far as tests on bodies of revolution are concerned. Hence powered models some 10 in. in diameter and up to 12 ft. long containing 100 h.p. can be tested in the 30-in. tunnel. These models are fitted internally with a five-component balance and also means of measuring the torque and thrust.

In addition to the novel working section, this tunnel is also fitted with a 'resorber'. This takes the form of four 11-ft. diameter passes up and down a 60-ft. deep pit, and by the combination of pressure and time re-absorbs any cavitation or gas bubbles that may have been formed in the working section during the course of the experiments.

Model Water Entry Tank

To assist in the study of the air-to-water entry behaviour of weapons, a new glass-sided tank 29 ft. long, 9 ft. deep and 5 ft. wide has recently been erected. This tank has been designed to examine the behaviour on entering water of 2-in. diameter models which are fired from a slotted cylinder catapult with entry speeds of up to 300 ft./sec., which on Froude scaling corresponds to about 1,000 ft./sec. full scale.

The virtue of this type of catapult is that it enables the models to enter into the tank with varying amount of pitch and yaw, which are vital parameters in these investigations. The models can be fired into the tank at any angle between horizontal and vertical, and high-speed photography is used to examine their behaviour.

USE OF SOLAR ENERGY

THE World Symposium on Applied Solar Energy and the Conference on Solar Energy, which were held recently in Arizona, have received considerable publicity. These conferences were sponsored by the Association for Applied Solar Energy, the Stanford Research Institute and the University of Arizona, with Mr. Lewis W. Douglas as the general chairman. That more than a thousand scientific workers, representing many nations, travelled to Arizona to discuss problems concerned in the application of solar energy, indicates the interest in a subject that was first exploited forty to seventy years ago and which has been intensively studied during the past ten years. Press reports from the conferences on the future of solar energy have varied from unqualified optimism to salutary pessimism. At the concluding session, the vice-chairman, Mr. Merritt L. Kastens, who was responsible for the organization on behalf of the Stanford Research Institute, said that he had been asked: "Were the conferences successful?" He said that he would be able to answer this question in ten years time; this was the only reply that could be given, for it is difficult at the moment to see in correct perspective the precise applications of solar energy that are economic, and the path of future developments.

Whatever may be the outcome of the conferences, there can be no question that never before have all the existing facts concerning the present position of research in the various applications of solar energy been presented simultaneously and freely discussed by scientists, engineers and industrialists, and the conferences mark a turning-point in progress. It was indeed this consensus of opinions from workers in many fields that gave unique importance to the meetings, for the problem of utilizing solar energy must be considered on a global scale and cannot be limited to the specific requirements of any one country.

The two meetings, held consecutively, were independent but complementary. The conference, which was held first in the University of Arizona, was for the purpose of discussing among scientific workers the basic problems that must be solved before solar energy can be successfully applied, with a detailed description of researches at present in progress for this purpose. The symposium, held in Phoenix, was intended to summarize the general position of solar-energy utilization and especially to acquaint industrialists with the problems involved, since successful development depends ultimately upon co-operation between science and industry.

Conference on Solar Energy

A total of nearly a hundred papers was presented at the Conference on Solar Energy, and this necessarily involved sub-division into a number of separate sessions. The opening session, of a general nature, dealt with the characteristics of solar radiation as emitted from the surface of the Sun and as received at the surface of the Earth, these studies being an essential preliminary to the study of utilization. Prof. Farrington Daniels also gave a general paper outlining the methods of utilization.

The remaining sessions, held concurrently, were as follows. Section *A*: Thermal processes comprising flat-plate collector design and the principles of selective radiation; solar furnaces for the production of high temperatures; solar energy for house and water heating, for cooking and water distillation; solar power machines. Section *B*: Photochemical processes comprising large-scale algal culture; algal physiology; photochemistry in higher plants and in non-biological systems. Section *C*: Electrical processes for the direct conversion of radiation to electricity, including thermoelectric generators, photovoltaic cells and $p-n$ junctions and photogalvanic cells. There was also a session devoted to a discussion of the measurement of solar radiation. The technical implications of these papers are discussed later.

World Symposium on Applied Solar Energy

The general scope of the technical papers at the World Symposium was similar to that of the papers presented at the preceding conference, but they were intended for an audience possessing a wider range of interests. Each author was a recognized authority on his subject, and presented this in the form of a comprehensive survey.

The opening remarks were given by Mr. Lewis W. Douglas, and were followed by an invocation delivered by the Right Rev. Arthur B. Kinsolving, Bishop of Arizona. Prof. Farrington Daniels, of the University of Wisconsin, who is doing so much to promote research on solar energy, and Dr. J. E. Hobson, director of the Stanford Research Institute, presented papers covering in a comprehensive manner the utilization and economics of the applications of solar energy. The principal speaker at the welcoming luncheon was Sir Edward Bullard, director of the National Physical Laboratory, who outlined the benefits that could accrue from solar energy, but also emphasized the difficulties involved in such developments. It was generally considered that his realistic speech counteracted the excessive optimism of those who were unaware of the true magnitude of the problem. At the banquet, Mr. John Jay Hopkins, chairman and president of General Dynamics Corporation, gave an inspiring address on the possibility of creating a World Energy Community by united governments to organize correlation of all energy resources. He emphasized the need to adapt our thinking to changing times and conditions in considering the relationship between the forces of atomic fission, fusion and applied solar energy.

An exhibition of solar appliances was arranged at Phoenix in conjunction with the symposium. Comparison was facilitated of the various schemes for house and water heating, for water distillation and for solar cookers. In this latter connexion efforts are being made by the research group at the University of Wisconsin to reduce costs by constructing the reflectors from aluminium-coated plastic instead of sheet aluminium. The largest single exhibit was an engine of Italian design, operated by sulphur dioxide vapour and used to drive a water pump. The National Physical Laboratory of India showed a small-scale model to illustrate its system of movable panels of mirrors which can be used to provide concentrated radiation for steam generation or other heating processes. Examples of solar furnaces were demonstrated and also some ingenious pumping devices operated directly by the action of vapour and liquid.

The particular value of the exhibition was that it enabled industrialists to see the present state of progress, and to compare directly designs from different countries. Though extremely instructive, many of the inventions shown clearly require much more development before becoming anything like economic possibilities.

Summary of the Technical Papers

It is impossible to describe in full detail the contents of such a large number of papers, but a brief indication is given below of the scope and present state of development in those fields where solar energy could be applied.

House heating. Much can be done by the suitable design of houses to reduce the artificial heat load required, by double-glazed windows and effective heat installation. Additional heat can be provided by collectors of the flat-plate type fixed on the roof with a sufficient hot-water storage to last over two or three days. Several solar-heated houses have been operated in the United States for a number of years, and a newly designed house will shortly be constructed at the Massachusetts Institute of Technology, which should be capable of supplying 80 per cent of the heating requirements throughout the year at Cambridge, Massachusetts.

Water heating. The heating of domestic hot water by solar radiation is a relatively simple process in suitable locations; the problem is to reduce the cost by mass production. Many designs of heater were described, and a large number of simple appliances are in operation in Japan, which has an acute fuel shortage, though the solar radiation conditions are far from ideal. The cheap supply of natural gas in the United States seems to have curtailed the development of solar heaters, even in areas having high solar radiation.

The efficiency of the flat-plate type of collector may be improved by coating the absorbing surface with a thin metallic oxide film which is a good absorber of visible radiation, but a poor emitter of the longer heat waves re-radiated from the collector surface. The researches in this field, described by Dr. H. Tabor, director of the National Physical Laboratory of Israel, created considerable interest at the conference and may have far-reaching consequences by raising the operating temperature of the flat-plate heat collector and extending its use to steam generation.

Water distillation. A simple design of water still for the conversion of brackish to potable water would be a great benefit to isolated farms in arid areas. Considerable development has taken place in the design of such stills in Algiers, Morocco, Australia and California. Here again the essential problem is to produce a design which will be cheap and yet robust. Experiments are being made with the substitution of plastic for glass condensing surfaces. The average rate of distillation is about 0·8 lb. of water per day per square foot of surface area.

Mechanical power. Small power units for irrigation pumping could replace the very inefficient devices, using human or animal power, which are still employed in some parts of the world. Present developments include the Italian design of engine using sulphur dioxide vapour as a working fluid which costs about a thousand dollars per horse-power output. Other possibilities are steam or hot-air cycles, and development of these is proceeding in India, the U.S.S.R. and Israel. Several ingenious designs were described in which the direct action of volatile fluid is used to operate water pumps, but the efficiency of all such devices is necessarily low because of the small temperature difference utilized.

Electrical power. Solar radiation may be converted to electricity by thermo-couples in which heat is an intermediate form of energy and which, therefore, are subject to the toll of the Carnot efficiency. Higher efficiencies are attained by photoelectric devices, and the Bell silicon cell which is now in commercial production attains a conversion efficiency of 11 per cent. The high cost of the cell (25 dollars a square inch) means, however, that at present such applications are very limited; but a battery of such cells is being used to charge accumulators on telephone systems, and to operate portable radio transmitters and receivers.

Photogalvanic effects. Certain chemical processes are affected by the action of light with a change in the equilibrium. This change may be used to create an electric potential which may be discharged when the products revert to their original state. At the moment such processes are inefficient, but there is the possibility of remarkable developments which may extend the scope of the applications of solar energy. It is possible in a similar manner to produce hydrogen which could be stored and used at any convenient time as a fuel.

Solar furnaces. A number of solar furnaces for the production of very high temperatures have been constructed; the largest at present in use is the well-known 40-ft. diameter mirror at Mt. Louis in the Pyrennees. This was designed by M. Felix Trombe, who announced that construction has now been commenced of a new furnace which will have a capacity of 1,000 kW. There are also large solar furnaces in operation in Algiers, the U.S.S.R. and the United States. At the moment these furnaces are used for research on the properties of materials up to temperatures of 3,000° C.; but they could also be developed for production purposes in suitable localities.

Algae cultivation. Intensive production of algae can be stimulated by the application of solar energy, though the general opinion was expressed that this would only be economically feasible for food production. A suspension of the algae in water, with the addition of nutrients and enrichment of carbon dioxide, is circulated in a suitably designed pond or tank. Although the efficiency of conversion based on the light quanta absorbed for the liberation of one oxygen molecule may approach 30 per cent, the overall efficiency does not exceed 5 per cent in these special cultivation tanks, compared with a figure of well below 1 per cent for the normal growth of crops on land. *Chlorella* is normally used, and there are many biological problems, such as the development of strains which will grow rapidly at temperatures up to 40° C. and will resist diseases or contamination. Considerable development work is in progress in the United States, Japan, the Netherlands and Germany.

Air conditioning, refrigeration and heat pumps. This is a field which is particularly apt for the utilization of solar energy and yet is one where little research work has been described. The problem is to adapt present well-known cycles, such as the absorption process, to operate at the low temperatures attainable by flat-plate collectors. Concentration by mirrors would enable existing cycles to be utilized, but it is generally considered that the expense of such systems would not enable them to compete with fuels as an energy source. Solar heat collectors could be used in temperate climates to improve the performance of heat pumps, if a suitable means of storing the low-temperature heat were available.

Conclusions

Solar radiation is almost the only source of energy that remains unexploited. The total amount of energy available is ample for the world's requirements, and the difficulty lies principally in its relatively low intensity and variability due to the changing position of the Sun and atmospheric effects. The normal energy sources, apart from nuclear energy, are naturally concentrated forms of solar energy—either as fuels which are a concentration in time, or water power which is a concentration in space. So long as these are available, there is little scope for the application of solar energy, mainly because of the high initial cost and the difficulties of energy storage. But there are many places where fuels are expensive or in some cases non-existent, and in such areas there are potential fields of application for solar energy. For example, electrical power could probably be developed from solar energy at a cost of about a shilling a kWh., which would be unacceptable for large communities but would be welcomed if no other source were available.

Artificial collectors of solar energy, namely, all processes except the natural photosynthesis by living plants, comprise essentially the flat-plate type of collector, or concentrating systems with mirrors, or devices which collect photon energy directly. The first method degrades the radiant energy to heat at a low temperature-level; the second system operates at a high temperature-level which can attain half the temperature of the Sun's surface, but is necessarily more complex and needs a guiding system. These systems are satisfactory if the energy is to be used in the form of heat, but in the production of power the inevitable toll of the Carnot cycle results in a low efficiency of operation. If the objective is electrical power, then devices that convert the photons directly into electricity by photovoltaic methods have higher efficiencies and are therefore more promising if the present cost can be reduced by a factor of ten or a hundred. It is along such lines that major developments in the future must inevitably proceed, though, in the meantime, the conventional heat-cycles of low efficiency may bridge the gap.

Applications of solar energy should not be considered as substitutes for existing energy sources but rather as complementary, and the various energy sources should be combined according to the requirements and the resources of the location. Solar energy cannot replace many of the existing uses of concentrated energy, either thermal or nuclear, but can supplement these, especially for the production of heat at relatively low temperature-levels, that is, below the normal boiling point of water. At the moment, solar energy is essentially for nations that 'have not' rather than for those that 'have'; it may enable many of the benefits of industrial civilizations to be attained by those living in isolated and undeveloped areas, by increasing the comfort of life and improving the amenities. In time to come, as fuel reserves are depleted, applications will be extended, and in the future solar energy may contribute greatly to the supply of energy. Considered from these aspects—that is, as an immediate policy for undeveloped areas and as a future policy for other areas—the continuation of research on the utilization of solar energy fulfils an important function in global development.

The Arizona conferences cannot do other than stimulate all these developments; but in addition two definite proposals have emerged from them. The first is the creation of a journal for the publication of solar energy research, and the second is the formation of an applied solar energy research laboratory, possibly in Arizona. Finally, the delegates from outside the United States, numbering more than a hundred, who attended through the generosity of American foundations, will have returned to their own countries with inspiration renewed from these memorable conferences. HAROLD HEYWOOD

LARGE-SCALE WEATHER PROCESSES

A SHORT course of three afternoon lectures on "Large-Scale Weather Processes" was given on November 3, 10 and 17 at the Royal Institution, London, by Dr. R. C. Sutcliffe, deputy director (research) of the Meteorological Office. The broad thesis, concerning those parts of the atmosphere, the troposphere and lower stratosphere, which are of primary interest in weather and climate, was first to consider the mean world distributions of temperature and wind as revealed by direct observations, mainly by the methods of radiosonde and radar wind, during very recent years; then to discuss the large-scale day-to-day variations upon this mean state; and finally to review the problem of the general circulation of the atmosphere in the light of these results.

Many serious gaps still remain in the world network of upper-air stations. For climatological purposes the northern hemisphere is tolerably well covered, special credit being due to the combined Canadian–United States efforts in the far Canadian North and to the international Ocean Weather Ship scheme of the Atlantic. The wide stretch of the Pacific is relatively poorly charted, but the tropical land areas have many valuable stations, India being notably progressive, as would be expected from its long tradition in meteorological work. The chains in the southern hemisphere, mainly the efforts of South Africa, Australia and New Zealand, still leave large uncharted areas, and the Antarctic is little known. Much hope is placed upon the coming International Geophysical Year to provide answers to outstanding questions on three-dimensional world climate.

The early ideas on the broad troposphere–stratosphere structure have stood up well to recent observations. The mean level of the tropopause near the equator is at about 100 mb. pressure, about 16 km. high, where the temperature averages about −80° C. with an inversion above continuing to the ozonosphere. In middle latitudes the values are about 250 mb., 10 km. and − 60° C., and approach 280 mb., 9 km. and −50° C. towards the northern pole during summer. During winter the north polar tropopause is often ill defined, and temperatures at these levels fall to lower values. The earlier model, with a continuous sloping tropopause, has, however, been generally abandoned during recent years, the data pointing to a rather sudden break and lowering from 100 to 200 mb. near lat. 30°. There is also frequently, although not everywhere and invariably, another discontinuous descent with increasing latitude in the neighbourhood of the polar front, although this is a region of large day-to-day variations, and in the northern winter the polar front discontinuity in the tropopause tends often to merge with that at low latitudes. The picture for the southern hemisphere is similar so far as data go, but the mean state in high latitudes is largely conjectural; temperatures at equal heights are certainly lower and may average − 60° C. in summer and − 70° C. in winter at the polar tropopause.

The upper-air pressure field can be derived from the surface pressure and the hydrostatic equation, while the equation for the geostrophic wind suffices to give the general pattern of winds except quite near the equator. The limited amount of upper wind data fits well enough into the geostrophic pattern. The most striking features are the jet streams—the more-or-less strong wind maxima reached below the tropopause—and it is now believed that there are two distinct westerly jet streams in each hemisphere associated with the two zones of rapid change or discontinuity in tropopause height. Again, the absence of adequate data makes the picture uncertain, and it is necessary, especially in middle latitudes, to draw the distinction between the climatological mean and the daily synoptic patterns. In the mean the two maxima seem to merge in some longitudes and seasons, whereas the separation can usually be traced on daily charts. The climatological mean maximum wind strength attains a value of 150 knots in certain longitudes in winter, and there seems no doubt that the jet stream structures can, with varying intensity, be traced through all longitudes.

In the study of variability Dr. Sutcliffe confined his attention to middle latitudes. The salient place in theory taken by horizontal wind divergence (in the normal hydrodynamical sense) was stressed by showing its relation with pressure change through the hydrostatic equation; with vertical motion and adiabatic changes through the equation of continuity; and with the development of circulations, cyclonic and anticyclonic, through the vorticity equation applied to quasi-horizontal motions on a rotating Earth. This key part played by divergence would indicate an approach to theory through its direct study; but it is one of the peculiarities of dynamical meteorology that this most interesting quantity is not determinable either from measured winds or geostrophic estimates. A significant divergence for hydrostatic pressure change is less than 1 per cent per day and for vertical motions less than 10 per cent per day. Since winds can be measured, even granted the network, with an accuracy little better than within 10 knots, the divergence over areas of dimensions 100 miles may be directly estimated only within some 10 per cent per hour. The use of the geostrophic wind has long been known to be useless in this respect, as the divergence of momentum vanishes identically, apart from a term due to variation of latitude which is a minor term in dynamical development.

The direct approach through divergence has therefore to be abandoned, at least in extra-tropical latitudes, but the problem has yielded much to an attack resting on the vorticity equation. Vorticity and its changes can be estimated approximately from the geostrophic equation (more recent work aims at using a less-restricted stream function), and the dynamics can be built up from this approach. The simplest, yet still fruitful, attack has come by studying the dynamics of a barotropic atmosphere, virtually non-divergent flow. The justification for meteorological application rests on the smallness of the vertical integral of divergence compared with rates of change of vorticity by advection. In a broad sense the whole troposphere may thus be regarded as moving with a mean field of motion which is almost non-divergent. From this first approximation Rossby derived his now classical barotropic wave equation for idealized zonal flow, which is almost certainly related with the observed long waves of continental dimensions in the circumpolar westerlies.

The two-dimensional solution of the barotropic equation carried out numerically with electronic computing aids and starting with the known initial conditions provides a forecast of the mean flow for twenty-four hours ahead which stands comparison with both the facts and the best efforts of trained forecasters using established methods. Dr. Sutcliffe went on to describe more elaborate dynamical models which take account of divergence and vertical motion and which can therefore handle not only the mean motion but also vertical variations with cyclones and anticyclones. It may now be said that a deductive theory of the behaviour of large-scale systems in extra-tropical latitudes can be presented as a straightforward, if still only approximate, development from the hydrodynamical equations. This branch of meteorology has therefore, within the past decade, rather suddenly become almost a matter for formal text-book treatment in the tradition of applied mathematics, and the application of the theory is at present going rapidly ahead towards a new system of forecasting using electronic aids, with the research division of the Meteorological Office at Dunstable making a major contribution. Results so far are definitely encouraging, although in the nature of the physical problem no revolutionary increase in forecasting accuracy can confidently be predicted.

The theory applied to the complex large-amplitude oscillations in the wind flow, coupled with other studies based on perturbation theory, lead to the conception of large-scale instabilities and exponential growth-rates of disturbances as the normal state of the atmosphere, and numerous slides shown by Dr. Sutcliffe, illustrating the surface and upper-air weather-maps, made this interpretation seem eminently realistic. The atmosphere is essentially in turbulent motion on the scale of many hundreds of miles, and the evolution of individual turbulent elements is likely to present tremendous, perhaps insuperable, difficulties when the prediction period is extended beyond the time-scale of growth or decay, of the order of one day.

In the final lecture the problem of the general circulation was formulated as that of deriving the mean state and motion of the atmosphere from the basic assumptions of an atmosphere of known composition on the rotating Earth, with land and sea surfaces, subject to solar radiation. At the present time there is no fundamental deductive theory available. Attention was directed to the summer and winter averages of mean-sea-level pressure and the radical differences between them, especially in the northern hemisphere, differences evidently linked with the land and sea distribution and broadly monsoonal in character. This complication is something superposed on a symmetrical planetary circulation, and the first step in a basic theory is naturally to derive the circulation as it would appear on a symmetrical ocean-covered Earth. Evidence, especially from the southern hemisphere, indicates fairly conclusively that the solution must provide for a mean low-pressure belt around the equator, subtropical high-pressure belts bounding the easterly trade winds of lower latitudes, broad belts of prevailing unsettled westerlies bounded at high middle latitudes by low mean pressure with relatively high pressure again at the poles, presumably also much disturbed by synoptic systems. Some sort of zonal mean organization is inevitable on a symmetrical Earth, but Dr. Sutcliffe was not prepared to prove that either a smaller or larger number of zones is fundamentally impossible. One must bear in mind that in certain tropical oceans intense cyclones are rather common in low latitudes, and that under rather different conditions the Earth might well have these features regularly, giving two belts of low mean pressure with prevailing westerlies and relatively high pressure at the equator. There is also a frequent, but passing, tendency for a double cyclonic zonal structure to appear in middle and high latitudes. A basic theory should show that the assumed zonal organization is necessary, but perhaps also that an essentially different organization would be found if the values of the fundamental quantities, in particular radiation, were different perhaps only by a little from their present values. Facile qualitative arguments which purport to explain the general circulation are of little value; quantitative treatment is essential.

Pending the development of such basic theory, meteorologists are devoting their attention to the mechanism of the circulation as it is observed and attempting, with some success, to show by what processes the long-term average state is maintained as a balance between losses and gains. Brief attention was given by Dr. Sutcliffe to the water, energy and zonal momentum accounts. Evaporation and precipitation must balance over a relatively short period of time, for the mean world value is about 90 cm. a year, whereas the air contains no more than the equivalent of about 2·5 cm. of water. The patterns are, however, very dissimilar, with precipitation maxima in low and middle latitudes separated by a precipitation minimum which, over the oceans, is an evaporation maximum. The evidence is that the relatively steady trade winds are the vehicle carrying moisture to the equatorial rains, but that the transport to the middle latitude rain areas comes mainly in bursts of moist tropical air (the warm sectors of depressions), separated by bursts of cold dry air moving towards the equator; the transport is then a turbulence phenomenon and not a steady flow in a mean meridional current.

Time prevented a detailed consideration of energy balance during the lecture, but attention was directed to the large amount of energy transported as latent heat and to the less well-known contribution from gravitational potential energy. An inflow of air at high levels coupled with an outflow at low levels could have a major effect in increasing the total energy over an area; the high values of thermal or internal energy over warm anticyclones are really derived from such overturning. The evidence is that a large part of the poleward flux of energy in tropical latitudes which redresses the lack of balance in radiation is carried as gravitational potential energy.

Considerations of zonal angular momentum have received much attention. The long-period balance requires a zero total couple around the polar axis as the result of friction between ground and atmosphere, and this requires a degree of balance between westerly and easterly winds. But taking zones separately, the trade-wind belt with a westward frictional couple exerted on the atmosphere must export westward angular momentum to be returned to the Earth through the friction of the prevailing westerlies. The different zones are thus very closely linked, and one wonders how far forecasting in middle latitudes, which at present takes no explicit account of the trade-wind belt, can be expected to go.

At the present time it is believed that a steady overturning in low latitudes—a meridional convective circulation with ascent near the equator and subsidence towards and in the sub-tropical anticyclones—is an essential link, but that farther northwards the momentum transport (as the moisture transport) is mainly the effect of the unsteady motions, with mean meridional motions playing a minor and perhaps negligible part.

The study of mechanisms, and especially of the relative importance of steady mean circulations and irregular motions, is important if the basic problem is to be formulated in a manner suitable for mathematical attack. It is now thoroughly established that the mean state of the atmosphere cannot be maintained by the mean motions and that the two together do not provide the solution to any real problem. Thus the nature of the turbulence, which is physically different in different zones, must be introduced into the theory at a very early stage: it is not a mere embroidery on a general circulation existing in its own right. It seems probable that the wave-length or scale of unstable synoptic systems which theory shows must develop in the baroclinic atmosphere sets a scale to the zonal mean organization.

The time now seems to be ripe for an attack on the basic problem, and experience with electronic computing for dynamical forecasting in middle latitudes has given to the mere complications of calculating a less formidable appearance. Much progress is almost certain to come during the next decade, and it is urgently required. When one compares the two summers of 1954 and 1955, as experienced in Europe, one is forcibly struck with the fact that the general circulation averaged over a matter of months may run quite differently from one year to the next and so far with no explanation whatever. It seems unlikely that such differences will be understood unless we have a basic theory of the planetary circulation on which to build, and the physical nature of the problem of seasonal weather prediction must for the present remain a mystery.

POPULATION OF BRITISH UNIVERSITIES IN THE 1960's

THE AGE-GROUP BULGE

AT the final session, on the afternoon of December 17, of the 1955 Conference of the Universities of Great Britain and Northern Ireland, the problem of "The Age-group Bulge and its Possible Effect on University Policy" was discussed, with Dr. D. W. Logan (principal, University of London) in the chair. In the opening address, Dr. G. E. F. Chilver (Queen's College, Oxford) defined the problem: at the peak of the bulge (1964–67) there will be at least 7,500 more applicants for university places each year; afterwards there will be a plateau, when the number of applicants will be at least 2,500 more than at present. This is calculated simply on the basis of the extra births in the years from 1944. In addition, there has been a trend towards more pupils aged seventeen years and more remaining at school, the increase since 1951 being 30 per cent in England and Wales and 15 per cent in Scotland. If this trend continues, then the numbers of applicants will be larger than the figures given. However, there are good reasons for believing that the trend is unlikely to operate during the peak of the bulge, though it may well be resumed in the later years.

The more important and tractable problem is that of the plateau. The universities should plan for an expansion of the order of 10–15 per cent in the 1960's, concentrated largely in science and technology. The Ministry of Education has provided places in secondary grammar schools to accommodate the extra children during the bulge, and there are signs that enough specialist teachers are coming forward for sixth-form work. The provision of additional university teachers is not so easily envisaged, since they must be found before the extra graduates are forthcoming; this is particularly so in science faculties, where the teachers will need to be withdrawn from other jobs. Capital development, to be in time to make the expansion possible, must take place earlier; it must be provided in the next quinquennium (1957–62). As regards the peak of the bulge, it may be unprofitable to speculate now, provided that planning proceeds for dealing adequately with the level of the plateau.

Exceptional difficulties are to be expected at Oxford and Cambridge, where it is unlikely that the expansion can be large, whatever may be desirable. This is a matter of fact, based on current views in the older universities, and is not a personal opinion. A major factor here is the existing system of college (as opposed to university) finance, the colleges not being directly in receipt of grants from the University Grants Committee. In any event, expansion in a city like Oxford is difficult, population growth being limited and college sites being too small for much further building. It is generally felt that, in view of their structure, colleges are reaching their maximum size. At the peak of the bulge, it is unlikely that Oxford and Cambridge will dilute their tutorial system to the extent tolerated after the Second World War; they are almost bound to raise their entrance standards.

In the second address, Prof. R. G. D. Allen (London School of Economics and Political Science) supported the contention that the problems of the plateau are more important than those of the peak of the bulge. He thought that 2,500 is a low estimate of the extra numbers the universities must soon absorb each year. Certainly a smaller figure would only arise if universities were to impose higher entrance standards or the economic climate in Great Britain deteriorate. The appropriate employment of 2,500 or so extra graduates a year raises special problems, but there can be no doubts about a ready market for scientists and technologists; for arts graduates also, even those with pass or general degrees, there are clear signs that there is an expanding market for their services, for example, in the Civil Service and local government, in banks and insurance offices. The likely recurrent cost of the expansion is not great—£3 million added to grants by the University Grants Committee and £2 million to maintenance awards—but the cost in capital grants is likely to be high and needs to be incurred early, particularly since much of the expansion must be in science and technology.

As regards the peak of the bulge (1964–67), the university population may well rise to more than

105,000, as compared with 50,000 before the Second World War and 80,000 now. The universities cannot easily absorb the peak numbers if they are concentrated heavily in science and technology, nor place them in employment unless they are so concentrated. But elaborate plans are not needed to meet the brief and passing phase of the peak. What is essential is that careful but generous plans should be laid during 1957–62 to provide for a university population at least 10–15 per cent higher than now, rising slowly and steadily during the late 1960's and 1970's as the trend towards more seventeen-year-olds at school operates. Prof. Allen also stressed the importance of maintaining the proportion of women (now about one-quarter) in the university population, and in this he was supported by Dr. C. M. Rigby (University College, London). The risk is that any strain in the universities, and the inevitable concentration on science and technology, will result in smaller numbers of women students.

Lord Simon of Wythenshawe, Prof. J. F. Allen (St. Andrews) and others stressed the extreme urgency of problems created by shortages of scientists and technologists in industry. Large numbers are reported as being trained in the U.S.S.R., and there is a growing scarcity in the United States, where British technologists are already being used. It is essential that in Britain we should not fall behind in the provision of technologists. Lord Simon noted that the universities have been able to achieve a large expansion since the Second World War, and he said that another increase, particularly of university-trained technologists, is now required.

Prof. A. V. Judges (King's College, London) asked the conference not to overlook the human side of the problem. The extra children of the post-war generation have already had a raw deal, through shortages of facilities, equipment and teachers, and they must not be barred from university education. They constitute an asset the country can ill afford to waste. Dr. G. B. Jeffery (director, Institute of Education, University of London) asked whether we are not failing to make best use of our population of university students. Jobs in industry are increasingly requiring a higher level of ability, and we are not turning out enough scientists and technologists even for teaching.

Two vice-chancellors, Sir James Mountford (Liverpool) and Sir Philip Morris (Bristol), expressed very strongly the view that the estimate of an expansion of 10–15 per cent is far too low. They would compound the effect of the higher birth-rate after 1944 with that of the recent trend towards larger sixth-forms in schools, the argument of the opening speakers providing the line from which to deviate—in an upward direction. Unless the estimate is raised, the plans of the universities will be too small, and too slow, to meet the real situation. The urgent need is for a large and immediate increase in capital grants to universities, and in this the Governments of the past decade have failed to provide what had been necessary, and indeed promised, for the expansion since the Second World War. Not only must the deficiency be made up, but there must also be full provision in capital grants for the expansion to come.

R. G. D. Allen

NEWS and VIEWS

Sir Edward B. Poulton, F.R.S. (1856–1943)

The son of an architect, Edward Bagnall Poulton was born at Reading a century ago on January 27, 1856. After taking first-class honours in natural science at Oxford in 1876, he became demonstrator of zoology under George Rolleston. Rolleston's successor, H. N. Moseley, supplied him with material from the *Challenger* Expedition, and in 1883 Poulton published three papers on the tongues of Australian mammals; five years later he discovered that Ornithorhynchus possesses true teeth which cut through the gums, but are replaced by horny plates. His real scientific interest lay in living insects, and he showed "a lifelong delight" in the coloration of animals and in mimicry. During 1884–88 he wrote several papers on the colours of larvæ and pupæ and on the factors influencing their survival value, and these studies led to his election to the Royal Society in 1889; in 1890 he published his classic book, "The Colours of Animals", which placed him in the front rank of protagonists of natural selection. Poulton's early interest in heredity is shown by an article in *Nature* (29, 20; 1883) on the inheritance of abnormal toes in cats. In 1893 he succeeded the first Hope professor of zoology, J. O. Westwood, and he occupied this Oxford chair of entomology for forty years. Recipient of many honours, he was vice-president of the Royal Society (1909–10) and Darwin Medallist (1914), president of the Linnean Society (1912–16) and Linnean Medallist (1922), and president of the second International Entomological Congress (1912). He was knighted in 1935. Poulton was a big man with penetrating blue eyes and a vigorous, friendly personality, and his fondness for making the title of a communication summarize all the contents sorely tried the patience of bibliographers. He died on November 20, 1943, at the age of eighty-seven.

Vice-chancellorship of Hull: Prof. Brynmor Jones

Prof. Brynmor Jones has been elected to be vice-chancellor of the University of Hull as from October next, in succession to Dr. J. H. Nicholson who is retiring. Prof. Brynmor Jones has held the G. F. Grant chair of chemistry in the University College (now University) of Hull since 1947. He has also acted as pro-vice-chancellor of the University since 1954 and prior to that was vice-principal of the College. Prof. Brynmor Jones was at the University College of North Wales prior to proceeding to St. John's College, Cambridge, in 1929. He was thereafter on the staff of the Chemistry Department of the University of Sheffield during 1931–46.

Theoretical Physics in the Australian National University: Prof. K. J. LeCouteur

The development of research in physics in Australia has been greatly strengthened by the appointment of Dr. K. J. LeCouteur to the chair of theoretical physics at the Australian National University, Canberra. Dr. LeCouteur, who at present holds a readership in theoretical physics in the University of Liverpool, has made important contributions to a variety of subjects. In recent years he has developed the theory of the emission of particles from excited nuclei to such an extent that it has become possible to use the relevant experiments for a quantitative determination of the density of energy-levels of nuclei. While occupied with this work, he has found time to develop quantitatively a method for the extraction of the beam from a cyclotron. This method has led to spectacular success on the Liverpool machine. Earlier in his career, he made interesting contributions to abstract field theory. Dr. LeCouteur's flexibility should be of great value in his new post and should help to start a new school of theoretical physics in Canberra.

Benjamin Franklin's Purse

In connexion with the 250th anniversary of the birth of Benjamin Franklin (1706–90), the Department of Mineralogy of the British Museum (Natural History) is exhibiting the asbestos purse sold by Franklin to Sir Hans Sloane in 1725. The purse came into the collections of the British Museum at the time of its foundation in 1753, on the death of Sir Hans Sloane. It had lain unrecognized for many years and was identified in 1938. On his arrival in Britain, Franklin worked for some time as a compositor and sought to augment his income by the sale of some 'curiosities' which he had brought with him from America. One of these, the asbestos purse, is referred to by Franklin in his autobiography, and also in a letter to Sir Hans Sloane, now preserved in the British Museum. The purse represents perhaps the earliest specimen of asbestos from North America to reach Great Britain.

European Organization for Nuclear Research

At a recent meeting in Geneva of the Council of the European Organization for Nuclear Research, a number of measures were approved. Two of these refer to a scheme of guest professorships whereby prominent workers are invited to spend a year in Geneva helping the research teams there: Prof. G. C. Wick, an Italian physicist at present at the Carnegie Institute of Technology, Pittsburgh, has been nominated for the guest professorship in theoretical physics and will act as leader of the Theoretical Group in Geneva; and Prof. W. K. H. Panofsky, director of the High-Energy Physics Laboratory of Stanford University, California, for the guest professorship in experimental physics. The estimates for the financial year 1956 and the capital investment programme for the period 1952–60 were approved by the Council. The budgetary contributions for 1956 have been fixed at about 34 million Swiss francs as compared with a figure of 25 millions for 1955. This year will be a period of great activity, and will involve a general move to the site at Meyrin, the installation of the laboratories and workshops, and the development of the scientific programme in relation to experiments with the machines. The staff will increase by about 40 per cent. By the end of 1960 the Organization will probably have spent about 197 million Swiss francs. Previous estimates were lower, but unforeseen problems were met in connexion with the stability of the foundations for the proton synchrotron; staff needs have also increased, and by 1960 about five hundred will be required. At the meeting of the Council the following officers were elected: *President*, Sir Ben Lockspeiser (United Kingdom); *Vice-Presidents*, M. Jacques de Bourbon-Busset (France) and Prof. Ivar Waller (Sweden); *Chairman of the Finance Committee*, M. Jean Willems (Belgium); *Additional Members of the Committee of Council*, Dr. Antonio Pennetta (Italy) and Prof. Paul Scherrer (Switzerland).

The Organization is planning to hold a symposium on high-energy physics in Geneva during June 11–23. The first week will be devoted to novel features in the design and techniques of high-energy accelerators, and this will be followed by papers and discussions on special experimental techniques (for example, bubble chambers) and new contributions to π-meson physics. Further information can be obtained from the Organization at Case postale 25, Geneva, 15-Aéroport.

Radiation Monitoring Service in Britain

The National Physical Laboratory radiation monitoring service, started for hospital staffs in 1942 at the request of the Ministry of Health, and extended in the following year to cover industrial workers, has grown steadily to the point where some 50,000 films are issued annually. In 1953 a new organization, the Radiological Protection Service, was set up under the joint auspices of the Ministry of Health and of the Medical Research Council to deal with general aspects of protection against ionizing radiations. This organization has now taken over the N.P.L. service. Initially the service will be operated by the Radiological Protection Service in a similar manner to that adopted by the National Physical Laboratory. The fee will be the same and also the procedure for supplying films and issuing reports. Inquiries should be addressed to the Director of the Service, Mr. W. Binks, at Downs Nursery Hospital, Cotswold Road, Sutton, Surrey (Telephone No. VIGilant 1329). The Service is also prepared to give advice on radiological hazards in general, and on the necessary protection measures for new installations involving such hazards. Future plans include the development of techniques for measuring accumulated radioactivity in the bodies of radiological workers.

U.S. Agricultural Research Institute

At the fourth annual meeting, held during October 17–18 in Washington, D.C., of the Agricultural Research Institute of the United States National Academy of Sciences and the National Research Council, the following officers were installed: *President*, Walter C. Dutton (Dow Chemical Co.); *Vice-President*, Max T. Goebel (E. I. DuPont de Nemours and Co., Inc.); and *Secretary*, Norman F. Kennedy (Corn Industries Research Foundation). The meeting included a paper on the strategy of research, by A. G. Norman, an address on the farmer and the future, by Ervin L. Peterson (U.S. Department of Agriculture), and a symposium on corn in the American economy; the proceedings will be issued shortly. The Agricultural Research Institute is composed of two types of members, those that pay subscription and those that do not, the former being industrial organizations and the latter scientific societies, agricultural experimental stations and Federal agencies. It is designed to foster the promotion of co-operative research that will ensure the best long-term uses of agricultural resources for the national welfare, and for this purpose it is affiliated with the Agricultural Board of the National Academy of Sciences and the National Research Council.

New Zealand Forestry Research

Some reorganization has taken place in forestry research in New Zealand, and the publication of *Forest Research Notes* and of *Forest Products Research*

Notes has now ceased. Their place is being taken by a new series, *New Zealand Forestry Research Notes*, published by the Government Printer, Wellington, which will report research carried out in New Zealand in any field of forestry by all types of worker—public, private, university, etc. The annual report of the Forest Research Institute, Whakarewarewa, will now be issued independently of any research series.

Pinus radiata forms a considerable proportion of the coniferous species constituting the new New Zealand forests and has been the subject of a great deal of research work. No. 1 of *New Zealand Forestry Research Notes* (pp. 72; 1955) treats of combined taper and volume tables for *P. radiata* for 1952 in unthinned stands in the Conservancies of Auckland, Nelson and Canterbury and in thinned stands in the fourth Conservancy of Southland. Technical Paper No. 4 of the Forest Research Institute (pp. 48) deals with some comparative tests with wood preservatives and covers work still incomplete for *P. radiata* that has been carried out in all four Conservancies.

Soil, Vegetation and Land-use Surveys in the Gold Coast

THE first of a series of memoirs to be published by the Gold Coast Department of Soil and Land-Use Survey, Kumasi, is a report, with detailed recommendations, on a "Detailed Soil Survey of the Kpong Pilot Irrigation Area" by H. Brammer (pp. 102+9 maps. Accra: Govt. Printer; London: Crown Agents; 1955; 10*s*.). It gives a survey of the irrigation research station on the Accra plains, where experiments are now being carried out to establish, among other things, the most suitable means for irrigating approximately three hundred square miles of tropical black clays. Besides reports on detailed surveys of development areas, this series is to include comprehensive reports and monographs on particular aspects of the systematic soil, vegetation and land-use survey of the country as a whole.

Chemistry Institute at Bogor, Indonesia

UNDER the Colombo Plan, Mr. H. J. Wood, chemist in charge of the food and drugs section of the Dominion Laboratory, Department of Scientific and Industrial Research, New Zealand, has been loaned for twelve months to the Government of Indonesia and will teach new methods of chemical analysis to the staff of the Chemistry Institute at Bogor. The Institute, which is in the grounds of the well-known botanical gardens at Bogor, covers a wide field of investigation; but its chief interests are the developing of the natural food resources of Indonesia and methods of control for quality—both processing and analytical control. There is a staff of two hundred; but only three of them are qualified chemists. Bogor contains a small European population, and besides the Chemistry Institute there are an agricultural institute and an American plant for the rubber industry.

Measurement of Rate of Dewfall

A PAPER by Dr. G. Hoffmann, published in *Berichte des Deutschen Wetterdienstes* (3, No. 18; 1955), discusses the thermodynamics of and meteorological conditions for dew formation, and then goes on to describe a novel instrument, invented by Dr. Hoffmann, for measuring directly the rate of dewfall based upon the release of latent heat to the body upon which the dew forms. The rate, of the order of 0·02 mm./hr., needs a very sensitive apparatus for its measurement. The apparatus consists of a series of separate radial sectors, the temperature differences between which can be measured thermoelectrically. One sector is unheated so that dew forms upon it, an adjacent one is heated at a certain rate H and a third sector on the far side of the second from the first at a rate $2H$. The temperature difference between adjacent segments is, in the steady state, proportional to the difference in the rates at which they are being heated, the constant of proportionality depending on wind and temperature. The arrangement gives the rate of dewfall as directly proportional to the ratio of two of the temperature differences. By using a fourth sector of different type of surface, the radiation balance can be measured and the heat conducted from the interior of the apparatus measured from temperature differences to obtain all the terms in the energy balance. A number of curves of rate of dewfall given by the instrument are reproduced, showing rates of dew formation and in some cases subsequent evaporation, amount of dew deduced from the sum of the rates, the radiation balance and the meteorological conditions. The correspondence between the records of dew formation and evaporation and radiation balance is good, but the computed dewfall showed sometimes marked differences from the total dewfall measured by a nearby Leick dew-plate which gives an amount from the volume of dew on the plate, the thermoelectric apparatus apparently giving totals about half those given by the dew-plate. Further improvements of the apparatus to provide an accurate picture of the nocturnal heat balance of the ground surface are envisaged.

International Association for the Exchange of Students for Technical Experience

THE continuing success of the scheme launched by the International Association for the Exchange of Students for Technical Experience in 1948 indicates that industry in many countries now appreciates the facilities offered for the general broadening of the outlook of the students taking part in the scheme by means of travel abroad, living and working with the people of other nations and, at the same time, obtaining some useful experience in the industry of another country. In 1955 the number of students taking part in the scheme was 5,153—an increase of 886 over 1954. More interesting is that, while, in 1948, 413 industries were participating in the scheme, in 1955 the number had risen to 2,314. Difficulties about establishing a central committee for the Association in the United States have now been overcome and in September 1955 the American Society of Engineering Education gave an official mandate to the Institute of Education for its sponsorship of the Association in the United States. India and Turkey joined the Association as associate members in January 1955, and it is anticipated that South Africa will join shortly.

Institute of Personnel Management

AN examination scheme for new entrants has been launched by the Institute of Personnel Management. The aim of the scheme is to widen the field of recruitment while ensuring that those recruited are suitably qualified for membership. The Institute will not organize any course of study; but students will be free to prepare for the examination by attending evening classes or by private reading. The choice of subjects is wide, so that people with different experience and knowledge may qualify. It will be difficult, however, for anyone who has not had practical experience in industry or commerce to reach the standard required in the two papers on personnel management and in the oral examination which, with an essay, form the compulsory part of the examination. Various qualified exemptions are allowed. The first examination was held in September 1955 and others will take place at half-yearly intervals.

Bernice P. Bishop Museum, Honolulu : Report for 1954

THE annual report for 1954 of the Bernice P. Bishop Museum, Honolulu, Hawaii (pp. 55 ; 1955), is issued under the attractive title of "Museum at Work". It is an impressive record of activities accomplished under rather isolated conditions and with the usual accompaniment of small staff and limited finance. It naturally concentrates on the presentation of a knowledge of the Pacific area to the public and research for the furtherance of the same policy, and to these ends it has recently installed an exhibit entitled "Insects Close-up", which deals mainly with the control of pests ; another display deals with the Hawaiian house and shows early ways of living. An innovation was Aloka week in the Museum, when a facet of Hawaiian history was presented in an authentic form. Several other special exhibits are described and illustrated. It is an impressive fact that 151 men and women volunteers gave 12,501 hours of their time to work in and for the Museum.

International Mixed Commission on the Ionosphere

THE proceedings of the fourth meeting of the Mixed Commission on the Ionosphere, held in Brussels in August 1954, have recently been published by the International Scientific Radio Union and are obtainable from the General Secretary of the Union at 42 Rue des Minimes, Brussels (pp. 238 ; 300 Belg. fr., £2 3*s*., or 60 dollars). This Commission comprises delegates from the International Scientific Radio Union, the International Union of Geodesy and Geophysics, the International Astronomical Union and the International Union of Pure and Applied Physics. The chairman of the Commission is Sir Edward Appleton, and Dr. W. J. G. Beynon, of University College, Swansea, is the secretary. At the Brussels meeting, which was attended by thirty-one individual delegates, the Commission discussed the ionospheric programme being prepared for the International Geophysical Year ; and also a wide range of papers describing research on the ionosphere and related subjects. Most of the scientific papers presented to the Commission are published in full in the *Proceedings*, together with summaries of the discussions at the individual meetings.

Announcements

PROF. T. G. COWLING, professor of applied mathematics in the University of Leeds, has been awarded the Gold Medal of the Royal Astronomical Society for his distinguished contributions to theoretical astrophysics and particularly for his work on the stability of stars.

PROF. LÉON BINET, professor of physiology in the University of Paris, has been elected vice-president for 1956 of the Paris Academy of Sciences.

MR. I. C. MCDOWALL, chief executive officer of the New Zealand Pottery and Ceramics Research Association (Inc.), has been appointed director of the Association. Mr. McDowall, who graduated from Victoria University College, Wellington, in 1944, has been on the staff of the Association since its formation in 1946.

DR. W. D'A. MAYCOCK, a member of the scientific staff of the Lister Institute of Preventive Medicine, has been given the 1955 award of £50 of the Oliver Memorial Fund for his contributions to the development of blood transfusion. Dr. Maycock is adviser in blood transfusion to the Ministry of Health and honorary consultant in blood transfusion to the War Office.

As in previous years, the British Association will rent tables during 1956 at the Marine Biological Station, Plymouth ; the Freshwater Biological Station, Windermere ; and the Zoological Station, Naples. Research workers wishing to use these facilities should write to the Secretary, British Association, Burlington House, London, W.1, giving their qualifications, the work intended and the dates required. Applicants should normally be members of the Association.

THE Food Group and the Oils and Fats Group of the Society of Chemical Industry are holding a conference on "Recent Advances in the Knowledge and Uses of Phospholipids in Foods", which will take place at the Wellcome Research Institute, 183 Euston Road, London, N.W.1, during February 9–10. The registration fee for the conference is 5*s*. for members of the Society and £1 for non-members. Registration forms, to be completed by February 6, and further information, can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

THE Textile Group of Aslib, in co-operation with the Textile Institute, is organizing a conference on "Textile Information—Uses and Needs", which will be held at the Textile Institute, Manchester, on March 9. The objects will be to direct attention to the need for establishing and maintaining channels for the flow of technical and economic information to units and individuals in the industry best able to make use of it ; to indicate methods by which the communication of ideas and information might be most effectively achieved ; and to renew existing sources of textile information. Further information can be obtained from the Textile Institute, 10 Blackfriars Street, Manchester 3.

THE Cortina-Ulisse European Prize of one million lire (about £570), which is awarded by the magazine *Ulisse*, is being offered this year for a work on the history of labour organizations during the past century up to the First World War from scientific points of view. Only original works printed for the first time in Europe during the past five years will be eligible, and five copies should be sent in, before February 28, either by the author or by the publisher, to the Editor of *Ulisse*, Sezione Premio Europeo Cortina Ulisse, Corso d'Italia 43, Rome.

A MEMORIAL service for the late Sir Richard Redmayne will be held at 12.30 p.m. on January 26 at St. Margaret, Westminster. The service, which will be conducted by Dr. E. G. Jay, chaplain to the Archbishop of Canterbury, has been arranged jointly by the Institutions of Civil Engineers, of Mining and Metallurgy, and of Professional Civil Servants.

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

MEETING IN LONDON

THE European Association of Exploration Geophysicists has grown rapidly since its foundation in 1951 and now has a membership of more than a thousand, which is still increasing by about two hundred a year. For its ninth meeting the Association met in London at Church House, Westminster, during December 7–9, the distribution by countries of those attending the meeting being as follows: Great Britain, 123; France, 37; Germany, 22; United States, 13; Netherlands, 8; Italy and Yugoslavia, 4 each; Denmark, 3; Belgium, South Africa and Sweden, 2 each; Algeria, Austria, Canada, Eire, Japan, Norway, Spain and Switzerland, 1 each; total, 228. As these figures indicate, the Association takes a very elastic view of its territorial limitations, but the various members are united in their interest in applying the discoveries of physics to the exploration of the Earth's crust and its mineral resources.

The technical meeting was opened by Sir Edward Bullard, then director of the National Physical Laboratory, Teddington, who reviewed recent progress from the point of view of a geophysicist who has just renewed his interest in geophysics after several years in the field of 'un-prefixed' physics. He confessed to having been rather disappointed at the lack of any spectacular progress in geophysical methods during these years. At the same time, he directed attention to the many directions in which progress has been made, and where important developments may be imminent. This theme was taken up again later with more detailed treatment by Dr. R. G. Van Nostrand, who read a paper prepared in collaboration with Milton B. Dobrin on "Current U.S. Developments in Exploration Geophysics". Dr. Van Nostrand disagreed with Sir Edward, and expressed the view that important advances have already been made and are being vigorously applied in the field. He selected as most noteworthy the techniques of magnetic recording and velocity logging, both of which are rapidly entering everyday use in oil prospecting in the United States.

As pointed out by Sir Edward Bullard, the application of magnetic recording techniques to seismic exploration work has been facilitated by the developments demanded by guided-weapon research. The latter is now benefiting in turn by a wider market for high-quality recording apparatus. The advantages of making seismic records magnetically rather than photographically derive from the flexibility introduced by being able to reproduce the information again as electrical impulses. Then varying filters may be applied, or more novel methods under development, to improve the signal-to-noise ratio; time delays may be introduced by automatic correction techniques in order to facilitate interpretation; and lastly, and perhaps most important, the information can be conveniently stored against the day when better interpretation methods allow one to make the fullest use of the recordings, without having to re-shoot in areas which are often exceedingly difficult of access.

The continuous velocity logging of boreholes, continued Dr. Van Nostrand, offers not only greater convenience and speed than the conventional well-shooting, but also, by measuring the seismic velocity through much thinner layers, it gives the variations in velocity in much finer detail. The study of these continuous velocity logs in conjunction with seismic reflexion records shot from the surface is leading to a better understanding of the origin of reflexions. This in turn can lead to better resolution in complex geological situations, and may even afford a solution in some cases for the most challenging problem of present-day oil-finding, namely, the detection of stratigraphic trap reservoirs.

Although recent research in petroleum geophysics has been mainly concentrated on seismic techniques, Dr. Van Nostrand dealt also with several important developments in the application of other geophysical methods to mining exploration and to civil engineering problems. New borehole logging techniques have been applied to the search for uranium, an induced electrical polarization method has been successful in finding ground water, airborne electromagnetic methods have been widely used in the search for base metals in Canada, and a new airborne magnetometer has appeared, which is especially adaptable for use in light aircraft. Also, high-frequency seismic reflexion equipment has now been developed which offers hope for the successful application of reflexion seismology to mining geophysics and other problems involving structure at shallow depths.

The principles of the new airborne magnetometer were dealt with at greater length by G. Phillips and G. S. Waters, of the Signals Research and Development Establishment, Ministry of Supply. They have independently developed an apparatus, similar to that now in use in the United States, for measuring the magnitude of the total geomagnetic field from the frequency of precession of the protons in water around the field. (For a brief account of this work, see *Nature*, October 8, p. 691.) The advantages of this equipment for airborne magnetometer-surveying derive from light weight and simplicity, occasioned mainly by the fact that, unlike the flux-gate type of magnetometer, precise orientation in relation to the direction of the total field is not essential, so that sensitive servo-systems for this purpose are not required. Another advantage lies in freedom from instrumental drift.

The high-frequency seismic reflexion system was also given more detailed treatment at the meeting, its application and future possibilities being the subject of a paper by Curtis H. Johnson. Whereas reflexion equipment in common use at present employs frequencies in the range 30–60 c./s., the new equipment makes use of frequencies of the order 70–200 c./s. By this means the power of resolution is increased, at the expense, of course, of some increase in attenuation within the Earth. By using a faster recording speed and rapid automatic gain control, reflexion as early as 0·025 sec. after the shot can be satisfactorily timed, so that reflecting horizons as shallow as 100 ft. can be mapped. Besides its usefulness for the shallower problems of geophysics outside the petroleum industry, there are circumstances where high-resolution equipment can help the petroleum geophysicist. In areas where deep weathering or drift presents difficult low-velocity-layer correction problems, the reflexion times down to a known shallow marker-bed will give the necessary corrections for the deeper horizons. Other areas seem to be particularly favourable for high-frequency reflexions, so that more reflexions, and greater resolution between adjacent reflexions, can be obtained even at depths down to 5,000–6,000 ft.

A paper on instrumental distortion and the seismic record, by N. A. Anstey, attracted considerable interest. Taking a standard seismic input pulse—the Ricker velocity wavelet—Anstey has determined the various distortions of this pulse which arise due to filtering, automatic gain control, and high-amplitude effects in reflexion amplifiers. These distortions may affect the relative amplitudes, the shapes of the pulses, and the arrival times. Clearly, in the attempts which are now being made to use the reflexion method to the utmost limits of its resolving power, these instrumental effects must be fully understood, and in this respect Anstey's work is a most valuable contribution.

Out of the remaining twenty-three papers presented at the meeting, almost half dealt with the detailed mathematical and geometrical problems involved in the interpretation of geophysical results. Of these, the papers by F. Veyretout, M. Rimbaut, and by J. Schoeffler and L. N. Nardon were concerned with seismic reflexion problems; those by L. H. Tarrant and by S. Wyrobek dealt with refraction interpretation; those by A. H. Kleijn and by K. Helbig investigated the effects of seismic ânisotropy; while A. Lundbak, C. Monnet, A. Hahn and T. Knight gave papers on gravity and/or magnetic interpretation.

Considerable interest was attracted by three papers presenting the results of gravity determinations: the first, by F. A. Vening Meinesz and A. P. Collette, reported a regional gravity survey of the North Sea carried out by means of an underwater gravity-meter, with the co-operation of the Royal Netherlands Navy; another, by G. P. Woollard, W. E. Bonini and J. C. Rose, gave the latest results in their programme for the establishment of a world-wide network of gravity bases; and the third, by Rose and Woollard, described the measurements carried out from end to end of the North American continent with quartz gravity pendulums, with the object of establishing a gravity calibration baseline. Three papers dealt with seismic field-research: two of these, by T. Gaskell and by M. Pieuchet and H. Richard, were concerned with the efficiency of the customary source, that is, explosives either in a shot-hole or on the surface; and in the other, R. G. Mason described investigations of surface waves near the less commonly used alternative source, namely, a dropped weight. Actual field-surveys for mineral resources were the subject of two papers, one by M. Guerrier and A. Rogier on the Lorraine coal-basin, and one by R. Cassinis on exploration for sulphur limestone in Sicily.

The remaining four papers serve to illustrate the diversity of topics at the meeting. W. Domzalski dealt with problems of very shallow refraction work for civil and mining engineering purposes. F. Sumi treated some of the refinements of the electrical earth-resistivity method. Some novel ideas on the possible turning to advantage of seismic noise in prospecting were expounded by M. Matschinski. Lastly, very precise hydrostatic levelling for foundation problems was described by O. Meisser.

The meeting ended with a showing of the British Petroleum Company's film, "The New Explorers". Despite the many counter-attractions of London, attendance at the technical meetings was consistently high, showing that the meeting was most successful in furthering the interchange of geophysical knowledge and ideas. L. H. TARRANT

STRUCTURE OF SEMI- AND NON-CRYSTALLINE MATERIALS

THE autumn conference of the X-ray Analysis Group of the Institute of Physics was held in London at the Institution of Civil Engineers during November 18–19, the topic for discussion being "Semi- and Non-Crystalline Materials". In her opening paper, on the mechanism of crystallite growth in carbons, Dr. R. E. Franklin reviewed her work on the structure of graphitic and non-graphitic carbons. The latter can be further classified into graphitizing and non-graphitizing carbons according to whether crystallite growth can be induced by heat-treatment or not. From this fact, and from the nature of order produced during growth, certain conclusions about the mechanism of crystallite growth can be drawn, in particular when the graphitic sheets grow by the addition of edge groups and when growth is normal to the plane of the sheets. In discussing this paper, Dr. G. E. Bacon described his own work on radiation damage in crystalline graphite, where the order destroyed by irradiation can be completely restored by heat-treatment.

Dr. R. Diamond gave an account of a new theoretical method which he has developed for the interpretation of amorphous scattering curves, and which he has applied to the composition of various coals. Exact theoretical curves for the X-ray scattering from perfect condensed aromatic ring systems of various sizes were first calculated on the EDSAC digital computer. A linear combination of such curves was then fitted to each of the observed experimental intensity curves by the method of least squares, and from the coefficients in the combination histograms were obtained showing the proportions of the various ring systems present. This matrix method is to some extent analogous to the process of Fourier inversion; in cases such as this one, where all the possibly existing components are known, it avoids the difficulties due to cut-off and to the inaccuracies in the experimental curves at high values of $(\sin\theta)/\lambda$. The method has been applied by Dr. Diamond to a study of vacuum carbonization of coal, where the effects of polymerization and evaporation have been clearly shown. Dr. L. Cartz has used the same method on the vitrain series of coals and on ethylene diamine extracts of coals, and has derived histograms of molecular sizes, matching being carried out in the region of the (11) band. Discrepancies occurring between theoretical and experimental curves in the region of the (10) band can be explained as due to the (00*l*), that is, to intermolecular effects. Replying to questions by Dr. Stadler, Drs. Diamond and Cartz stated that they have also examined quinone extracts in which experimental and calculated curves do not agree; a chemical change during extraction is thought to have taken place.

Prof. R. W. Douglas reviewed some of the experimental work on the structure and physical properties of glass. The principal X-ray work in the subject, that of Warren and his associates on silica, and on soda-silica and boric oxide glasses has led to a concept of network-forming atoms and network-modifying atoms. The rather anomalous physical properties of boric oxide and sodium borate glasses have to some extent been explained by recent infra-red absorption measurements on these materials which have given important information on the bonds present. The

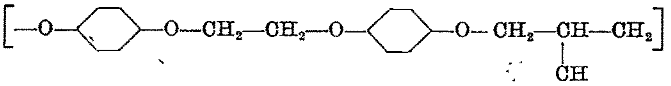
X-ray results have indicated the liquid-like structure of glasses, and, on the whole, their behaviour fits well into this pattern; much research, however, is still needed into the long-range order of glasses.

Dr. R. L. Gordon described X-ray measurements made by himself and his colleagues which indicate the presence of a disturbed layer, effectively about 1000 A. thick, existing at the surface of finely ground quartz particles which could be partly removed by etching, particles of diameter less than about 0·5μ apparently not containing any perfectly crystalline material. This conclusion was not universally accepted in the subsequent discussion, which, however, failed to produce an alternative explanation of Dr. Gordon's X-ray results; these were supported by other measurements such as differential thermal analyses. In discussing the papers on glasses and on quartz, Dr. A. E. J. Vickers described the difficulty of producing commercially truly isotropic fused silica.

Dr. W. May next gave an account of special X-ray diffraction techniques developed for obtaining patterns of liquid systems. His apparatus consists of a cylindrical powder-camera on the axis of which a free jet of liquid serves as specimen. The camera is kept filled with helium so that the pattern is practically free of unwanted scattering. The liquid is circulated by a pumping unit of the 'closed' type needing little attention, and interlocking safety devices between the X-ray unit and the pumping unit safeguard the operation of both. Provision has been made for working temperatures between 0° C. and 80° C.

Mme. J. Longuet-Escard described the work which she has carried out with J. Mering on colloidal nickel hydroxide. In settling from a fresh suspension, very small crystals of nickel hydroxide tend to stick together by their (001) faces. In this coagulation the ionic double layer of the surface is imprisoned, and non-rational (00*l*) reflexions are produced. The abnormal spacing (that is, the thickness of the imprisoned ionic layer) cannot be calculated from Hendricks's and Teller's formula, since its distribution in the stacking process does not follow a law of constant probability. The spacing can be determined directly by a Fourier transformation of the (00*l*) intensity distribution. The thicknesses thus measured were found to depend upon the nature of the anion and the state of hydration of the double layer. In the case of a chloride ion, spacings more than three times the normal spacing of nickel hydroxide (4·60 A.) have been found.

The final session of the conference was devoted to a discussion of non-biological fibres. Dr. L. Brown described preliminary crystallographic investigations on a polymer of repeating unit:



which may be prepared from 4,4'-dihydroxydiphenoxyethane and epichlorhydrin in the presence of sodium hydroxide. In the crystal the molecule is found to be twisted, probably S-shaped with the planes of the benzene rings at an angle to the chain axis. The crystallographic repeat is probably two molecular units, arranged around a two-fold screw axis. The symmetry is monoclinic with two chains (that is, four residues) in the unit cell. The interesting point about this structure is that the *b* (chain) axis extends reversibly from 27·6 A. to 29 A. on stretching, with only slight changes occurring in the diffraction pattern. Under suitable conditions the molecules may be drawn out to a straight form with a repeat of 16 or 32 A., but they do not appear capable of crystallizing in this form.

Dr. E. R. Howells next presented the results of X-ray examinations carried out by Mr. C. W. Bunn and himself on straight-chain fluorocarbons, particularly on 'Fluon', polytetrafluoroethylene. The fluorocarbon chains, both in 'Fluon' and in perfluorocetane, $C_{16}F_{34}$, were found to have a helical configuration with six turns in the repeat unit of thirteen (CF_2) groups. On account of the relatively large van der Waals radius of 2·7 A. of fluorine, the cross-section of the fluorocarbon chain is very nearly circular, and it should therefore be easy for chain segments to rotate about their own axes. This rotation probably accounts for the remarkable room-temperature transition which occurs in 'Fluon' some 300 deg. below the melting point; as Mr. Bunn pointed out in a reply to a question, the rotation may also be the explanation of the remarkably low coefficient of friction of the polymer: the cylindrical molecules may be acting as roller bearings.

Dr. A. Keller has been studying orientation phenomena in synthetic crystalline polymers, where the crystallites do not appear in a haphazard way, but form sub-microscopic fibrous aggregates. These fibrils themselves can build up larger structures, the spherulites, within which they are essentially radially disposed. Thus a polymer which is macroscopically unoriented is in fact composed of minute oriented regions which arise spontaneously from melt or solution. Dr. Keller has studied the orientation of the unit cell within these regions by means of a micro X-ray technique and found it to be such as to result in a predominantly perpendicular disposition of the chains with respect to the radii of the spherulites. In certain special cases the X-ray results have been correlated with birefringence measurements. The existence of these spontaneously oriented regions can manifest itself when a crystalline or crystallizing polymer is artificially oriented. A number of uniaxial orientations were observed which are unusual since the molecular chains are oriented preferentially in directions other than that of the external orienting influence. While this is unexpected from simple molecular considerations, Dr. Keller showed that the anomaly is only apparent and that the actual orientations fit in well with his picture. Prof. J. D. Bernal pointed to a possible similarity between Dr. Keller's spherulites and those observed, although of a much larger size, by Dr. Conmar Robinson in solutions of synthetic poly-γ-benzyl-L-glutamate.

In a short contribution, Dr. K. Dornberger-Schiff gave examples of the type of misalignment and 'mistakes' occurring in semi-crystalline material in which only a two-dimensional periodicity is retained. Such structures are best treated by considering the planar symmetry of the two-dimensionally ordered regions rather than by space-group theory. Important examples of the type of treatment suggested by her are afforded by certain fibrous minerals, notably chrysolite, halloysite and garnierite, which Dr. E. J. W. Whittaker has been examining. He has found that, while these minerals do not possess crystal lattices of the ordinary kind, their structures can be described in terms of cylindrical lattices. He defined a cylindrical lattice as a set of congruent two-dimensional lattices inscribed on a set of cylindrically curved surfaces and mutually ordered with respect to the cylinder axis, there being equal and uniform normal spacings between each successive pair of such surfaces; he then developed a classification of such lattices which is a cylindrical analogue of ordinary space-group theory.

Dr. D. E. Corbridge reported on his structure analysis of the fibrous 'Kurrol' salts, which are long-chain metaphosphates; they are insoluble and exhibit colloidal behaviour. In the case of rubidium metaphosphate, the unit cell is monoclinic and contains continuous chains of composition $(PO_3)_n^{n(-)}$ spiralling around the screw axes with a repeat pattern every two PO_3 units; similar structures have been found for the potassium and cæsium salts. Dr. Corbridge pointed out some interesting structural resemblances between the metaphosphate chain and long-chain anions found in certain silicate minerals which also form helical structures.

An interesting and stimulating evening discourse was delivered during the conference by Prof. A. R. Ubbelohde, whose subject was "Crystallography and the Phase Rule". The next conference of the Group will be held jointly with the Low Temperature Group of the Physical Society; it will take place in Oxford during April 11–13 and will be devoted to low-temperature crystallography. U. W. Arndt

DENSITY OF THE LUNAR ATMOSPHERE

SOME of the values of the density of the Moon's atmosphere obtained by observers in the U.S.S.R. are discussed by E. J. Öpik, of the Observatory, Armagh, in a paper in the *Irish Astronomical Journal* (3; March 1955). The Russian workers determined the relative polarization of the diffuse light of the sky near the horns of the lunar crescent and they arrived at a value approximately $0{\cdot}5 \times 10^{-4}$ of the terrestrial atmosphere, but A. Dollfus in 1952 found a value 10^{-9} for the upper limit (*C.R. Acad. Sci., Paris*, 234, 2046; 1952). J. N. Lipskij carried out a detailed investigation and arrived at a value of the order 10^{-4} (*Pub. Sternberg Astro. Inst., Moscow*, 22, 66; 1953), but Öpik's examination of the matter shows that the values obtained by the Russian observers must be far too big.

In his investigations, Öpik completely ignores any possible absorption by the hypothetical lunar atmosphere, which is too thin to cause absorption effects, and hence the surface brightness in a given direction will be proportional to the intensity of illumination and to the illuminated air mass per unit cross-section along the line of sight. On this assumption, he shows that the surface brightness of the earth-shine at quarter phase is at least thirteen times as great as that of a vertical column of the lunar atmosphere illuminated by the Sun, and this result is used to determine the upper limit to the mass of the lunar atmosphere. It seems highly probable that any lunar atmosphere (if such exists) will be practically free of dust, and Raleigh scattering of light by the gas molecules prevails. It is assumed that the scattering power of the lunar atmosphere is about the same as that over high mountain tops, such as Mount Whitney (4,420 m. above sea-level), and C. G. Abbot's observations on Mount Whitney (*Ann. Astrophys. Smithsonian Inst.*, 3, 145; 1913) showed that the surface brightness of a sunlit atmosphere at sea-level, but of a degree of purity equal to that on Mount Whitney, is $3{\cdot}02 \times 10^{-7}$. The surface brightness of the earth-shine, measured by Öpik in 1924 and by Danjon in 1936, is about 25·84 mag., from which it is easily found that the surface brightness of earth-shine is $4{\cdot}61 \times 10^{-11}$. The ratio of the lunar to the terrestrial atmospheric masses in vertical columns of unit cross-section is therefore less than $4{\cdot}61 \times 10^{-11}/13 \times 8{\cdot}02 \times 10^{-7}$—that is, less than $4{\cdot}42 \times 10^{-6}$—making use of Öpik's figure thirteen, as already explained earlier.

It appears from this investigation that the mass of the lunar atmosphere is less than 1/226,000 of the terrestrial, and with the smaller gravity on the Moon, the pressure and density of the lunar atmosphere cannot be more than one part in 1·3 millions of those of the terrestrial atmosphere.

INSECTICIDES AND THE BALANCE OF ANIMAL POPULATIONS

DR. H. E. HINTON, of the Zoology Department, University of Bristol, has recently directed attention to the dangers involved in the indiscriminate use of insecticides (*Sci. Prog.*, 43, No. 192; October 1955).

Much has been written on the kinds of direct injury that can be done to crops and other useful plants by insecticides, while individuals using poisons are materially concerned with any damage they may do to farm animals, crops and ornamental plants. They are not always as interested in the damage they may do to wild animals and birds, and they occasionally tend to dismiss injuries to their operatives as unavoidable occupational hazards. For example, in Argentina the incidence of dermatitis in workers exposed to BHC was once as high as 25 per cent. Fish are said to be as sensitive to DDT as insects; but the possibility of producing damaging concentrations in water as the result of normal control operations is slight.

In 1952 many instances of death or serious injury following the use of DDT, BHC and other chlorinated hydrocarbons had been reported. The chlorinated compounds which are fat-soluble and chemically stable tend to accumulate in the fatty tissue; this explains why animals with a large amount of fat tend to be less susceptible to acute poisoning than under-nourished ones. It has been shown that, in mammals, accumulation occurs at all ordinary levels of intake, and rats may accumulate DDT in the fat body until there may be as much as thirty times the level of intake. More DDT may accumulate in the fat body than is required for a lethal intravenous dose without the mammal showing any obvious signs of poisoning. Elimination occurs slowly; but sudden starvation may release enough DDT to affect the animal seriously. It is also known that there are great seasonal differences in the susceptibility of insects to chlorinated compounds, and there is good evidence that these seasonal differences are related to the amount of depot fat present. Many investigators believe DDT should not be used on dairy cattle and animals that are to be eaten because it accumulates in the milk and fatty tissues.

THE SECOND ENTOMOLOGICAL EXPEDITION TO THE HIMALAYAS

By PROF. M. S. MANI

School of Entomology, St. John's College, Agra

DURING May–June 1955 I led the Second Entomology Expedition to Lahoul-Spiti in the North-West (Punjab) Himalayas. There were a team of seven members and more than a ton of equipment and supplies of food. The University of Agra made a small grant towards a part of the expenses of the Expedition. Leaving Agra on May 18, we reached Manali at the end of the Beas Valley. Owing to unexpected and unusually late snow-fall, we were greatly delayed and held up for several days at about 9,000 ft. Our original plan of establishing a supply base at about 15,000 ft. on Kanzam La in the Spiti border had to be abandoned. The base camp was established a little below 13,000 ft. in a meadow opposite the Kulti Nal glaciers. After overcoming numerous difficulties and considerable delays, some essential supplies were pushed to an advance base camp below the Great Ice Fall Mountains of the Purana Khoksar Nal. Although not specially organized for spectacular peak-climbing, the Expedition climbed several unnamed and unclimbed peaks in search of high-altitude insect life.

Although the climbing programme had to be greatly curtailed owing to continued bad weather, more than five thousand specimens were brought back, some of them being taken at altitudes never before reached by an entomologist in this part of the Himalayas. We also studied the various conditions under which the high-altitude insect life flourishes and made observations on the habits and peculiarities of life-cycles. Several hundred close-ups in 'Kodachrome' and black-and-white were also made of the high-altitude flowers and insects in their natural surroundings with the help of a 'Leica' camera and its accessories.

The collections, which will ultimately be deposited with the Zoological Survey of India, are now being sorted out and card-indexed. Nearly every specimen has been microfilmed. The identification of the material, descriptions of the new forms and detailed reports of the Expedition's findings will not be ready for some time. I may, however, direct attention to certain interesting features of the high-altitude insect life of the Himalayas.

Although the variety and abundance of insect life as a whole rapidly fall off beyond the limits of tree-growth, the zone of permanent snows immediately above these limits is by no means barren. On the permanent snow at altitudes rarely ever reached by ordinary human beings, there habitually live a remarkable variety of insects. They thrive well under conditions of glare (great radiation especially in the ultra-violet part), intense cosmic-ray activity, reduced pressure, great oxygen deficiency, constant fierce cold-dry winds, frequent avalanches and snowstorms, absence of plant life, relative scarcity and lack of variety of food and restriction of the feeding period to the very brief summer, etc. Dry barren rock that often gets heated to an uncomfortable degree in the summer sun even at great elevations, damp moss-covered stones, snow-fields, glaciers, glacial torrents, cracks and crevices in rock, caves and other spots have each their characteristic insect inhabitants.

While nearly every order of insects with which we are familiar in the plains also occurs at high altitudes, the species are different in almost all cases. The high-altitude insects of the Himalayas superficially resemble the alpine type; but actually they show closer affinities to the Tibetan and Central Asian faunal elements rather than to European. There are also sufficient indications to believe that the insects of this region represent, at least partly, a geographical relict of the Pleistocene life of Central Asia. Deep infiltrations of the subtropical and often also of the tropical faunal elements may be detected as high as 10,000 ft. above the mean sea-level.

Among the high-altitude insects of the Himalayas, Collembola, Diptera, Coleoptera, Dermaptera, Plecoptera and Ephemerida (given in order of abundance) stand foremost. Between 8,000 and 14,000 ft., Plecoptera, Ephemerida and Trichoptera are dominant types, especially in the glacial torrents. Some of these ascend right up to the edge of the permanent snow. Remarkably enough, the insect population of all kinds is far more dense in the glacial torrents than in stagnant waters. This concentration in the torrents is perhaps due to the more uniform though lower temperatures of the torrents than in the still waters. From 12,000 ft. upwards we come across Dermaptera–Coleoptera associations, and beyond 15,000 ft. above sea-level Collembola, Coleoptera and Diptera replace the Dermaptera–Coleoptera complex. The last-mentioned three orders seem to have successfully taken up permanent abode at much higher altitudes than any other insect and also occur at greater elevations than 15,000 ft. Collembola are perhaps the only forms which may be found as high as 18,000 ft.

In addition to the species that occur habitually at great altitudes, the Expedition came across great swarms of migrating Lepidoptera. *Colias ladakensis* and *Argynnis claudi* were taken at about 17,000 ft. on snow-fields. Upper-air currents and the afternoon winds blow up millions of minute insects like aphids, fruitflies and even larger forms like noctuid moths from the plains of India on to snow-fields and glaciers between 14,000 and 17,000 ft., especially on the southern aspect.

A most remarkable variety of adaptations can be correlated to the peculiar conditions of life. Widely unrelated groups occurring on exposed boulders, in glacial torrents and on wind-blown snow-fields and glaciers exhibit considerable adaptive convergence in the development of devices for securing firm anchorage. The great majority of the truly high-altitude insects show extremely low tolerance of even slight increase in temperature, due undoubtedly to long acclimatization to the generally sub-zero temperatures. Some of them are capable of surviving under 30 ft. of snow for several months without apparent harm.

A striking feature of the high-altitude insects of the Himalayas is the greatly prolonged larval life, with hibernation and diapause often extending to one or even two years. The adult is extremely short-lived. We came across a great number of forms still hibernating towards the end of June under stones covered by several feet of snow. *Calosoma madeirae kashmirense* is, for example, a common carabid beetle that was hibernating in this way at about 13,000 ft. On an enormous glacier at about 14,000 ft. on the Dhauladhar I found on a previous occasion a mass assemblage of hibernating adults of Coccinellidæ. At relatively lower altitudes just beneath the permanent snow line, with the advance of summer and the gradual melting of the snow, the scene becomes one of a mad race of different species against time. The noon-day sky with the air 4° below zero becomes filled with gigantic swarms of may-flies, stone-flies, caddis-flies, butterflies, gnats and various other insects which mate, lay eggs and perish before the same evening. The few that survive may be destroyed in a blizzard the next afternoon. Unlike polar forms, most of the high-altitude insects here are heavily pigmented as a protection against the glare and ultra-violet radiation. This may also be the result of crowding during development in sheltered spots. While only a small fraction of them thrive on lichen, moss or algal slimes, the great majority of the species are either scavengers or carrion feeders or devour each other. As one goes higher and higher the increasing proportion of the carnivorous species can be recognized, until at altitudes above 15,000 ft. they are the only types that occur permanently. The wind-borne organic matter already referred to also contributes to the food resources of the high-altitude insect life.

A MODIFIED METHOD OF TWO-DIMENSIONAL ZONE ELECTROPHORESIS APPLIED TO MUCOPROTEINS IN SERUM AND URINE

By R. L. MARKHAM

Department of Rheumatology, Royal Free Hospital, London

DURRUM[1] has described a technique of two-dimensional zone electrophoresis on paper in which the analysis in the first buffer is transferred on a strip of paper to the surface of a sheet of paper soaked in the second buffer. The strip is placed in such a position that the substances on it migrate in a direction at right angles to that in the first buffer. We wished to use two-dimensional electrophoresis to obtain direct confirmation of the positions of serum mucoprotein fractions in the serum protein pattern obtained by electrophoresis at pH 8·6. Two serum mucoprotein fractions may be isolated from all other serum proteins by electrophoresis at pH's between 4·4 and 4·6[2] (Fig. 1). Since in the latter technique filter paper is sandwiched between glass plates, the following modification of Durrum's method was developed.

Instead of placing the strip on the surface of the paper, a slot to receive it of corresponding width and slightly greater length was cut in the centre of the second sheet at right angles to the direction of the second separation. The strip was partially dried at room temperature before being placed in position. The edges of the two pieces of paper were then carefully teased together, except at either end of the strip where a gap was left. The sheet of paper had been soaked in buffer, blotted, and placed on the lower glass plate before receiving the strip, and the flow of the new buffer into the strip concentrated the material in it as a narrow band along its centre. The absence of buffer flow inwards at either end of the strip prevented disturbance of spatial distribution along it. The upper sheet of glass was then placed over the paper, the second electrophoresis carried out after a short period of equilibration, and the paper—minus the strip—was then stained. The results obtained are shown in Fig. 2 (A). The occurrence of M-1 and M-2 in the α_1- and α_2-globulin positions respectively is clearly indicated. The pH of the second buffer is chosen to ensure that the fractions to be studied are carried clear of the transferred strip. With other combinations of buffer systems the buffer on the strip may alter the pH on the remainder of the paper; but this can generally be avoided by adjustment of the buffer concentrations or by transferring a narrower strip.

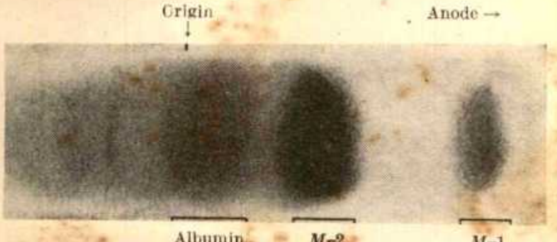


Fig. 1. Serum mucoprotein fractions M-1 and M-2 isolated by electrophoresis at pH 4·6 in a citric acid – sodium phosphate buffer. Paper stained by periodic acid – Schiff technique

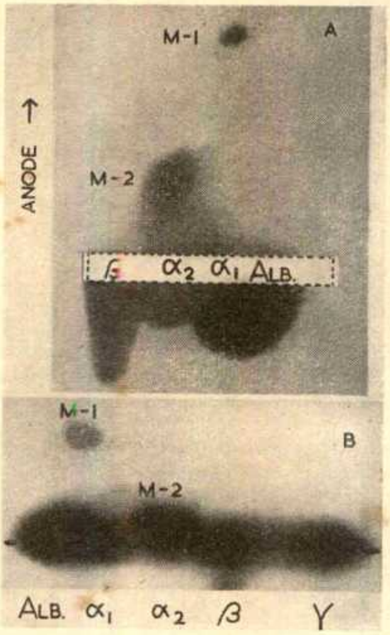


Fig. 2. Two-dimensional electrophoresis showing position of mucoprotein fractions in serum protein pattern obtained with veronal buffer, pH 8·6

(A) First separation transferred on paper strip, position of strip indicated by dotted line. Second buffer citric acid – sodium phosphate, pH 4·4

(B) Veronal buffer removed by 66 per cent acetone, second buffer citric acid – sodium phosphate, pH 4·6

Stained with naphthalene black. M-1 spots intensified for reproduction

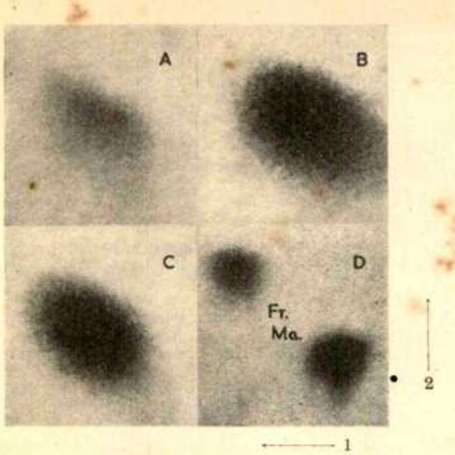


Fig. 3. Details of shapes of spots obtained by two-dimensional electrophoresis. Arrows indicate direction of migration in first and second analyses

	Substance	Buffer *p*H 1	Buffer *p*H 2	
A	Serum, *M*-2	8·6	4·6	Stained with naphthalene black
B	Urine, *M*-1	8·6	4·4	,, ,, ,, ,,
C	Serum albumin	8·6	8·6	,, ,, ,, ,,
D Fr.	Fructose	8·6	8·6	Detected with *m*-phenylenediamine. Borate buffer
D Ma.	Mannose	8·6	8·6	,, ,, ,, ,,

Both electrophoretic analyses can be carried out on the same sheet of paper when serum mucoproteins are being studied, since veronal buffer may be removed by washing the paper in ice-cold 66 per cent acetone. The mucoproteins are not denatured by acetone, and the low temperature and rapid removal under vacuum avoid excessive denaturation of the other proteins present, which, if rendered insoluble, might retain some of the mucoprotein. The results of such an analysis are shown in Fig. 2 (*B*).

In the course of these experiments it was noticed that fractions appearing to be homogeneous after one electrophoretic analysis gave, after a two-dimensional analysis, elliptical spots with their long axes at an angle to both directions of migration (Fig. 3). This was observed with both mucoprotein fractions, run either at two different *p*H's or twice at the same *p*H, and with serum albumin run twice at *p*H 8·6. In a two-dimensional analysis using borate buffer at *p*H 8·6 [3], fructose and mannose showed no tendency to form spots of this nature (Fig. 3). The transferred strip technique was used in all these two-dimensional analyses, and both serum and urine were obtained from patients suffering from acute rheumatoid arthritis. The shapes of spots were not influenced by position on the paper, or by the order in which the buffers were employed. Kunkel and Tiselius[4] suggested that these diagonally disposed elliptical spots are the result of the presence of components with different mobilities within what appears to be a homogeneous fraction when subjected to a single electrophoretic analysis, and that the presence of such a spot-shape is a sensitive test for heterogeneity. No heterogeneity of these two mucoprotein fractions or of serum albumin was detected when patterns obtained by a single electrophoretic analysis were scanned, the curves obtained showing no sign of containing more than one component.

In the method reported here, where the same buffer has been used for each analysis, the fact that the axis of the elliptical spot is not at 45° to each direction of migration is due to the concentration of the spot on the base line before the second analysis. This reduces in one direction only the effect of diffusion on the shape of the spot. Kunkel and Tiselius were not able to demonstrate the heterogeneity of serum albumin by their method, and the ability of the method here described to do this may also be due to this reduction of diffusion by reconcentration, resulting in a more sharply defined spot.

Serum albumin[5] and mucoprotein *M*-2 [6] are each known to contain several components, but only one component is known to occur in mucoprotein *M*-1 of normal serum[7], and in normal serum a round spot is obtained on two-dimensional electrophoresis of the latter fraction. The intensity of this spot was too low for photographic reproduction. *M*-1 in serum of patients suffering from active rheumatoid arthritis, however, gives a diagonal ellipse and has been reported as containing two components, detected by boundary electrophoresis[8].

I thank Dr. Ernest Fletcher and the Board of Governors of the Royal Free Hospital for permission to publish this communication, and the Endowment Fund Sub-Committee for providing facilities. [Sept. 22

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CYCLIC POLYAMIDES FROM NYLON 6 and 6.6 POLYMERS

Constitution of the Cyclic Polyamides isolated from Nylon 6 Polymers

In a previous paper we reported the isolation from technical ε-caprolactam polymerizates of three individual crystalline substances (designated here as *A*, *B* and *C*) having identical elementary composition ($C_6H_{11}ON$) and containing no free NH_2 or COOH groups[1]. They obviously represent cyclic oligomers of ε-caprolactam.

Cryoscopic molecular-weight determinations in phenol at a concentration of about 5 per cent (by weight) led us to conclude that *A* and *B* are stereoisomeric cyclic dimers and *C* a cyclic trimer (molecular weight found for *A* and *B* 212 and 250; for *B* 342; calc., 226 for dimer and 339 for trimer).

A private communication received from Dr. L. Valentine in Leeds expressed doubt as to the reliability of the cryoscopic molecular-weight determinations (owing to the fact that no extrapolation to zero concentration was included). This led us to seek an independent method of determining the constitution of these compounds. Stepwise hydrolysis in aqueous (25 per cent by weight) hydrochloric acid at 110° (at a concentration of 0·5 repeating units, "Grundmole", per litre) was chosen. This procedure was recently also suggested by Zahn *et al.*[2]; but no definite results were communicated.

Upon hydrolysis, a cyclic *n*-mer should produce the linear *n*-mer as the first product, which then is transformed into the linear (*n*–1)mer and so on, until complete conversion into ε-aminocaproic acid is reached.

A paper chromatographic technique[3] allowed us to separate, identify and estimate approximately quantitatively mixtures of the lower linear oligomers up to the tetramer.

Applying this technique, which will be published elsewhere in more detail, it was found that the intermediate product first appearing in the hydrolysis of the cyclic oligomers *A*, *B* and *C* were the linear dimer, trimer and tetramer respectively, providing conclusive evidence that *A*, *B* and *C* are indeed the cyclic dimer, trimer and tetramer.

The results of our hydrolysis experiments are in conformity with the extensive cryoscopic molecular-weight determinations of the same substances in solvents other than phenol (lactam of hexahydro-*p*-aminobenzoic acid and acetanilide) recently published by Rothe and Rothe[4]. These authors also confirmed anomalous results obtained in phenol as a solvent. It remains to be explained why the melting-point depressions of these substances in phenol are abnormally high.

The properties of these cyclic oligomers can now be summarized thus :

Substance	*A*	*B*	*C*
Melting point (corrected)	347–348°	247–248°	241–242°
Solubility in water, parts per 100 (17°)	0·1	0·93	0·04
Former designation (ref. 1)	α-dimer	β-dimer	trimer
Correct designation	dimer	trimer	tetramer
Molecular weight, cryoscopic method (ref. 4)	225	336	439
Molecular weight, calculated	226	339	452

The paper chromatographic identification of the linear oligomers was facilitated by samples of the synthetically prepared compounds obtained by courtesy of Dr. Van der Want, Central Laboratory TNO, Delft[5].

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Intramolecular Hydrogen Bonds in certain Cyclic Polyamides

The intermediate products formed in the hydrolysis of the cyclic oligomers of ε-caprolactam and some linear oligomers of ε-aminocaproic acid (in a large excess of 25 weight per cent hydrochloric acid at 110°) have been identified and semi-quantitatively determined.

A paper chromatographic technique[1] has been used for this purpose. The results allowed determination of the approximate values of the pseudo first-order hydrolytic rate-constants of the amide groups in these substances. (The theoretical and experimental details of this work will be published elsewhere.)

The kinetic analysis of the hydrolysis of the linear oligomers was simplified by the assumption that the rate-constants of the amide groups in these linear polyamides are independent of chain-length and location in the chain, which seemed justified by a previous investigation[1].

Included in this investigation was also a cyclic diamide isolated from nylon 6.6 polymerizates obtained by courtesy of Dr. R. J. W. Reynolds (Manchester). This substance, which on hydrolysis yields the linear monoamide $NH_2(CH_2)_6NHCO(CH_2)_4COOH$ as an intermediate and hexamethylene diamine plus adipic acid as the final products, is isomeric with the cyclic dimer of caprolactam.

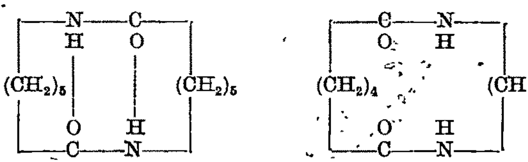
The approximate hydrolytic rate-constants in h^{-1} (for one amide group) of the substances investigated are given in Table 1 along with their solubilities in water at room temperature.

Table 1

	Rate-constant (h^{-1})	Solubility (parts/100)
Caprolactam cyclic dimer	0·025	0·1
,, ,, trimer	0·21	0·93
,, ,, tetramer	0·15	0·04
Nylon 6.6 cyclic monomer	0·34	2·35
Linear ε-aminocaproic acid oligomers	0·34	—
ε-Caprolactam	> 2	320

These results disclose some interesting features. It is seen that the amide groups in caprolactam cyclic dimer are very resistant to hydrolysis as compared to those in the other cyclic lactam oligomers, and, in particular, as compared to the amide groups in the isomeric nylon 6.6 cyclic monomer, which react with practically the same rate as the amide groups in linear chains. Also the solubility in water of the nylon 6.6 derivative is more than twenty times larger than that of the lactam dimer. This peculiar difference requires explanation.

It would seem that the low reactivity of the cyclic dimer can be understood from the fact that in this compound the two CONH groups can readily assume a position opposite to each other, which is particularly favourable for the formation of two intramolecular hydrogen bonds, whereas in the nylon 6.6 derivative the different sequence of CO and NH groups does not permit a configuration equally favourable for the formation of internal hydrogen bonds. This can be represented diagrammatically thus :



Cyclic dimer Nylon 6.6 monomer

Examination of Stuart models corroborates this view.

In the cyclic trimer, only two out of the three CONH groups could possibly form intramolecular hydrogen bonds with each other, and it seems to be not merely accidental that this oligomer is the one having by far the largest solubility in water. It also hydrolyses much easier than the dimer.

In the tetramer, pairwise engagement of all the CONH groups is again geometrically possible. Stuart models show that this is even possible in two different ways (Fig. 1).

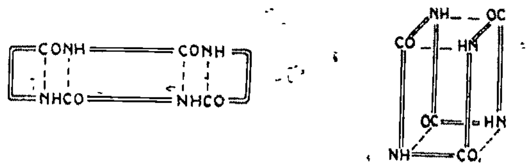


Fig. 1

The fact that its rate-constant is nevertheless much larger than that of the dimer and but slightly smaller than that of the trimer is presumably related to the very much larger internal mobility of this 28-membered ring-system, which is also clearly demonstrated by the Stuart model. This mobility may favour the existence of a great many conformations in which the amide groups lie too far apart to allow intramolecular hydrogen-bond formation. The number of such conformations is undoubtedly much larger than in the dimer.

This paper and the preceding form part of a programme of fundamental research sponsored by AKU (Arnhem) and Netherland States Mines (Geleen).

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[1] Hermans, P. H., Heikens, D., and van Velden, P. F., *J. Polymer Sci.*, 16, 451 (1955)

Constitution of the Cyclic Polyamides isolated from Nylon 66 Polymer

WHEN nylon 66 polymer (polyhexamethylene adipamide) is heated in a glass vessel under an inert atmosphere above its melting point, a white crystalline sublimate condenses on the cooler parts of the vessel. A similar phenomenon occurs in the melt-spinning of nylon, when a sublimate condenses on the cooler parts of the spinning equipment just below the spinneret. It was obviously of interest to know whether this material was a by-product of the polymerization process or of thermal decomposition of the polymer.

A sample of the crystalline material sublimed out of nylon 66 polymer by heating it under vacuum at 295–300° C. was found to have a melting point of 249–251° C. (uncorr.): its analysis showed 63·6 per cent C, 9·8 per cent H and 12·4 per cent N (calc. for $C_{12}H_{22}N_2O_2$, 63·8 per cent C, 9·75 per cent H and 12·4 per cent N). This material had refractive index of 1·554 and density of 1·166 gm./c.c.

In some later work, nylon 66 polymer was extracted by boiling with water for a long period and the aqueous extract evaporated to dryness. The residue was found to comprise two materials—one soluble in ethyl acetate, from which it crystallized, and the other insoluble; the insoluble portion was purified by recrystallization from methyl 'Cellosolve'.

The material soluble in ethyl acetate was found to be identical with the material which had been sublimed from 66 nylon polymer. Its melting point was 248° C. and by analysis was found 63·3 per cent C, 9·6 per cent H and 12·2 per cent N. Molecular weight determination gave 210 (by cryoscopic method in phenol), 218 (by ebullioscopic method in methanol) and 225·2 by X-ray diffraction assuming two molecules per unit cell. The dimensions of the triclinic unit cell were $a = 9·58$ A.; $b = 8·71$ A. and $c = 8·47$ A., with angles $\alpha = 110° 58'$; $\beta = 104° 35'$ and $\gamma = 86° 17'$. The specific gravity of the crystals, measured by flotation, was 1·171. The calculated molecular weight for $C_{12}H_{22}O_2N_2$ is 226.

The material insoluble in ethyl acetate crystallized from methyl 'Cellosolve' in fragile white crystals with melting point 237° C. On analysis its composition was found to be 63·2 per cent C, 9·6 per cent H and 12·2 per cent N. Molecular weight determination (by ebullioscopic method in methanol) gave 445.

The crystals were not good enough for unit cell measurements to be made, but the powder diffraction pattern was different from that of the soluble fraction in ethyl acetate.

It seemed probable that these two compounds were cyclic hexamethylene adipamide monomer and dimer respectively.

It is possible to obtain a mixture of low-molecular weight materials comprising mainly these two compounds by dissolving 66 polymer in formic acid and adding the solution slowly to a large volume of methanol, so that the polymer is precipitated in a granular and easily filterable form. The 'methanol-soluble' material can be recovered by filtering off the polymer and evaporating the filtrate to dryness. Using this procedure as a method of analysis, it has been shown that the low-molecular weight compounds are formed from the linear polymer, and that the amount formed is dependent upon the temperature to which the polymer is heated. A single experiment indicated that the reaction is reversible. The amount of 'methanol-soluble' material found varied from 1·9 per cent after heating at 275° C. to 4·3 per cent at 295–300° C. and 5·9 per cent at 310° C.

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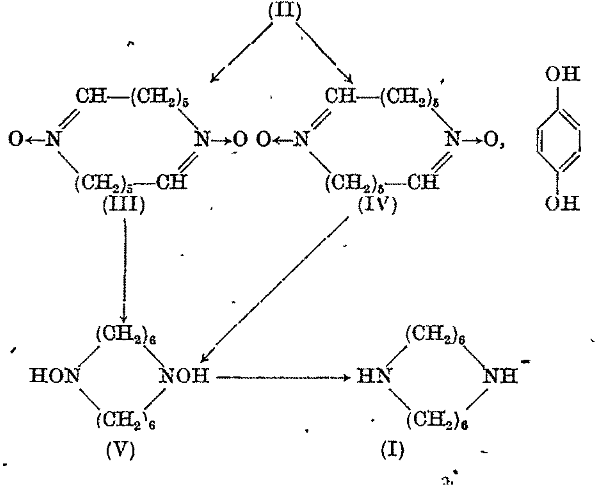
Synthesis of 1 : 8-Diazacyclo-tetradecane

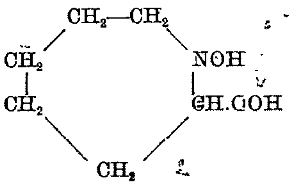
THE 14-membered-cyclic diamine (I) has been synthesized in these laboratories by three entirely independent routes. In two of these the large-ring diamides discussed in Dr. P. H. Hermans' communications were the starting materials. Both the nylon 6 : 6-cyclic monomer, kindly supplied by Dr. R. J. W. Reynolds, and the cyclic dimer from caprolactam, kindly supplied by Dr. Hermans, were reduced by lithium aluminium hydride in boiling tetrahydrofuran without difficulty. The identity of the reduction product from these two sources thus provides chemical proof of the cyclic systems, no other structures leading to a common product. The diamine is strongly basic, melting point 72°, boiling point 145°/12 mm., dipicrate melting point 248° C., dihydrochloride melting point 315–9° C.

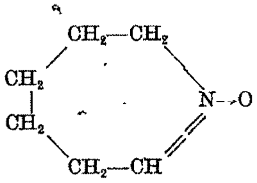
The third route is less to be expected, and uses as starting material N-hydroxyhexamethyleneimine (II), boiling point 94–5°/13 mm., melting point 7° C., which has been prepared by two methods[1], and the structure assigned to it has been confirmed by analysis of the base, its hydrochloride, acid oxalate and picrate, and by its reduction to hexamethyleneimine. It behaves normally as a hydroxylamine in every respect save only the remarkable sensitivity of the free base to atmospheric oxygen. It is characteristic of N-dialkylhydroxylamines to autoxidize very rapidly in aqueous alkali[3], and very slow oxidation often takes place on keeping the free base in air. N-Hydroxyhexamethyleneimine is so sensitive to oxygen that all operations must be carried out in an atmosphere of nitrogen. Exposure to oxygen for a few minutes leads to cloudiness and for longer periods to the precipitation of a flocculent, amorphous, and no doubt polymeric, solid, which is insoluble in practically all solvents. Eventually (after some weeks) a film of the hydroxylamine exposed to air will set to a brittle solid.

The phenomenon shows particularly clearly in ether solution, which soon becomes opaque and strongly peroxidic to starch iodide paper; and after a few hours, especially when oxygen is passed through the solution, deposits a film on the walls. It was observed that the deposit, though largely amorphous, contained traces of crystalline material, and this has been isolated in very low yield and found to be very labile, losing its solubility in organic solvents when heated to temperatures approaching 100° C. It was then found that much more crystalline material was formed when quinol in roughly half-molecular amounts was present during the oxidation, and that the product was much less heat-labile, though becoming insoluble in organic solvents at temperatures above 100° C. Analysis of this latter compound suggested an empirical formula $C_{18}H_{28}N_2O_2$, that is, a combination of quinol and a dimerized oxidation product of N-hydroxyhexamethyleneimine. To the two crystalline products have been assigned structures (III) and (IV). On hydrogenation of (IV) by Adams catalyst in methanol, four atoms of hydrogen are absorbed, and the products are free quinol and a new compound (V) with the properties of a hydroxylamine. Compound (III) can be reduced in the same way, and the X-ray powder patterns and infra-red absorption curves of the products are identical. Dr. C. J. Brown of these laboratories has examined crystals of (V) by X-ray diffraction and has deduced that a large ring (12-, 14- or 16-membered) is consistent with all the intensity results; but as yet the final electron-density map showing the position of the atoms has not been obtained.

Compound (V) has now been hydrogenated further with Raney nickel in glacial acetic acid to the cyclic diamine (I), this constituting the third synthesis.

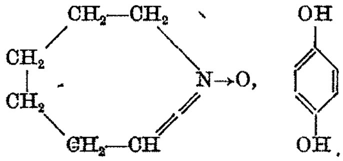



(VI)

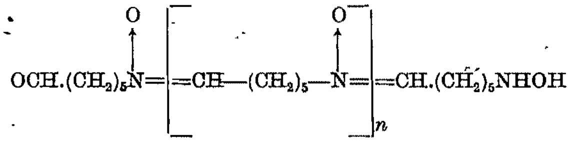

(VII)

The structure assigned to (IV) leaves open the question of whether the quinol is bound to the nitrone by covalent or ionic bonds or as a molecular complex or clathrate system.

It is now possible to see how N-hydroxyhexamethyleneimine polymerizes during autoxidation, though no really convincing explanation of why it does so has yet been suggested. The first product is probably the hydroperoxide (VI), and indeed very labile, strongly peroxidic, solids have been detected, but isolation has not been possible. Hydrogen peroxide is eliminated from (VI), leaving the cyclic nitrone (VII), which can be shown to be unstable and to polymerize, for it can be made by a different route: N-hydroxyhexamethyleneimine reacts rapidly with quinone in ether with hydrogen transfer and formation of the complex (VIII), a crystalline solid, which, after a few hours, changes to a resinous polymeric material, insoluble in solvents, and quinol.


(VIII)

Again the question of the precise structure of the complex is reserved for further discussion. The polymer formed by autoxidation is thought to be of rather low molecular weight, and is represented:



$$\mathrm{OCH.(CH_2)_5\overset{O}{\overset{\uparrow}{N}}{=}}\left[\mathrm{{=}CH{-}(CH_2)_5{-}\overset{O}{\overset{\uparrow}{N}}{=}}\right]_n\mathrm{{=}CH.(CH_2)_5NHOH}$$

(IX)

In agreement with this, reduction by Raney nickel in glacial acetic acid gives polyamines, showing positive spot tests for both primary and secondary amines. The water formed during the oxidation, via hydrogen peroxide, is probably an effective chain stopper. The strong reducing properties, to triphenyltetrazolium chloride[1], suggest a high proportion of hydroxylamine groups.

Full details of this work will be submitted to the *Journal of the Chemical Society* for publication.

I acknowledge gratefully the help of Drs. E. J. Alford and J. A. Hall, and the crystallographic examination by Dr. C. J. Brown.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Filamentous Forms of Influenza Virus

There is good evidence that the filamentous forms characteristic of many recently isolated strains of influenza A are infective units[1]; but their significance in relation to the process of influenza virus replication is by no means clear. It has been suggested that filaments represent the initial form in which the infective phase of the virus is produced, spheres being formed secondarily[2]. Others have suggested that the filament is a by-product, as it were, of the process by which new infective particles are produced at the free surface of the allantoic cell[3].

Although it has been known since 1949[4] that the filaments are clearly visible by dark-ground illumination at a magnification of 500 or even less, very little use has been made of this method of observation. It has, however, a number of advantages over the conventional use of the electron microscope for such work. A simple, and for most purposes sufficiently accurate, method of comparing concentrations of filaments is as follows. A standard volume, 20 c.mm., is placed on a clean slide and covered carefully with a coverglass of standard size (⅞-in. circle). The preparation is put into a moist chamber for 15 min. or longer to allow the great majority of the filaments to attach themselves to one or other glass surface. Using a standard area of field with an 'Ehrlich' eyepiece and a 47 × objective, the number of filaments on the two glass surfaces plus the few seen in moving from one focal level to the other can be readily counted. To a reasonable approximation the number of filaments per field area X is equivalent to $X \times 10^7$ filaments per c.c., and with the highly filamentous strains Oc. Is., *PERS* and *RYAN*, X is of the same order as the hæmagglutinin titre. For convenient counting it is necessary to dilute the average infected fluid 1 : 10 or 1 : 20.

This method has been used in an exploratory series of investigations for finding agents capable of destroying the filaments as estimated by the reduction in the numbers of visible forms. The interesting result has emerged that most agents capable of hæmolysing red cells will destroy virus filaments and show a threshold at about the same level of concentration. Hypotonic salt solutions are destructive at concentrations of 0·3 per cent sodium chloride or lower. At or near threshold concentrations, distorted forms with angulation and a beaded appearance may be seen; at lower concentrations forms recognizable as filaments become extremely rare. Disintegration is more rapid and complete at *p*H 6 than at *p*H 8.

As representative hæmolytic agents saponin, cetyltrimethylammonium bromide and sodium lauryl sulphate were used. They were completely destructive at concentrations of 0·01 per cent, but had virtually no effect at a concentration of 0·001 per cent. The end point of hæmolysis of 1 per cent fowl cells also lay between these concentrations. Saponin was less active in the sense that few filaments were completely destroyed. Obvious evidence of damage was produced to a concentration of 0·003 per cent in the form of distortion, beading and, particularly around 0·01 per cent, very firm adsorption to glass surfaces. The damage was confirmed in electronmicrographs made for me by Dr. Heather Donald.

Shaking with ether or chloroform destroys the filaments. Using the normal procedure of shaking infective fluid with 20 per cent of freshly redistilled ether and leaving overnight in the refrigerator, virtually all filaments were destroyed. The hæmagglutinin titre showed a moderate fall when tested with fowl cells; but a rise with human or guinea pig cells. Untreated, the strain Oc. Is. gave fowl-to-human hæmagglutinin titres of 600/700, after treatment with ether 300/3,200. Of non-filamentous strains similarly treated, only *PR*8 showed a change of this type from 500/700 to 130/600. Infectivity titrations showed no reduction beyond 0·5 $\log_{10}$ when treatment was with redistilled ether on allantoic fluid buffered with phosphate at *p*H 7·0. The same lack of effect on infectivity was seen when filaments were broken down with water lightly buffered at *p*H 7·0 or 8·0.

The results suggest that the filaments have qualities resembling those of the host cell surface, and that their formation is a result of an interaction of virus components with the surface of the cell in which virus has multiplied. Failure to influence infectivity by filament destruction may mean that their infectivity is limited to the spherical units that often appear to be incorporated in the filaments.

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Walter and Eliza Hall Institute,
Melbourne. Oct. 26.

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Reactivation of Partially Degraded Tobacco Mosaic Virus

Recent infectivity studies with partially degraded tobacco mosaic virus have led to the inference that the virus particles can remain active after some of the protein has been experimentally removed so as to expose portions of the ribonucleic acid core[1,2]. In one of these studies[2] it was found that, upon heating the virus briefly with a detergent, the infectivity was reduced from that in the original sample by a factor of 4–10; most of the activity then remaining was found to reside in partially degraded virus particles, as judged by the fact that their infectivity could be greatly reduced by digestion with crystalline pancreatic ribonuclease.

While there is as yet no clear understanding of the separate roles of virus protein and ribonucleic acid in the process of infection, it appears that the structural integrity of the ribonucleic acid is essential for activity[2], whereas the protein coat need not be intact. It may then be asked whether the mere removal of part of the protein has any direct effect on infectivity. Such an effect is not necessarily indicated by the partial inactivation occurring in the heat-detergent treatment, since the treatment may disrupt the ribonucleic acid as well as the protein in some of the particles. In order to determine whether part of the heat-detergent inactivation might be directly due to the removal of protein, an attempt has been made to reverse this inactivation by replacing the protein removed in the treatment. That a replacement of protein might be possible was suggested by the work of Fraenkel-Conrat and Williams[3], who showed that the purified protein and

Table 1. EFFECT OF TREATMENT UPON INFECTIVITY OF TOBACCO MOSAIC VIRUS
(Ratio of infectivity of treated to untreated material)

Treatment	Exp. 1	Exp 2	Exp. 3
Heat-detergent treatment	0·06	0·04	0·044 ± 0·004
Heat-detergent treatment followed by reactivation treatment	0·3	0·5	0·29 ± 0·05

ribonucleic acid components of tobacco mosaic virus can be combined *in vitro* to form active virus particles.

The heat-detergent treatment was like that described previously[2], except that the heating period was changed from 6 sec. to 10 sec. In material treated for the longer period, it was found that about 15 per cent of the total ribonucleic acid was so exposed as to be digestible with ribonuclease (in contrast with a possible exposure of less than 5 per cent following the shorter treatment). About 5 per cent of the original infectivity remained, and most of this could be destroyed by ribonuclease digestion.

In the reactivation treatment, a solution containing about 0·01 mgm./ml. heat-detergent treated tobacco mosaic virus and 1 mgm./ml. purified protein of tobacco mosaic virus (prepared by Dr. H. Fraenkel-Conrat[3]) was made 0·01 *M* in acetate by the addition of 3 *M* acetate at *p*H 6. The mixture was then allowed to stand at room temperature for a period of 4–24 hr. before final dilution and assay[2].

Table 1 lists the results of three separate reactivation experiments performed with the same initial preparations of the purified virus and virus protein. The uncertainties of measurement (corresponding roughly to 95 per cent confidence limits) are indicated only for the third experiment, which differed from the others in that the dilutions of the inocula compared had been so adjusted that they produced approximately the same numbers of local lesions on the test plants. In the assays where lesion numbers were not well matched, it was necessary to assume proportionality between lesion number and infectivity over wide ranges in order to estimate the infectivity ratios. Since the accuracy of this assumption is questionable, it would be misleading to give estimates of uncertainty based only on the variations in the results of those assays. A number of additional reactivation experiments were done with different starting preparations of the virus and virus protein While the results were not always in close quantitative agreement with those given here, all were qualitatively consistent in indicating a rise in the infectivity of heat-detergent treated tobacco mosaic virus upon standing in the presence of the purified protein.

The explanation offered for the above results is that the reactivation treatment does replace some or all of the protein removed from the particles in the heat-detergent treatment. A direct demonstration of this reaction by chemical methods was considered impractical because of the relatively small amount of protein which would be involved; however, a number of biological tests have been made in order to check the hypothesis. These tests are described below.

(1) The purified protein alone was found to be non-infectious. and it could not be 'reactivated' by treatment with acetate alone. (Similar results have been previously reported[3].)

(2) The heat-detergent treated virus did not increase in infectivity upon standing in water or in acetate solution alone.

(3) When the heat-detergent treated virus, protein and acetate were mixed at the time of final dilution (that is, immediately before assay) little or no reactivation took place.

(4) The reactivation treatment had little or no effect on the infectivity of intact tobacco mosaic virus.

(5) The heat-detergent treated tobacco mosaic virus could not be reactivated after exposure to ribonuclease. Also, when ribonuclease, protein of tobacco mosaic virus, and acetate were added simultaneously to heat-detergent treated virus, and the mixture allowed to stand, the infectivity was then reduced from that in the initial heat-detergent treated sample. When the addition of the ribonuclease for such a mixture was postponed until 24 hr. after the addition of the protein and acetate, the reactivated sample then showed little or no reduction of infectivity upon standing with the enzyme.

The last result indicates that after the reactivation treatment the ribonucleic acid is no longer exposed to ribonuclease digestion; thus it appears that protein has indeed been added to the particles. However, even though the ribonucleic acid is apparently 'covered', less than half the original infectivity is restored. The experimental results described here do not indicate whether the final deficit from the starting infectivity is due to chemical changes in the ribonucleic acid or to defects in the protein coat (other than 'gaps' large enough to permit attack by ribonuclease). The results do indicate that about one-fourth (and perhaps more) of the inactivation of tobacco mosaic virus in the heat-detergent treatment may be accounted for by the removal of part of its protein.

I am grateful for the advice and assistance of Drs. Robley C. Williams, Heinz Fraenkel-Conrat and C. Arthur Knight.

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Multiplicity Reactivation of Bacteriophage

Luria and Dulbecco[1] formulated the most simple theory that could account for multiplicity reactivation. They supposed that each bacteriophage particle contains a certain fixed number of genetic units; if one or more of these units is damaged by irradiation, the particle will not multiply unless it shares a bacterium with other particles which can supply undamaged versions of the units needed to make a complete set. Therefore the probability that a multiple-infected bacterium (multicomplex) contains a complete set of undamaged units should be simply a function of the number of units in a particle, the proportion of units which have been damaged by irradiation, the number of particles per bacterium (multiplicity), and the distribution of particles among bacteria. Early experiments showed that, within certain limits, this probability (termed 'the survival of multicomplexes') behaved in the expected way when multiplicity and degree of irradiation were varied.

Later, Dulbecco[2] subjected the theory to a stricter test in the range where prolonged irradiation of the particles makes subsequent multiplicity reactivation a very rare event. According to the proposed theory, as the time of irradiation is increased the slope of the curve of survival of multicomplexes against time of irradiation should approach the slope of the curve of survival of single particles. In fact, the decline in survival of multicomplexes was shown to occur much less rapidly. Since no simple process of unit substitution could be more efficient than the proposed one, the recombination theory of multiplicity reactivation was therefore regarded as disproved.

Variation in bacterial size would produce exactly this effect. In an extreme case, the decline in survival of multicomplexes with increasing irradiation would merely represent decline in the number of cells large enough to have collected enough particles to ensure the presence of one complete set of undamaged units. We have therefore recalculated expectations for Dulbecco's experiments, incorporating the frequency distribution of cell-sizes given by Dulbecco in an appendix to the earlier paper. We have assumed that there is a Poisson distribution of bacteriophage particles over the bacterial surfaces, that the bacterial lengths given by Dulbecco can be equated with surface areas, and that there is no loss through lysis-from-without. We have also had to assume that a frequency distribution of cell-sizes, based upon measurement of 764 cells, is adequate for predicting events which have a frequency of 10^{-4} to 10^{-7}.

As shown in Fig. 1, the agreement between observation and recalculated expectation is surprisingly good, considering the uncertainties of the calculation. The observed survival of multicomplexes is now seen to be close to, or rather lower than, expected. Therefore, it seems no longer necessary to seek an alternative to the recombination theory of multiplicity reactivation.

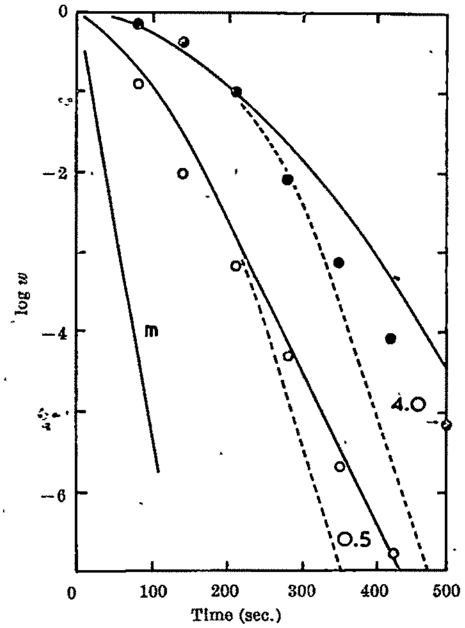

Fig. 1 Effect of increasing irradiation on the survival of multicomplexes. The proportion of surviving multicomplexes (*w*) is plotted against the time of irradiation for the two multiplicities, 0·5 and 4·0 bacteriophage particles per bacterium. Broken lines represent the expected survival as calculated by Dulbecco, assuming a Poisson distribution of particles among bacteria; solid lines are for the recalculated distribution, assuming a Poisson distribution of particles over the bacterial surfaces. Each particle was taken to contain 25 units. The points and the curve for survival of single particles (*m*) are from Dulbecco's paper

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Composition of a Hypertensin Peptide

The isolation of a homogeneous pressor peptide (hypertensin or angiotonin) made by the action of rabbit renin on ox serum was previously reported by me[1]. Further quantitative study on the composition of this pressor peptide has shown the empirical structure to be:

One residue: leucine, phenyl alanine, tyrosine, proline, aspartic acid and arginine.

Two residues: valine and histidine.

This gives a minimum molecular weight of 1,445. The distinction between aspartic acid and asparagine has not yet been made.

Only one N-terminal amino-acid, aspartic, was found, using the dinitrofluorobenzene technique[2], and this was supporting evidence of homogeneity.

The hypertensin peptide recently described by Skeggs, Marsh, Kahn and Shumway[3] differed only by the presence of *iso*leucine in place of one of the two valine residues. This would presumably represent a species difference, since these workers used pig renin and horse serum substrate. The N-terminal amino-acid was not stated, and no further comparison is possible.

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Effect of Antibody on the Respiratory Rate of *Trypanosoma vivax*

The West African N'Dama breed of cattle shows a remarkable tolerance to trypanosomiasis, as was demonstrated by Chandler[1]. In order to investigate the nature of this tolerance, it was necessary to develop a technique which would give a quantitative estimation of antibody titre. Methods employed in the study of bacteriological immunity are not generally applicable to the study of the immune response as it occurs in African trypanosomiases. Tests such as the mouse protection test employed by Fiennes[2] in studying *T. congolense* infections do not readily give a quantitative estimate of antibody titre and are operative only when the trypanosomes survive in the host as a patent or latent infection.

It was noted that the oxygen consumption of two strains of *T. vivax*, one cyclically transmitted and maintained in sheep and the other adapted to rats and passaged by syringe, showed a marked decrease

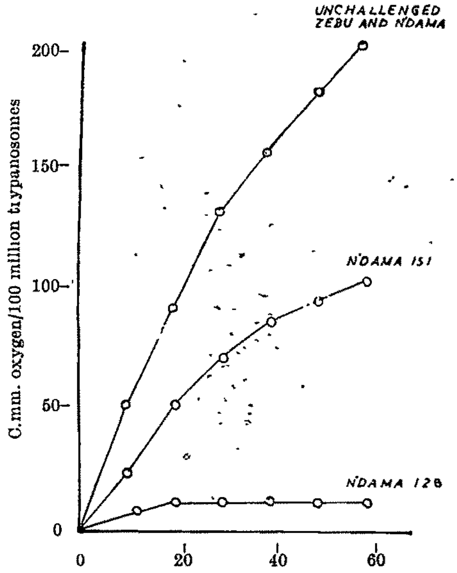

Fig. 1. Effect of N'Dama 128 serum one week after challenge, and N'Dama 151 serum 42 months after challenge, on the oxygen consumption of the rat strain of *T. vivax*

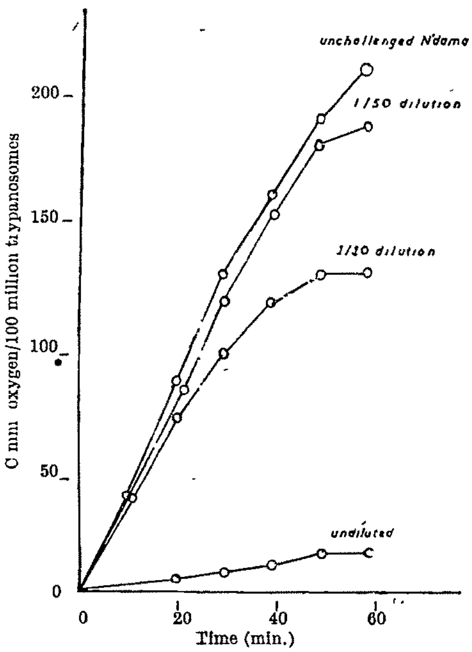

Fig. 2. Oxygen consumption of the rat strain of *T. vivax* suspended in unchallenged N'Dama sera and in various dilutions of N'Dama 128 serum

when suspended in sera of N'Dama cattle previously challenged with this species of trypanosome. It was afterwards found that the rat strain, adapted to this host by a method described by Desowitz and Watson[3], was considerably more sensitive to the action of the sera than the sheep strain. The reduction in oxygen consumption appears to be caused by a species-specific antibody in the N'Dama serum as indicated by accompanying trypanolysis. Furthermore, the degree of inhibition of oxygen consumption seems to be related to the titre of antibody present, since the degree decreases as the period after challenge increases (see Fig. 1). No inhibitory effect occurs with sera from unchallenged Zebu or N'Dama cattle, indicating the absence of any 'natural' antibody possessed by the N'Dama breed.

N'Dama 128 was challenged with the sheep strain of *T. vivax*. A few parasites appeared in the blood three days following challenge, after which no trypanosomes were seen. One week after challenge serum was obtained and was found to effect an almost total suppression of oxygen consumption of the rat strain. Lysis of all trypanosomes was noted after an experimental run of 1 hr. The effect on the respiration-rate of the rat strain of *T. vivax* of various dilutions of N'Dama 128 serum with unchallenged N'Dama serum is shown in Fig. 2.

In December 1952, N'Dama 151 was challenged with a strain of *T. vivax* that had been maintained in Zebu cattle; a low-grade intermittent parasitæmia persisted until August 1953, after which time no parasites were detected in the blood. In June 1955, serum from this animal was found to suppress partially the oxygen consumption of the rat strain of *T. vivax*, indicating that antibody in N'Dama serum may persist for some two years.

All trials were carried out in conventional Warburg respirometers for 1 hr. at 36·5° C.; 2 ml. sera were placed in 20-ml. flasks and trypanosomes added to give a suspension of 30–60 million trypanosomes per cm.[3]. The method is believed to be rapid and simple in giving a quantitative estimation of antibody titre in the immune response to trypanosomiasis. Full details of the comparative immune response of Zebu and N'Dama breeds will be published elsewhere.

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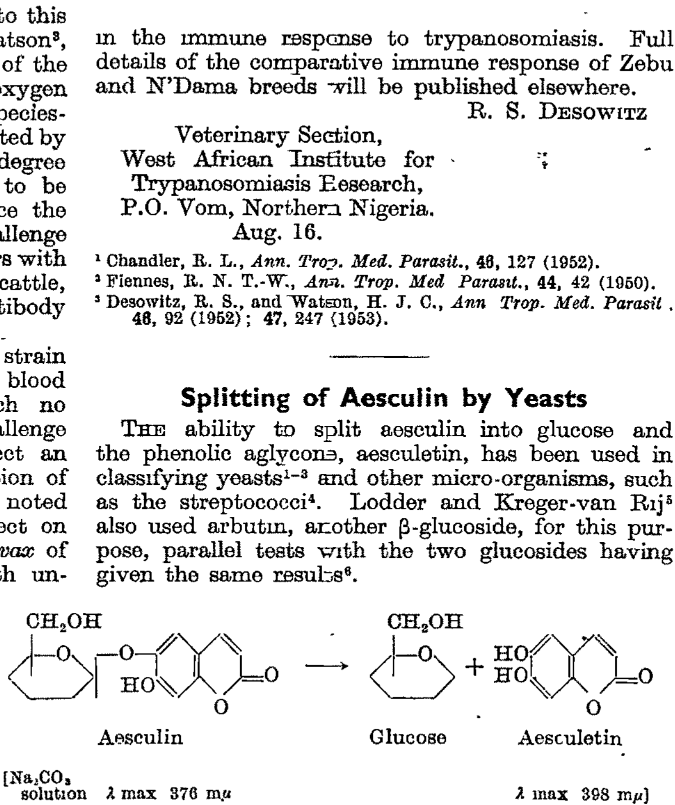
Splitting of Aesculin by Yeasts

The ability to split aesculin into glucose and the phenolic aglycone, aesculetin, has been used in classifying yeasts[1–3] and other micro-organisms, such as the streptococci[4]. Lodder and Kreger-van Rij[5] also used arbutin, another β-glucoside, for this purpose, parallel tests with the two glucosides having given the same results[6].



We find that all yeasts we have tested are capable of splitting aesculin under appropriate conditions of nutrition. Our survey included 115 different strains (Table 1), mainly obtained from the chief national culture collections. Ninety-one of these strains are listed as species which are said not to split arbutin[5] and therefore, *a priori*, were not expected to hydrolyse aesculin[3,6].

Table 1. TYPES OF YEAST USED

Classification (refs. 3, 5)	Number of strains
Saccharomycetaceae	
Saccharomyceteae	
Saccharomyces	87*
Pichia	5
Hansenula	5
Debaryomyces	1
Cryptococcaceae	
Cryptococcoideae	
Cryptococcus	1
Torulopsis	1
Candida	5
Kloeckera	6
Rhodotoruloideae	
Rhodotorula	3
Sporobolomycetaceae	
Sporobolomyces	1

* Includes 11 strains of *Saccharomyces cerevisiae*

The techniques we used differ from those of previous workers[1,2,5], both for growing the yeast cells and for assessing the splitting activity. The yeasts were grown on malt–yeast–glucose–peptone agar[8] in Roux bottles at 25° C. for three days. The growth was washed off the agar surface with 10 ml. of a synthetic medium (*A*2), containing trace elements, vitamins, salts, ammonium sulphate, but no source of carbon[9]. 2 ml. of this suspension was pipetted into a *T*-tube[9] and another 2 ml. of the same medium, containing 0·05 per cent aesculin sterilized by Seitz-filtration, added.

The tubes were shaken[9] for 20 hr., the yeast suspension centrifuged, and the supernatant liquid extracted with ethyl acetate (5 ml.). 3 ml. of the upper layer was shaken with 1·5 *M* sodium carbonate solution (5 ml.) in a separating funnel. The yellow colour in the aqueous phase was due to aesculetin, as shown by its characteristic ultra-violet absorption spectrum ($\lambda_{max.}$ 398 mμ), and in every case contrasted markedly with that of the control. The colour change was measured with a spectrophotometer.

Results were quite different when the yeasts were grown on the *A*2 synthetic medium[9] to which 1 per cent glucose and 2 per cent agar had been added. After growth on this medium, which is less rich than the malt–yeast–glucose–peptone agar, only about half the strains split aesculin measurably. For example, the following seven strains split about 50 per cent or more of the aesculin in 20 hr. when grown on the complex medium, but less than 5 per cent if cultured on the synthetic medium: in each case the cell suspension introduced from the synthetic medium into the aesculin medium was of the same order of size as that from the complex malt–yeast–glucose–peptone agar medium:

Pichia membranaefaciens (CBS 10)
Saccharomyces acidifaciens (CBS 26)
Saccharomyces bisporus (NCYC 171)
Saccharomyces carlsbergensis (NCYC 324)
Saccharomyces cerevisiae (NCYC 176)
Saccharomyces fermentati (CBS 13)
Saccharomyces rouxii (CBS 24)

(NCYC: National Collection of Yeast Cultures.
CBS: Centraalbureau voor Schimmelcultures; the CBS number in each case refers to the Zygosaccharomyces strain in the 1950 catalogue.)

We conclude that the ability to split aesculin is far more widespread among yeasts than has been suspected hitherto. This fact may have been unnoticed so far because (*a*) the yeasts have been grown on nutritionally poor media; (*b*) much smaller inocula have been used; and (*c*) the methods for detecting aesculetin have been relatively insensitive. There has been no mention previously of any one α- or β-glycoside, including disaccharides, which is split by so many kinds of yeast.

We intend to publish a full account of this work later. It was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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A Dielectric Study of the Low-Conductance Surface Membrane in *E. coli*

DIELECTRIC studies have shown that the low electric conductivity of many biological cells originates in an extremely thin layer—apparently of the order of 30 A. thick—located somewhere in the cell envelope, presumably in the cytoplasmic surface structure[1]. This insulating structure is called here the 'low-conductance surface membrane'.

Although it has been repeatedly shown[2] that the conductivity of bacteria is well below that of the suspending medium, it is not yet known whether the conductivity lies in the range of very low values found in other types of cells. Neither is it known whether the control of the conductivity lies in the cell envelope. In order to throw light on these questions, we have examined suspensions of *E. coli* (*B*), taken from a 20-hr. culture in aerated nutrient broth ('Difco') at 37° C.

To obtain significant information on the conductivity of the bacterial cell, it is necessary to work with very dense suspensions. This was done by centrifuging the bacteria into a plastic conductivity cell mounted on a fast centrifuge. Similar observations at lower speeds were reported many years ago by Shearer[2a]. To enable us to take into account[1a] the conductance of the residual medium, its volume was determined by suspending the bacteria in dilute hæmoglobin and measuring the amount of the protein left between the packed cells. The method is still under development; but it is clear that the conductivity of the bacterial cell is quite low, the upper limit set by the present observations (taken at 50 kc./s.) being 10 per cent of that of the suspending sodium chloride or sodium plus calcium chloride medium. (In contrast to Shearer[2a], we found *E. coli* to be quite stable in pure sodium chloride (without calcium), both in terms of conductivity and viability.)

To determine the cause of the low conductivity of the bacteria, their conductivity and dielectric constant were measured over a frequency-range of 50 c./s., to 150 × 10^6 c./s., using three different bridges and conductivity cells[1a,1b,3a,3b]. The effect of

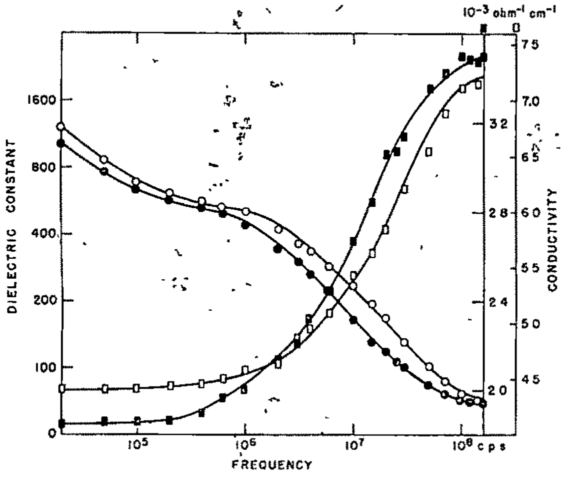

Fig. 1. Dielectric constant (circles) and conductivity (squares) of *E. coli B* in 0·25 per cent sodium chloride (solid symbols) and 0·50 per cent sodium chloride (open symbols). 5 × 10^{11} cells/ml.

electrode polarization in the low-frequency region was eliminated by means of the 'movable electrode' method[1b,4].

The bacterial spectra (Fig. 1) resemble those found in other cells[1]. The strong low-frequency band (only partly shown in the figure) complicates the analysis somewhat. Similar bands have been found in other types of cells[1b,5], but their meaning is still obscure[1b,4a]. The presence of the low-conductance surface membrane is indicated by the high dielectric constant of the cells in the frequency-region above this band, and by the band in the high-frequency region. This band represents the effect of the resistance of those elements of the cell and of the surrounding medium, which electrically are in series with the membrane[1a]. This interpretation is supported by a quantitative analysis of the spectra. This analysis, which is a generalization of one described earlier[6], was applied to a series of experiments with different salt concentrations in the suspending medium (0·07–0·6 per cent sodium chloride). This variable controls the resistance of the elements in series with the membrane and hence the spectral position of the band, which showed the theoretically expected shift toward higher frequencies with increasing salt concentration (Fig. 1). A significant point in this analysis is the great width of the high-frequency band, compared with the Debye form, which is explained by the oblong form and heterogeneity in size of the bacteria.

The analysis leads to the conclusion that the dielectric constant of the membrane becomes constant above 1 or 2 Mc./s. The capacity of the membrane in this frequency-region was calculated as that of a perfect insulator in the manner described before[7]. For this purpose, the membrane was assumed to be located at the geometrical surface of the bacterium, as observed microscopically on wet unstained material. The possible presence of cells with transverse membranes was ignored. The value calculated was 0·7 μF., in satisfactory agreement with values of 0·8–0·9 μF. obtained for other cell species (erythrocyte, leucocyte and yeast) in which it was found possible to establish a constant value of the dielectric constant of the membrane in the high-frequency region[8]. The corresponding value for the ratio of the thickness to the dielectric constant of the bacterial membrane is t_m/ε_m = 13 A., against earlier values[8] of 10–11 A.

We conclude that the *E. coli* organism possesses a low-conductance surface membrane of approximately the same thickness and dielectric constant as those found in the cell species studied previously. The estimate of 30 A. given above for the thickness of the membrane was based on the assumption that its dielectric constant in the high-frequency region studied is not much above its optical value, which may be taken to be 2·3 (corresponding to a refractive index of 1·5).

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Kinetics of Photosynthesis and Photo-inhibition

THE use of our recording micro-volumeter[1] with reaction vessels of 10 μl. volume or larger and irradiated area 5 mm.[2] or more allowed the concentration of quite high light intensities on samples of *Chlorella* cells, the rate of oxygen exchange of which was measured. Kinetic studies were made of the limiting photosynthetic reactions and of the inhibitory effects caused by strong light ('solarization'). Experiments with flashing light of mainly two types were carried out: variation of dark-time (t_d, 10^{-3} – 1 sec.) with a constant time of flash (t_f, 10^{-4} sec. or higher) and variation of time of flash (10^{-4} sec.–1 sec.) with a constant dark-time (5×10^{-2} – 1 sec.). In all cases a sufficiently high light intensity[1] was applied to ensure saturation. We were able to corroborate most of the earlier observations made in this field—which often were apparently inconsistent—and combine the result in a common scheme. A more detailed account of the literature will be given elsewhere.

If very short flashes are alternated with dark periods of increasing length, the yield per flash increases linearly with dark-time during the first few milliseconds. The rate thus observed equals the saturation-rate in continuous light; that is, photosynthesis continues for a while at full rate after removal of the light and the dark reactions act on a substrate of long life formed in the flash.

If the dark-time is further extended, the yield per flash rises more slowly and ultimately approaches a final value. This maximum yield per flash (for $t_f \rightarrow 0$, $t_d \rightarrow \infty$ and $I \rightarrow \infty$) is independent of temperature and has the value observed by Emerson and Arnold[2]. As was first shown by Kohn[3], the relation between yield per flash and intensity (for $t_f \rightarrow 0$, $t_d \rightarrow \infty$) is of exponential (first-order) character.

From this we considered that in a brief flash a stable intermediate is produced photochemically in a 'one-quantum' process. In a single flash one light quantum can be stabilized per 150–400 chlorophyll molecules, assuming that 10 quanta are required per oxygen molecule.

If the time of flash is systematically increased (for $t_d \rightarrow \infty$), the (saturation) yield per flash initially increases strongly above the value observed with the shortest available flash, and the higher the temperature the faster the increase. Ultimately, the yield per flash increases proportionately with time, and this increase corresponds to the photosynthetic saturation-rate, as observed in continuous light at the prevailing temperature; that is, photosynthesis attains its steady-state rate only after the flash has lasted a definite time.

From this we conclude that in 'long' flashes an additional intermediate between light and oxygen is formed in a dark process. This can be regarded as the charging of an enzyme system. In several cases the time-courses observed in both types of flashing-light experiment can be quantitatively described by a reaction sequence, formally similar to that proposed by Briggs[4]:

$$U \xrightarrow{k_1 I} U^* \qquad (1)$$

$$E + U^* \xrightarrow{k_2 U_0} E^* + U \qquad (2)$$

$$E^* \xrightarrow{k_3} E + \varphi\,(O_2) \qquad (3)$$

U represents a complex of 150–400 chlorophyll molecules arranged around a final acceptor to which an absorbed light quantum is conducted. Excitation of this complex by a light quantum yields a stable product (U^*), which is insensitive to light unless restored in reaction (2). Reaction (3) in turn limits the regeneration of E and is in most types of algae the slower step. The concentration of enzyme E ($E_0 = E + E^*$) is of the same order of magnitude as that of the primary product of photolysis ($U_0 = U + U^*$), k_3 = 50–100 sec.$^{-1}$, k_2U_0 = 200–600 sec.$^{-1}$ (at 30° C.).

The above reaction mechanism also describes quantitatively the intensity vs. rate curves as observed in continuous light. A variation of the relative concentrations (E_0/U_0) and time constants (k_3/k_2U_0) involved may account for the variation of the saturation-rate and of the shape of light curves observed in differently pretreated algae.

Additional evidence for the arrangement of pigment molecules in functional units, which are as such involved in the (rate-limiting) photosynthetic dark reactions, was obtained from kinetic studies of photo-inhibition. In very strong light the quantum yield of photosynthesis (φ) decays with a first-order time course, scarcely affected by temperature. This indicates a photochemical inactivation of the pigment system. As soon as the quantum yield is decreased to about half its original value (in some algae even earlier), the saturation-rate in continuous light (R_m) also starts to drop. The time course and the dependence of the decay of both magnitudes on intensity and wave-length are very similar and could in some cases be quantitatively correlated.

We conclude that only one primary solarization reaction occurs, namely, the inactivation of complete pigment complexes. Such a decrease of U_0 will not only lower the quantum yield—since light absorption becomes ineffective—but also the saturation-rate, and this relatively faster the larger the ratio k_3/k_2U_0 in the algae studied. It can be shown from (1)–(3) that the saturation-rate corresponds to:

$$R_m = \frac{k_3E_0}{1 + k_3/k_2U_0}.$$

Photo-inhibition thus resembles the effect of poisons with so-called narcotic action. Conversely, it will be clear that, following the above picture, all poisons which attack U in preference to E will have 'narcotic' effect. This explains simply the narcotic type of action on photosynthesis which was observed with several 'catalyst poisons'. This suggests that acceptor U contains a heavy-metal system.

The influence of the light intensity on the process of photo-inhibition was further analysed. It appears that in general the half-times of decay are inversely proportional to the square of the applied intensity. From this it follows that the coincidence of two light quanta within a brief time interval may be responsible for the inactivation of a pigment complex. The results show that excited units (U^*) are less susceptible to photochemical destruction than non-excited ones (U).

Details of this work will be published elsewhere in greater detail.

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Molecular Weight of Algal Chloroplastin

No recent experimental results are available for the molecular weight of chloroplastin. The available data for chloroplastin have been obtained from leaf extracts (spinach and aspidistra) prepared in a manner similar to that of Smith[1] and calculated from the ultracentrifuge data. Smith[1] and Smith and Pickels[2] found values of the order of 265,000 for chloroplastin; this high estimate is in part due to the contribution of the digitonin micelle. More recently, Takashima[3] made a leaf extract, crystallized a chlorophyll–lipoprotein complex in the cold from α-picolene and determined its molecular weight from diffusion studies to be 19,200. He postulated a complex of two molecules of chlorophyll per molecule of lipoprotein.

Chloroplastin, in the present communication, was prepared from cultures of two algal flagellates,

Table 1. CHLOROPLASTIN (*Euglena gracilis*)

	'Digitonin' extract			'Nacconal' extract		
	(1)	(2)	(3)	(1)	(2)	(3)
w mgm./ml.	29·0	27·3	29·6	44·3	42·5	23·0
w' mgm./ml.	0·37	0·36	0·35	3·1	3·8	0·67
p moles/litre (calculated from equat. 1)	10×10^{-5}	$9·4 \times 10^{-5}$	$10·2 \times 10^{-5}$	$6·4 \times 10^{-4}$	$6·1 \times 10^{-4}$	$3·6 \times 10^{-4}$
p' moles/litre (experimental)	$4·2 \times 10^{-5}$	$6·3 \times 10^{-5}$	$7·7 \times 10^{-5}$	9×10^{-4}	9×10^{-4}	$0·9 \times 10^{-4}$
M^1 gm./mole (ultracentrifuge)	290,000	290,000	290,000	69,400	69,400	69,400
M calculated (from M^1)	43,500	43,500	43,500	10,400	10,400	10,400
M calculated (from nitrogen)	59,000	38,000	30,000	23,000	28,000	50,000

(*Euglena gracilis* and *Poteriochromonas stipitata*). The organisms were concentrated by centrifugation and the centrifuged pellets were ground with sand and 0·9 per cent saline in the cold and recentrifuged twice at 3,000 r.p.m. Each time the pelleted material was discarded. The green supernatant fluid was dried under vacuum. This dried supernatant was extracted either with 2 per cent aqueous digitonin ('Digitonin', $C_{55}H_{90}O_{20}$, non-ionic detergent, *D*-58, Fisher Chemical Co.) or 'Nacconal *NRSF*' (anionic organic detergent–alkyl sulphonate, National Aniline Division, Allied Chemical and Dye Corp.), and these extracts (chloroplastin) were diluted to 1·8 per cent with buffer to *p*H's between 8·0 and 9·2. The pigment concentration, the sedimentation constant, the nitrogen, and the dry weight of the chloroplastin–detergent extracts were determined on freshly prepared material.

The molecular weight of algal chloroplastin was determined by two independent methods. The first was based on the analytical results for the extracted chloroplastin and the second on the geometrical form of the chloroplast, from microscopy.

The molecular weights of the macromolecules may be measured directly by extracting the pigment–macromolecule complex from the chloroplasts by nitrogen-free detergents, 'Digitonin' and 'Nacconal'. The contribution of the macromolecules to the weight of the extracted product may be established by determining the amount of nitrogen in the extract and by employing the assumption that the nitrogen comprised 15 per cent of the protein molecule. If, in addition, it is assumed that each macromolecule is associated with a single pigment molecule, a determination of the pigment concentration permits calculation of the molecular weight of the macromolecule. Alternatively, the molecular weight of the pigment–macromolecule–detergent complex may be determined by analytical ultracentrifugation. From the nitrogen determination, the molecular weight of the pigment–macromolecule may then be calculated directly. The determination of the weight of the complex by analytical ultracentrifugation and the determination of the percentage of nitrogen in the complex provide the best means of determining the molecular weight of the macromolecule.

From the extract, it was possible to obtain: (1) p', the chlorophyll concentration by optical absorption methods; (2) M^1, the molecular weight of the pigment–macromolecule–detergent complex by analytical ultracentrifugation; (3) w, the dried weight of the extract from which the pigment–macromolecule weight could be obtained by subtracting the known contribution of the detergent; and finally (4) w', the nitrogen content of the dried extract. From the analytical data (Table 1) it is also possible to show that one pigment molecule is associated with each macromolecule (lipoprotein; this term is used in preference to lipid layer since it includes the lipids and other macromolecular material as shown by their affinity for osmium tetroxide used in fixation). This is done by demonstrating that the experimentally determined concentration of chlorophyll p' is substantially the same as p calculated from the formula

$$p = \frac{w}{M^1} = \frac{\text{weight of dried residue}}{\text{molecular weight of complex from ultracentrifuge}} \qquad (1)$$

The molecular weight M itself is obtained from the assumption that all the nitrogen is in the lipoprotein molecule and that approximately 15 per cent of the lipoprotein weight is nitrogen.

Studies by electron microscopy of the chloroplasts in fixed algal flagellates[4] and isolated chloroplasts from a variety of plant material[5] have shown that the chloroplasts are composed of lamellæ (disks or plates). The electron micrographs of the chloroplasts permit a determination of the number and the dimensions of these layers.

Using the geometrical data from the electron micrographs of the algal chloroplasts, a knowledge of the chlorophyll concentration, and the assumption that the pigment molecules are arranged in monolayers, an estimation of the molecular weight of the pigment–macromolecule (Table 2)[6] can now be made from:

$$M = \frac{\pi D^2 T s L n}{4N} \qquad (2)$$

where D is the diameter of the photoreceptor, T is the average thickness of the dense (lipoprotein) layer, s is the density of a protein, L is Avogadro's number, N is the pigment concentration expressed in molecules per photoreceptor and n is the number of dense (lipoprotein) layers.

Table 2. STRUCTURAL DATA OF CHLOROPLAST AND CALCULATED MOLECULAR WEIGHTS

Chloroplast	D, chloroplast diameter (μ)	T, thickness of lipoprotein layers (A.)	n, No. of lipoprotein layers per photoreceptor	N, No. of pigment molecules	M, molecular weight chloroplastin
Euglena gracilis	8·27	242	21	$1·02 \times 10^9$	21,000
Poteriochromonas stipitata	4·15	390	10	$1·10 \times 10^8$	37,000

Molecular weights, *Euglena* chloroplastin, calculated from geometrical considerations alone, and from an independent analytical method, are in good agreement. The average value from twelve determinations in 'Digitonin' is 37,000, and from twelve determinations in 'Nacconal' is 29,000; whereas that from the geometry of the chloroplast is 21,000. For chloroplastin from another alga (*Poteriochromonas stipitata*) an average of 37,000 was obtained from the geometry of the chloroplast.

We have applied the same methods to the retinal rods of the frog and cattle eye[6] and obtained values of the order of 60,000 for frog rhodopsin and 40,000 for cattle rhodopsin, which are similar to recently determined experimental values[7].

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Influence of Thyro-parathyroidectomy on the Hæmatological Changes induced by Cortisone in the Rat

The existence of a functional relationship between the adrenal cortex and the thyroid gland has been reported by many workers[1]. In the course of research into the underlying mechanisms responsible for this relationship, the effect of thyro-parathyroidectomy on the blood changes induced by injected cortisone, as indicated by modification of the leucocyte count[2], has been studied.

Twelve female albino rats of the Italico strain of about 250 gm. weight were used for the investigation. Six animals were adrenalectomized and used as controls: the remaining six were thyro-parathyroidectomized and four days later were adrenalectomized. The operations were performed under light ether anæsthesia. Two days later, the animals of each group received a single dose of cortisone acetate (Lepetit) subcutaneously, the dose being calculated on the basis of 2 mgm. per 100 gm. of body-weight. Blood was taken from the tail immediately before the injection of cortisone and thereafter at 3, 24, 48 and 72 hr. The blood films were stained with May–Grunwald–Giemsa's stain.

In the adrenalectomized controls the total leucocyte count showed a slight fall three hours after the cortisone injection, then rose to just above normal and remained at this level from 24 to 72 hr. The mononuclear count showed similar changes. On the other hand, the polymorphonuclear count rose sharply after three hours, then returned to about the normal level after 24 hr.

In the thyro-parathyroidectomized–adrenalectomized rats the total leucocyte count before the cortisone injection was about double that found in the adrenalectomized controls, the mononuclears being increased by about 10,000 and the polymorphonuclears by about 6,500. Three hours after the injection a fall in the total count was recorded and was more marked at 24 hr.; thereafter the total count returned to 'normal' at 48 and 72 hr. after the injection. The mononuclear and polymorphonuclear counts thus showed changes similar to those of the controls, but they were more marked and more prolonged.

The above results show that when adrenalectomy is combined with thyro-parathyroidectomy, the blood changes caused by the injection of cortisone are accentuated and prolonged.

Table 1. Leucocyte Counts in Six Adrenalectomized and Six Thyro-parathyroidectomized–Adrenalectomized Rats after Injection of Cortisone Acetate

No. of leucocytes (thousands per c.mm.)	Adrenalectomized controls					Thyro-parathyroidectomized–adrenalectomized animals				
	Before injection of cortisone	Hours after injection of cortisone				Before injection of cortisone	Hours after injection of cortisone			
		3	24	48	72		3	24	48	72
Total number of leucocytes	16	14	17	17	18	32·5	29	27	32	32
Mononuclear count	15	11*	16	15	17	25	15*	15*	21	22·5
Polymorphonuclear count	1·3	3·3*	1·4	1·2	1	8	14*	12*	11*	9·5*

* Difference from values before injection statistically significant (Student's *t* test; $P < 0{\cdot}05$)

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Plasma Protein as a Precursor of Rat Liver and Hepatoma Protein

While there is little evidence that one protein can be converted into another without complete degradation to amino-acids in the tissues of normal animals (see Askonas *et al.*[1]), there is some evidence that such an interconversion of proteins can occur in tumour tissue. Thus Babson and Winnick[2] showed that the Walker rat-carcinoma incorporated amino-acids from injected plasma protein without complete hydrolysis of the latter to free amino-acids. Recently, Busch and Greene[3] have demonstrated a more rapid uptake of amino-acids derived from plasma protein by implanted tumour tissue than by normal tissue. In these experiments the uptake by the tissues of injected free amino-acids served as a control.

In order to determine whether this phenomenon is a characteristic of tumours, the incorporation of amino-acids derived from injected serum albumin into the proteins of liver and hepatoma has been studied in the rat.

A rat (340 gm.) was injected intraperitoneally with 50 μc. of L-^{14}C-lysine and killed after 6 hr The plasma was fractionated by the method of Campbell and Stone[4] to give a purified preparation of radioactive albumin. A rat (310 gm.) bearing several discrete hepatomas produced by feeding 4-dimethyl-aminoazobenzene was intravenously injected with 150 mgm of the ^{14}C-lysine-albumin (equivalent to 0·4 μc.) in 3 ml. of saline together with 20 μc. of L-^{14}C-alanine (1·0 mgm.). After 95 min., the rat was killed and the liver perfused with saline. The hepatoma tissue was separated from the unaffected lobes of the liver, and saline extracts containing the soluble proteins were prepared from the homogenized tissues.

After precipitation with trichloroacetic acid, the protein was hydrolysed with 5 N hydrochloric acid and the amino-acids were separated by ion-exchange chromatography (Hirs *et al.*[5]). The specific radioactivity of the lysine and alanine from each protein fraction was determined after conversion of the amino-acids to their dinitrophenyl derivatives. The ratio of the specific radioactivity of alanine to lysine from the hepatoma protein was 9·8 and from the liver 10·3.

Since the radioactive lysine in the tissue proteins was derived from plasma protein and the radioactive alanine from the pool of free amino-acids, these results suggest that amino-acids derived from injected serum albumin are not incorporated into the soluble proteins of hepatoma tissue to a greater extent than into those of liver tissue.

In order to make this a firm conclusion, two requirements remain : (*a*) that the size of the pools of alanine and lysine are approximately the same in the two tissues ; (*b*) that the presence of radioactive serum albumin in the tissue extracts does not materially alter the ratio of the radioactivity of alanine to lysine. Determination of the amounts of albumin in the extracts by precipitation with an antiserum for serum albumin[6,7] showed that, in fact, 8·4 per cent of the soluble protein from hepatoma, and 4·0 per cent of that from the liver, consisted of serum albumin. In view of this, experiments designed to provide more conclusive evidence on this point are proceeding.

This study will be extended to include tissues other than liver and hepatoma and plasma proteins other than albumin. We thank Prof. F. Dickens for his interest, and the British Empire Cancer Campaign for a grant to the Middlesex Hospital Medical School which covered the cost of the work.

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Electrical Responses of Certain Lepidopterous Tympanal Organs

Although from a variety of behaviour work[1-3] there must be a strong presumption that the tympanal organs of certain night-flying moths respond to airborne sounds, hitherto no direct physiological evidence on this point has been forthcoming. We have recently been able to record electrical responses in the tympanal nerves of certain moths in response to stimulation by airborne sounds, and these preliminary experiments have revealed certain features of interest in the responses of the organs.

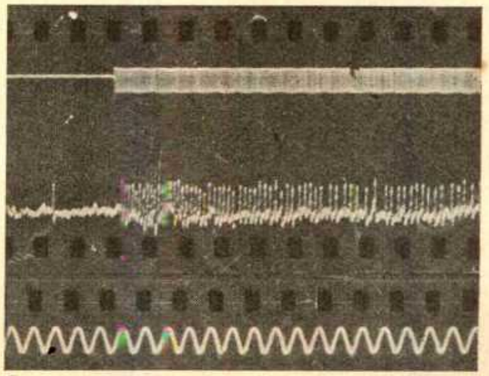

Fig. 1. Response in tympanic nerve of *Arctia* (middle trace) to pure tone stimulus of 3·5 kc./s. (upper trace). Timing wave, 50 c./s. (lower trace)

The insects used were the buff tip moth, *Phalera bucephala* L. (Notodontidae), and the garden tiger moth, *Arctia caja* L. (Arctiidae). The nerve preparations were made by clearing the mesoscutum of scales, cutting a window in the cuticle, dissecting away the overlying tissues to reveal the pterothoracic ganglion and tracing the compound nerve which serves some of the flight muscles and the tympanal organ. The branch serving the latter leaves the main trunk near the wall of the lateral air sacs ; it is thin and susceptible to desiccation, especially when severed from the main nerve, and therefore recording was done by placing two platinum wire electrodes on the nerve *in situ*. Since the nerve serving the tympanal organ is itself a mixed nerve, the records are marked in almost every case by large spikes derived from the motor fibres present.

Recording under conditions of zero stimulation showed that no resting discharge was present ; this is in contrast to other invertebrate hearing organs where, as Pumphrey[4] points out, all those so far investigated show this phenomenon. The moth tympanal organs responded to pure tone stimuli in the range 3–20 kc./s., the limit of the apparatus, and Fig. 1 shows the discharge in the tympanic nerve of *Arctia* to a stimulus of 3·5 kc./s. ; the response is asynchronous and shows no equilibration. Threshold measurements were not taken, but using the human ear as a standard the preparations were much more sensitive to high frequencies of the order of 16–20 kc./s. No apparatus for generating ultrasonic stimuli was available, but the preparations were very sensitive to the squeaks of a bottle top, which contain very high frequencies, and responded to such noises over a distance of 24 ft. Fig. 2 shows the responses in

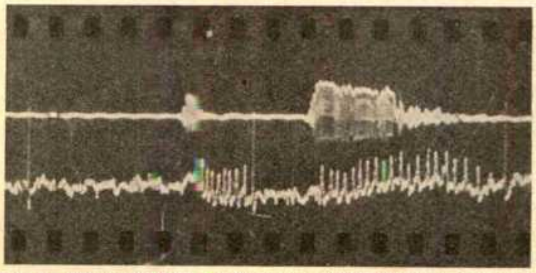

Fig. 2. Response in tympanic nerve of *Phalera* (lower trace) to pulses of high-frequency sound (upper trace). Note after-discharge and recurrent motor spikes in nerve record

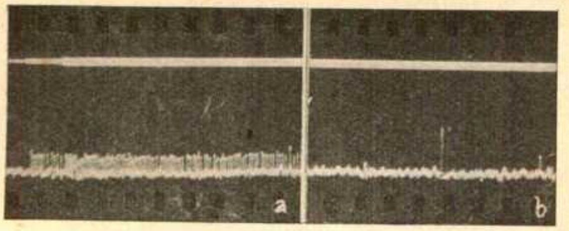

Fig. 3. Responses in tympanic nerve of *Arctia* (lower trace) to pure tone stimulus of 3 kc./s. (upper trace). (*a*) Onset of stimulus and nerve response; (*b*) the same record after 6 sec., showing only one motor spike

the tympanic nerve of *Phalera* obtained with such stimuli. It seems probable that the upper frequency limit of the tympanal organs is very high, extending well into the ultrasonic range, as in some Orthoptera.

One of the most interesting features of the responses of these organs was the adaptation shown to a constant stimulus, consisting of the reduction in frequency of the discharge from an initial high rate (Fig. 3*a*) to zero when the stimulus was maintained for 6 sec. or longer (Fig. 3*b*). That this was true adaptation and not fatigue was shown by the fact that a change in the intensity of the stimulus produced an increased discharge in the nerve. Such adaptation has not been found in any other invertebrate hearing organs so far investigated; it explains some of the observations of previous workers[3] that Noctuid moths remain unaffected by loud, continuous noises.

Response to high-frequency sounds of short duration also showed pronounced after-discharge (Fig. 2). The duration of the after-discharge was such as to make it probable that the appearance of volleys of spikes synchronous with the pulse or modulation frequency of the stimulating sound would only occur at modulation frequencies up to 45 c./s., a much lower figure than that obtaining in Orthoptera[5] or in Homoptera[6]. If the frequency of modulation exceeds this figure, the discharge first becomes continuous, and then ceases through adaptation, provided the stimulus continues long enough.

These preliminary findings suggest that the tympanal organ in these moths will respond to short pulses of high-frequency sound repeated at rates up to 45 c./s. with a volley of spikes for each pulse, but that continuous noise or sounds consisting of rapidly repeated pulses will produce adaptation and ultimately cessation of the discharge. This suggestion may be considered against the background of two hypotheses on moth behaviour in relation to auditory stimuli. Hinton[7] has proposed that night-flying moths may make use of echo-location to avoid obstacles, in the same manner as bats; the characteristics of the hearing organs as outlined above are very suitable for such a mechanism, but it has yet to be demonstrated that moths emit ultrasonic pulses. The second hypothesis, apparently first advanced by Richter[8] in 1909, is that night-flying moths avoid their typical predators (owls and bats) by taking flight in response to high-pitched sounds of short duration—characteristics of the cries of these animals. The little observation of behaviour that exists seems to support this latter view; Schaller and Timm[2] have shown that certain night-flying moths take flight or feign death on exposure to ultrasonic frequencies between 40 and 80 kc./s., and point out that this range includes those frequencies found in the cries emitted by bats. The present findings suggest a basis for further work in this connexion that might be more rewarding.

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Chromosomes of Five Rodent Species

SATISFACTORY cytogenetic studies with existing laboratory mammals are at present virtually impossible owing to the large number and small size of their chromosomes. A small eutherian which could be bred in the laboratory and which had few, relatively large, chromosomes would be invaluable. Matthey's[1] recent count of $2n = 17$ in the fossorial vole, *Ellobius lutescens*, and the earlier report of $2n = 14$ in the South African insectivore *Elephantulus myurus*[2] (which, however, is questioned by Matthey[3]) encourage the hope that a suitable species may yet be found. Only about 120 rodent species, representing forty-nine of the 345 genera listed by Ellerman[4], have been studied cytologically. We have therefore examined the chromosomes of five African species which we have been able to obtain from laboratories in Great Britain.

Young males were used where possible. All animals were given an intraperitoneal colchicine injection (0·6–1·0 ml. of 0·1 per cent or 0·05 per cent aqueous solution) two hours before killing. The testes were cut up and put into distilled water or hypotonic saline for 5–30 min. before fixing in acetic-alcohol (1 : 3) for two hours, hydrolysing in *N* hydrochloric acid at 60° C. for 6–12 min., and staining in the Feulgen reagent. Squashes of short pieces of tubule

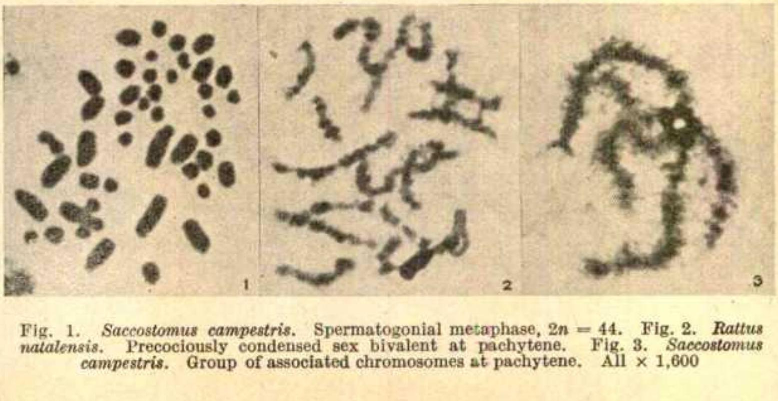

Fig. 1. *Saccostomus campestris*. Spermatogonial metaphase, $2n = 44$. Fig. 2. ***Rattus natalensis***. Precociously condensed sex bivalent at pachytene. Fig. 3. *Saccostomus campestris*. Group of associated chromosomes at pachytene. All × 1,600

Table 1

Species	No. of animals	Chromosome No. n	Chromosome No. $2n$	Range of chromosome length
Rattus (*Mastomys*) *natalensis*, A. Smith	2	18	36	$2\cdot2\,\mu$–$9\cdot0\,\mu$
Mystromys albicaudatus, A. Smith	1	16	32	$1\cdot1\,\mu$–$4\cdot7\,\mu$
Meriones lybicus, Lichtenstein	3	22	44	$1\cdot3\,\mu$–$4\cdot0\,\mu$
Lemniscomys barbarus, L.	2	27	54	$0\cdot7\,\mu$–$2\cdot8\,\mu$
Saccostomus campestris, Peters	1	22	44	$1\cdot0\,\mu$–$4\cdot0\,\mu$

were made, sometimes after additional staining in aceto-carmine or aceto-orcein. Skins and skulls of the animals killed were submitted to Mr. R. W. Hayman, of the British Museum (Natural History), who kindly checked their identity.

Counts obtained at diakinesis or metaphase in primary spermatocytes, and at spermatogonial metaphase, are given in Table 1. Measurements made of the shortest and longest chromosomes in well-spread spermatogonial metaphases, one from each species, are also entered in the table. They are intended to give a rough estimate only of size and range of variation, and in any event are likely to be somewhat less than normal owing to the action of the colchicine. The numbers given for the first four species confirm counts obtained by Matthey[5,6] in papers which reached us after the work had been completed. The chromosomes of *Saccostomus campestris* (Fig. 1) have not been examined previously, so far as we know.

Although the main object was to determine chromosome number and size, two additional observations are worth recording. The presence of a prominent unpaired interstitial loop in the precociously condensed sex bivalent of *R. natalensis* at pachytene (Fig. 2) strongly suggests the presence of an intercalary differential segment such as Koller[7] has inferred to be present in the sex chromosomes of the cat. In *S. campestris* prominent darkly staining regions in the pachytene chromosomes regularly fuse together (Fig. 3), sometimes into more than one group, the arms radiating outwards like the spokes of a wheel and calling to mind the chromocentre and attached chromosome arms in the salivary gland nuclei of *Drosophila melanogaster*.

Chromosome counts on mammals can now be obtained quickly and accurately; the techniques are simple, and it is part of the purpose of this communication to encourage others to use them. Meanwhile we would be glad to examine the chromosomes of other, cytologically unknown, rodents or insectivores if material is sent to us. Although we are primarily concerned with finding a mammal with low chromosome number for experimental purposes, chromosome counts themselves may help to reveal biological situations of wider interest. For example, the recent counts made by Wahrman and Zahavi[8] indicate that the taxonomic species *Gerbillus pyramidum* in the Mediterranean area is a complex of several distinct chromosome races.

We are indebted to Mr. M. K. Totton, of the London School of Hygiene and Tropical Medicine Field Station, St. Albans, for *Rattus natalensis* and *Mystromys albicaudata*; to Dr. F. J. Aumonier, of St. Bartholomew's Hospital Medical School, for *Meriones lybicus*; and to Mr. O. G. Jones and the Zoological Society of London for *Saccostomus campestris* and *Lemniscomys barbarus*.

Note added in proof. We find $n = 15$, $2n = 30$, in testis material of *Elephantulus myurus* fixed in South Africa and sent to us through the kindness of Prof. B. I. Balinsky.

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Cytoplasmic Inheritance in *Culex*

From an analysis of non-reciprocal fertility in *Aëdes scutellaris*, Smith-White and Woodhill[1] drew the conclusion that this phenomenon must be due either to anomalous meiosis in the course of oogenesis, with polarized segregation of bivalents and the elimination of part of the paternal genom, or to cytoplasmic factors acting independently of the nucleus. They state that "There is no critical evidence enabling a choice between the two types of hypothesis". Crossing relations in *Aëdes scutellaris*, as studied by Smith-White and Woodhill, are essentially similar to the more complex relations encountered in the *Culex pipiens* complex[2]. Some geographically representative populations are fully fertile in both directions, whereas others, although morphologically indistinguishable, are almost completely isolated by intersterility. In this case the limitations of a purely morphological species concept are obvious. A third group of populations is interfertile with the others in one direction only. Parthenogenesis, with pseudogamy, predetermination and multiple incompatibility genes can be excluded as causative mechanisms. These cases of strictly maternal inheritance can be explained only by the two hypotheses mentioned by Smith-White and Woodhill.

Further evidence is now available which may make possible a choice between the two hypotheses. Mutations induced by X-rays have been produced in *Culex pipiens*, and the mutant genes have been introduced into other populations with the view of studying their mode of inheritance. A description of some of these mutations is given elsewhere[3]. They are mostly clear-cut morphological characters affecting the antennæ, palps and wing venation. Four of them, at least, can be used to mark the two autosomes and the male and female sex chromosomes respectively. All of them segregate in clear-cut Mendelian ratios. There is no indication of polarized segregation (Table 1). Similar ratios are obtained on out-crossing to other populations. Thus the ratio obtained from the cross $+/+ \times Rap/+$, using the strains *O* (southern Germany) and *Alg* (Algiers), which can cross only in the direction ♀ *Alg* × ♂ *O*, is 147 : 143, = 1 : 1. Using the same strains, the cross $+/kps \times +/kps$ gives the ratio 253 : 81, which is 3 123 : 1. It will be seen that, in *Culex*, there is no evidence of abnormal behaviour of the chromosomes at meiosis and only the cytoplasmic hypothesis therefore remains.

An experiment now running in the forty-fourth back-cross generation seems to make possible a

Table 1. Mutations in *Culex pipiens*

Gene	Location	Status	Cross	Segregation in next generation	Ratio
kps	Autosomal (I)	Recessive	+/+ × *kps*/*kps*	All phenotypically normal	—
			+/*kps* × +/*kps*	178 normal : 56 *kps*	3·178 : 1
*Rap**	Autosomal (II)	Dominant	+/+ × *Rap*/+	331 normal : 332 *Rap*	1 : 1
var	Sex-linked with ♀	Recessive	+*M*/var. *m* × var. *m*/var. *m*†	All ♂♂ normal, all ♀♀ var.	—
Kpu	Sex-linked with ♂	Dominant	*Kpu M*/+*m* × +*m*/+*m*	All ♂♂ *Kpu*, all ♀♀ normal	—

* Homozygous lethal.
† *M* = ♂ sex-determining factor; *m* = ♀ sex-determining factor (ref. 4).

further distinction. Cytoplasmic inheritance may be independent of the nucleus with autonomous plasmagenes, or it may depend on nuclear cytoplasm-conditioning genes. Assuming normal meiosis, repeated incrossing of a foreign genom *B* into a given strain *A* can be made to result in replacement of genom *A* by genom *B*. A character independent of the nucleus of strain *A*, controlled by the cytoplasm, will not be affected by this change of genom. This is precisely the case in a long-running crossing experiment with strains *H* (northern Germany) and *O* (southern Germany). In every generation the hybrid (*H* × *O*) female was back-crossed to *O* males. After forty-four serial back-crosses of this kind, it may be presumed that the original genom *H* will have changed wholly or largely to *O*. Nevertheless, the mating type of the hybrid shows no change, that is, the hybrid males remain intersterile with *O* females, as in the original strain *H*.

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Influence of Temperature on the Histological Evolution of the Ovotestis of *Cepea nemoralis* L.

THE conditions which determine the differentiation of indifferent gonocytes in hermaphrodite glands, either in the male or the female direction, constitute a major problem in the biology of sexuality. Ancel[1] showed in 1902 that in the ovotestis of pulmonates the differentiation of germinal cells was independent of the gonocytes, but depended on the appearance of nutritive cells. Ancel remarks: "Une cellule progerminative indifférente deviendra mâle ou femelle suivant les conditions qu'elle rencontre dans la glande génitale au moment de son apparition, conditions réglées par la transformation d'un certain nombre de cellules épithéliales en éléments nourriciers élaborateurs d'un matériel spécial". But experiments with undifferentiated strains of *Rana fusca* and *Rana sylvatica* (Witshi, Piquet[2,3]) have indicated that several factors, and more especially temperature, can condition gametogenesis.

Witshi and Piquet have pointed out that at an elevated temperature (30° C.) one obtains only males. Some are genotypically males, the others are inverted females. The female differentiating agent situated in the cortical part of the gland regresses whereas the medulla develops. The male differentiating agent then becomes preponderant. At low temperatures the opposite happens. The differentiation of gonocytes towards oogenesis or spermatogenesis appears here as a result of conditions prevailing outside the gonocytes, in this case in the cortex or medulla of the gonad.

It seemed interesting to me to follow the evolution of the ovotestis of Pulmonata at different temperatures. This work was carried out in the Zoology Laboratory of the University of Brussels, under the direction of Prof. P. Brien, to whom I am greatly indebted.

My observations were made on the snail *Cepea nemoralis* L. Four groups of animals were set up. The first three were kept at temperatures of 0°, 6° and 23° C., respectively.

The animals of the fourth group were reared in conditions approaching as nearly as possible those prevailing in hibernating animals; they were used as controls. For this group the average monthly temperature was established throughout the experiment as follows: November, 7·0°; December, 2·8°; January, 1·7°; February, 1·3°; March, 6·8°; April, 13·5°; May, 19·0° C.

At regular intervals during a period of seven months, the ovotestis was taken from a number of animals of each series and a study was made of their histology. A summary of the results follows.

(1) Low temperatures of approximately 0° C. inhibit all gametogenesis—both oogenesis and spermatogenesis.

(2) At a slightly higher temperature, 6° C., the development of male germinal cells is inhibited. In the meantime, oogenesis begins and proceeds at a higher rate than in the corresponding controls. The observations did not cover sufficient time to allow me to conclude whether spermatogenesis was definitely inhibited, or whether it was only slowed down.

(3) Controls influenced by seasonal environmental variations showed all aspects of gonad evolution, namely: (*a*) a period of no sexual development corresponding to the first months of hibernation (October to February); (*b*) oogenesis (March to April) including formation of oocytes (a fact already noted by Laviolette[4] in *Arion rufus*), which slowly increase in size; (*c*) spermatogenesis (April to May); this being much faster than oogenesis, the sperm will be ripe before the oocytes, the animal acting first as male then as female.

(4) A higher temperature (23° C.) promotes and maintains spermatogenesis, but without completely inhibiting oogenesis: a few oocytes differentiate but maturation does not follow.

It is concluded that temperature has an effect on sexual differentiation in the Pulmonata. A low temperature is more favourable to development of primary gonocytes in the female direction; and a high temperature promotes development in the male direction.

These results are similar to those obtained by Witshi on frogs; but in the case of the Pulmonata, hermaphrodite animals having a germinal epithelium ensuring simultaneously the elements of male and female germ cells, it remains to be shown at what level external factors such as temperature can act to influence sexual differentiation in one direction or the other.

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Photostimulation of an Equatorial Bird (*Quelea quelea*, Linnæus)

Few data are available concerning the environmental factors involved in the 'timing' of the reproductive cycles of equatorial birds. The annual fluctuation of day-length on the equator is only about two minutes. Wolfson[1,2], considers it possible that "summation of daylengths or the daily dose of light", rather than increasing day-lengths as such, might be the critical environmental factor in determining the periods of migration and breeding of equatorial, as well as other, species.

Attempts to photostimulate tropical birds have been rare, and the results confusing. Scott and Payne[3] exposed guinea-fowl to additional illumination in the United States and ascribed the lack of response in this species to its tropical origin. On the other hand, Brown and Rollo[4] and Rollo and Domm[5] showed that the cycles of a variety of tropical whydahs and weavers (purchased in California) were modifiable by photoperiodicity.

Quelea quelea (Sudan Dioch), the weaver-bird used in the present experiment, ranges transequatorially over a vast area of the drier regions of Africa. In Tanganyika it nests colonially after rainfall. It is strongly nomadic and so an East African flock, sometimes several millions strong, may cross and re-cross the equator in search of food, and thus be temporarily exposed to either a minute increase, or decrease, in day-length according to its wanderings and the period of the year.

The present birds were trapped at about latitude 3·22° S. and were habituated to the aviary for more than a year, when the males were moulting out of the vivid breeding plumage into eclipse, and becoming indistinguishable from the dull-coloured females.

The normal breeding season in northern Tanganyika is in May or June provided that rain has fallen and conditions are favourable for nesting. At this period, day-length is diminishing at a rate of only seconds per day in the area in which our birds were collected. In other areas within a few hundred miles, reproduction occurs when days are slowly increasing in duration. Our experiment was begun on July 23 (day-length approximately 11 hr. 57 min.) at about the estimated end of the post-nuptial refractory period and before the next season's spermatogenesis began.

Forty-four individuals in or near eclipse plumage were divided into two groups of seventeen, and one of ten. These were placed in three almost identical cages with a diet of wheat, weed-seeds and water. The cages were of approximately 12 cu. ft. capacity; experience has shown that *Q. quelea*, accustomed to congregating in hundreds within a few feet, thrives in close confinement. The experiment was ended on September 17 (day-length approximately 12 hr. 5 min.) after being conducted as follows.

Cage 1. Ten control birds, under normal day-length.

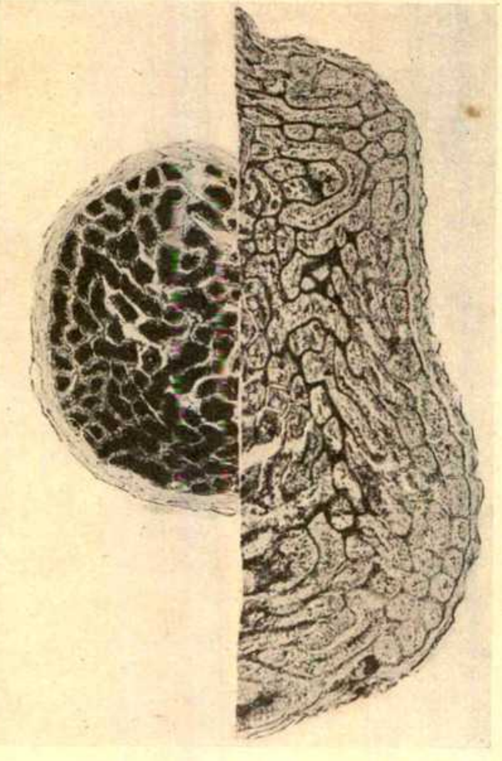
Cage 2. Seventeen experimental birds illuminated by a single 100-watt bulb 5 ft. from cage for five minutes daily at dusk (about 7 p.m.).

Cage 3. Seventeen experimental birds similarly illuminated from about 7 p.m. to midnight and receiving, therefore, an additional five hours light, making a total of more than seventeen hours of daily illumination. (These usually, however, appeared to be asleep by 10 p.m.)

The results were as follows.

Cage 1. (Controls, which were found to be five males and five females.) Each male had testes measuring 1 mm. × 1 mm. in diameter. In all birds the seminiferous tubules were still in a state of post-nuptial lipophanerosis in varying degree. The interstitium remained in a meagrely lipoidal condition[6] (Fig. 1*A*). The tubules in each case were 35μ in diameter, measured in the wax-embedded section. Each of the five females had oocytes invisible or only just visible to the naked eye.

Cage 2. (Plus 5 min. daily. The birds were found to be five males and thirteen females.) Each male had testes measuring 1 mm. × 1 mm. in diameter (similar to those of the controls) except one in which the dimensions were 2 mm. × 1 mm. and 1·5 mm. × 1·5 mm. In the tubules of each organ there



(*A*) (*B*)

Fig. 1. Photostimulation of *Quelea quelea* showing changes in size and internal arrangement of testes. *A*, Testis appearance in control birds and those subjected to five minutes additional day-length over a period of fifty-five days. The seminiferous tubules are still in the post-nuptial lipoidal condition (indicated by black material) and the interstitium remains undeveloped. *B*, Testis appearance of birds subjected to an additional day-length of five hours for fifty-five days. A lipoidal interstitium has developed (indicated by black material) and the tubules have cleared. (Formal-calcium fixation, sudan-black coloration at 7μ. × 53)

remained uncleared post-nuptial lipids (as in Fig. 1*A*), although only faint traces remained in the slightly enlarged tubules of the exceptional organ. The tubules of the smaller testes were of similar diameter to those of the controls. Those of the largest testes measured nearly 45μ in diameter, the increased dimensions being caused by a slight proliferation of spermatogonia. The interstitium was in each case similar to that of the control birds. Each of the thirteen females had ovaries in the same condition as those of the control group.

Cage 3. (Plus 5 hr. daily. The birds were found to be six males, ten females and one intersex.) Each normal male had testes enlarged to between 2 mm. × 1·5 mm. and 2·9 mm. × 2·3 mm. except one in which they were 1 mm. × 1 mm. in diameter. In all enlarged organs the increase in size was due to the production of several rows of spermatogonia resulting in tubule expansion up to 50μ. Post-nuptial lipids had been cleared (Fig. 1*B*). In the exceptionally sized organs the tubule diameter was only 35μ; but the tubules were almost clear of lipids. In all cases the Leydig cell cytoplasm of the interstitium had become sprinkled with lipid droplets. Each of the ten females had ovaries in the same condition as those of the two former groups.

The above results show that near the end of their post-nuptial testis metamorphosis, the males of this equatorial weaver-finch are susceptible to photostimulation making up a total daily illumination of about seventeen hours—a period not naturally experienced within its geographical range. Not unexpectedly, the females remained apparently uninfluenced (see also Whetham[7]).

The results give no support to Wolfson's "summation hypothesis". The birds which received an additional five minutes of light per day showed no significant gonad modification even though they received an additional grand total of 275 minutes, made up of five-minute increments over a period of fifty-five days. The normal annual variation of daylight at latitude 3·22° S. (at which these birds bred) is only about ten minutes. We subjected our + 5 min. experimental birds to artificial 'summation' equalling that which would be normally received over a period of more than twenty-seven years. There was no appreciable result.

Further experiments with *Q. quelea* of different ages, involving various light increments at different periods of the sexual cycle, are being undertaken. We believe, however, that it is the environmental conditions arising after rainfall, operating in conjunction with the internal sexual rhythm[6,8], that constitute the critical factors regulating the time of reproduction.

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Yield Stress of Clay-Water Systems

I HAVE shown elsewhere[1] that the variation of specific viscosity (η_{sp}) with solid content (c) for concentrated sodium montmorillonite sols follows the Schultz–Blatschke relation[2] for systems of anisometric particles:

$$\eta_{sp} = [\eta]c + k'[\eta]^2c^2 + k'[\eta]^3c^3 \qquad (1)$$

$[\eta]$, the 'intrinsic viscosity', depends on the dissymmetry (p) of the dispersed and solvated clay platelets; while k' represents the particle–particle interaction at unit dissymmetry. At any sol concentration, $\bar{\eta}_{sp} = \eta_{sp} - c[\eta]$ will thus measure the contribution of this latter factor to the specific viscosity.

The precise interpretation of 'yield value' or 'yield stress' in clay sols is still a subject for speculation; but most theories approximate to the view that this property defines the shearing stress, at which the internal attractive forces between the dispersed particles have been overcome, and laminar flow prevails. One may thus expect the optimum yield stress (S) of a clay–water system to depend on some simple function of the particle interaction as expressed by $\bar{\eta}_{sp}$, and

$$S \text{ should equal } f(\bar{\eta}_{sp}) \qquad (2)$$

I have investigated the rheological properties of sols prepared from American, English and Mediterranean sodium and sodium–calcium montmorillonites, and kaolinites, under different experimental conditions; and have plotted the yield stress in terms of the property $\bar{\eta}_{sp}$. The Stormer viscometer has proved to be a satisfactory instrument for measuring both the optimum yield stress and the specific viscosity at low shear (corrected for the initial yield stress) over a wide range of conditions. Some typical results from these investigations are presented in this communication.

The variation of yield stress with particle interaction in any particular system is determined by the state of peptization or coagulation of the clay micelles. Sodium montmorillonite sols, when prepared in distilled water, exhibit the phenomenon of 'heterocoagulation' (that is, positively charged edges are orientated perpendicular to the negative faces of the clay platelets); and the results for sols prepared from a series of such clays of similar B.E.C. (80–90 m.equiv./100 gm.) but of different particle shape are presented in Fig. 1. (The ultimate particle size as determined by sedimentation techniques is in all cases of the order of 0·1 micron.)

At $\bar{\eta}_{sp} \ll c[\eta]$, the yield stress is negligible, even after standing for 72 hr. With increasing $\bar{\eta}_{sp}$, S rises rapidly and the following relation has been observed over a wide range of sol concentration and particle dissymmetry:

$$S = g\bar{\eta}_{sp}^2 \qquad (3)$$

The values of g increase in the order: clay D (Cyprus sodium montmorillonite) < clay C (English sodium montmorillonite) < clay F (North African sodium montmorillonite) < Wyoming bentonite; while Wyoming bentonite > hectorite. The first three were prepared from the corresponding natural calcium clays by interaction with sodium carbonate[1].

These values of g are related to the shape of the dispersed clay particle as demonstrated by their electron micrographs[3]. The strongest gels at a

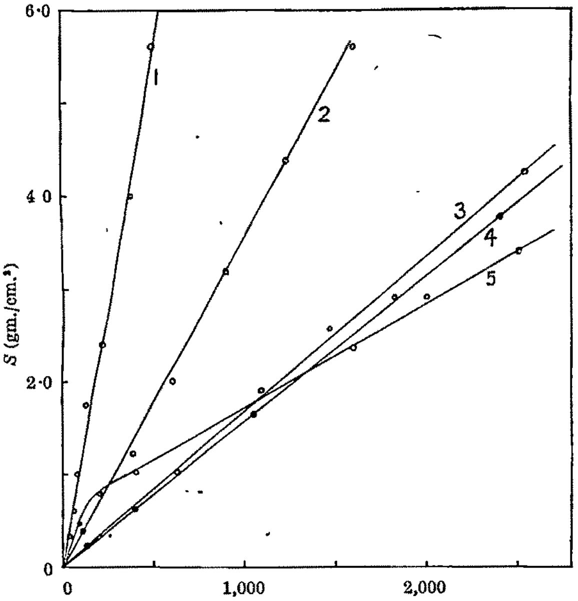

Fig. 1. Yield stress of sodium montmorillonite sols. Variation of $\bar{\eta}_{sp}$ with solids content (20° C.; pH 8·5): (1) Wyoming bentonite (ref. 3*a*); (2) clay *F* (ref. 3*d*); (3) clay *C* (ref. 3*c*); (4) clay *D* (ref. 3*c*); (5) hectorite (ref. 3*b*)

particular value of $c[\eta]$ are obtained with systems of large platelets, while needles and 'fluffy' platelets lead to weaker structures.

Heterocoagulation may be eliminated by heat treatment or by addition of certain anions that are strongly adsorbed on the positively charged edges of the clay platelets[4]. Addition of electrolytes such as sodium, calcium or aluminium chlorides to pre-solvated sodium montmorillonite sols, on the other hand, leads to rapid coagulation beyond some specific minimum electrolyte concentration, and results in a change-over from the 'house of cards' structure to an edge-to-edge association of clay platelets. The specific viscosity is reduced in the former systems, due to fall in the value of $[\eta]$; but the enhanced dissymmetry that results in the latter system leads to a marked overall rise in both specific viscosity and yield-strength.

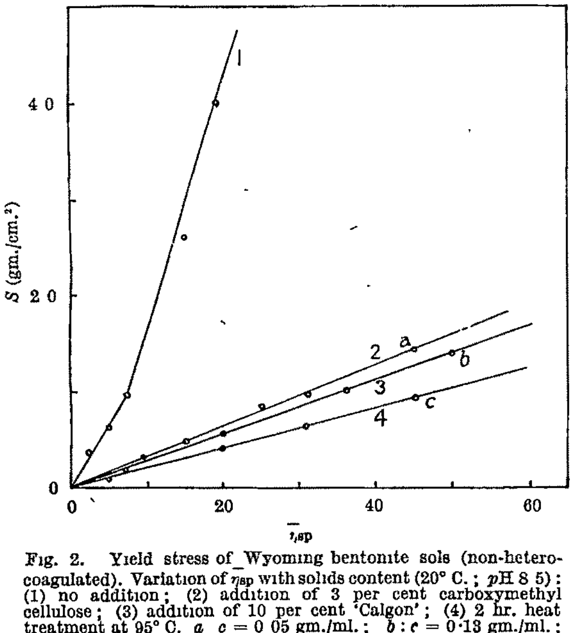

Fig. 2. Yield stress of Wyoming bentonite sols (non-heterocoagulated). Variation of $\bar{\eta}_{sp}$ with solids content (20° C.; pH 8 5): (1) no addition; (2) addition of 3 per cent carboxymethyl cellulose; (3) addition of 10 per cent 'Calgon'; (4) 2 hr. heat treatment at 95° C. *a* $c = 0$ 05 gm./ml.; *b*: $c = 0·13$ gm./ml.; *c*. $c = 0·03$ gm./ml.

In all such systems, S varies directly as $\bar{\eta}_{sp}$ over a wide range of conditions ($c = 0$–$0·16$ gm. per ml.; $\bar{\eta}_{sp} = 0$–60; $[\eta] = 10$–500); and (see Fig. 2)

$$S = g'\bar{\eta}_{sp} \qquad (4)$$

Similar results have been obtained with suspensions of the non-swelling calcium montmorillonites and kaolins.

g' increases in the same order as the constant g for heterocoagulated systems.

The experimental data clearly demonstrate that the yield stress of clay systems in which the internal attraction is mainly determined by short-range van der Waals forces varies directly as $\bar{\eta}_{sp}$ over a wide range of conditions. From equations (1) and (4) it is seen that at $C > 0·02$ gm./c.c.,

$$S = g'k'c^2[\eta]^2 \qquad (5)$$

According to Simha[5], $[\eta]$ varies approximately as p^2 (where p is the anisometry); while in the more concentrated sols, C will vary inversely as the particle separation ($\bar{d}$); and (5) may be written in the form

$$S = g'k'[p^2/\bar{d}]^2$$

For a particular value of p, the shape factor (g') is greatest for plates, and increases in the order plates > needles > spheroids. Such a relation for the internal attraction in systems of anisometric particles had indeed be derived theoretically in a recent work by Vold[6].

The factors affecting the yield stress in heterocoagulated systems will be discussed fully elsewhere.

This communication is based on work carried out in the Clay Development Laboratory, F. W. Beck and Co., Ltd., to which thanks are due for permission to publish it.

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Carioazulene, Natural and Synthetic, derived from Caryophillene

IN the fractionation of hydrocarbons found in Copaiba balsam, we have isolated, from a bluish fraction, at a boiling point of 130°–136° C., under 0·2 mm. pressure, a compound with the typical reactions of azulenes, and which we propose to call 'carioazulene'. In an attempt to establish if its formation results from dehydrogenation of caryophillene, we submitted the remaining isolated fractions, consisting of caryophillene, to a dehydrogenation process using, respectively, selenium, sulphur and palladium under pressure, in an autoclave.

It was found that all caryophillene fractions resulted in the formation of azulene, the most convenient method being that in which a palladium–carbon catalyst (containing 11·36 per cent palladium) in the proportion of 4·7 catalyst to 100 caryophillene is used. Carioazulene may also be obtained using sulphur as a dehydrogenizer, the best proportion being 10 sulphur to 100 caryophillene. In both processes, temperature was increased to 280°–300° C. for a period of 40 min., while the internal pressure of the autoclave gradually increased to 20–25 atmospheres, due to release of gas. The proportions of palladium and sulphur mentioned give the best results ; if they are used in larger quantities, a polymer is produced. Of the two, the palladium – carbon catalyst furnishes the purer product.

At atmospheric pressure, selenium on asbestos heated to a temperature of 200° C., can be used. The results, as regards efficiency and purity, are much less satisfactory than those obtained with palladium – carbon or sulphur.

The caryophillene that fails to react, once the azulene has been extracted, can be used in new dehydrogenations and, when a palladium – carbon catalyst is used, the same portion may be employed again, always keeping the fixed proportion between catalyst and caryophillene. It is consequently preferable to proceed to successive operations using the same oil from which, by means of vacuum distillation, the resulting azulene is removed. Carioazulene concentrated fractions are purified in the usual manner, by means of acid treatments, by the formation of trinitrobenzenic derivatives and by passage through alumina columns.

Melting point of trinitrobenzoate (Kofler): 145°–147° C.
Trinitrobenzoate crystals: long reddish-purple needles.

These experiments are of special interest, because azulenes derived from natural products described until now possess the fundamental structure of *cyclo*pentano-*cyclo*heptane, whereas the carioazulene we have obtained probably originated from the *cyclo*pentano-*cyclo*octane fundamental hydrocarbon, clovene.

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Urea Adducts of Glyceryl Esters

Glyceryl mono-esters are extensively used in the food and other industries, but the commercial products are often mixtures containing a range of fatty acids (free or combined), free glycerol and varying proportions of mono-, di- and tri-glycerides. The fractionation of such mixtures by classical methods is by no means easy, and in view of the importance of obtaining pure esters, we have investigated the possibility of fractionation with urea ; the formation of adducts between urea and various lipids has proved of value in the purification of various fatty acids and related compounds[1].

We have been able to show that urea adducts can be formed with glyceryl mono- and di-esters as well as with methyl and other simple esters ; similar results have been reported from other laboratories[2-4].

Beginning with a commercial preparation containing 39 per cent monostearin, and employing a stepwise extractive crystallization with urea in methanol solution, similar to that used by Abu-Nasr *et al.*[5] for the fractionation of fish oils, a fraction was obtained with a monostearin content of 86 per cent, representing 46 per cent of the monoglyceride originally present. By a variation of the urea concentration a higher yield of the monostearin fraction was obtained, but at the expense of the purity of the fraction (68 per cent). Martinez *et al.*[3], using mixtures of glyceryl esters, have also succeeded in producing monoglyceride samples up to a maximum of 74 per cent purity.

It has been shown[6] that mono-, di- and triglycerides can be fractionated by crystallization from solvents. Samples of the commercial glyceryl monostearate were therefore extracted with 90 per cent methanol at 30° C. and the soluble material treated with urea, giving a precipitate containing monostearin of 85 per cent purity (cf. original 39 per cent) in a yield of 79 per cent.

In further attempts to increase the monostearin content of the 85 per cent material, this was dissolved in methanol and treated with gradually increasing quantities of urea, the inclusion compounds being allowed to crystallize over a two-hour period. The most favourable results were obtained when the weight ratio of lipid, urea and methanol was 1 : 14 : 80 ; the lipid fraction in solution had a monostearin content of 90 per cent (in 83 per cent yield) in contrast to the precipitated lipid containing 58 per cent monostearin.

These latter experiments indicated that under the experimental conditions used, the distearin was preferentially precipitated by urea. Some of the results of Martinez *et al.*[3] confirm this conclusion ; but Heckles and Dunlap[4], in work with technical glyceryl monolaurate, concluded that inclusion compounds were more readily formed with the mono-esters ; they also showed that urea is of value in the separation of mixed monoglycerides containing fatty acids of different degrees of unsaturation.

The monostearin estimations were carried out by the method of Handschumaker and Linteris[7], which determines 1-monoglycerides only ; recent work[8] has suggested that considerable amounts of 2-monoglycerides may be associated with the 1-isomer in commercial mixtures. Thus the fractions we have obtained of 90 per cent monoglyceride content could contain up to 10 per cent of 2-monoglycerides, although it seems improbable that the latter compounds form adducts with urea.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 23

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. R. J. F. Withers: "Logical Form and Explanation".

Institution of Electrical Engineers, Radio Section (joint meeting with the Measurement Section, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. R. Wiblin: "Particle Accelerators".

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p m.—Mr. G. R. A. Short: "Essential Oils and their Pharmaceutical Applications".

Tuesday, January 24

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1 15 p m.—Prof. J. B. S. Haldane, F.R.S.: "The Second Indian Five-Year Plan".*

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. A. A. Lombard: "Low Consumption Jet Engines".

Wednesday, January 25

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. V. B. Wigglesworth, F.R.S.: "Insect Physiology in Relation to Insecticides" (Fernhurst Lecture).

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Symposium on "Electronic Methods of Pictorial Reproduction".

Society of Chemical Industry, Corrosion Group and Chemical Engineering Group (joint meeting with the Institution of Chemical Engineers, in the Large Lecture Theatre, King's College, Strand, London, W.C.2), at 6.30 p.m.—Dr. F. R. Himsworth and Mr. W. D. Clark: "Control of Corrosion in the Heavy Chemical Industry".

Society of Chemical Industry, Food Group—Nutrition Panel (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Third meeting in the new series "Nutrition Requirements, and Food Fortification".

British Psychological Society, Medical Section (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—Prof. T. Ferguson Rodger: "The Other Man's Point of View".

Thursday, January 26

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. K. A. Sinnhuber: "Sea-shores, Mountains, and Forests: the Struggle for Living-Space in Middle Europe".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. F. J. Schonland, F.R.S.: "Benjamin Franklin—Natural Philosopher" (Wilkins Lecture).

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S W.1), at 5.30 p.m.—Dr. H. I. Andrews: "The Development of a Steam Operated Refrigerator Van".

Friday, January 27

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. D. A Wrangham, Mr. R. McCrae and Mr. W. K. Rooney: "Sandwich Courses".

North-East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. C. E. Iliffe: "Nuclear Reactors for the Generation of Power".

Society for Analytical Chemistry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.45 p.m.—Annual General Meeting of the Microchemistry Group; 7.15 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1); at 9 p m.—Brig.-Gen. Sir Harold Hartley, F.R.S.: "World Needs and World Resources".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Fellow in Cosmic Rays at the University of Tasmania—The Registrar, University of Tasmania, Box 647C, G.P.O., Hobart, Tasmania (January 31).

Senior Research Fellow (with an honours degree in psychology and preferably experience in children's work) in the Department of Child Health—The Secretary, The University, Aberdeen (January 31).

Assistant Lecturer or Lecturer (with an honours degree and special qualifications and interests in either aesthetics and moral philosophy or the philosophy of science and mathematics) in the Department of Philosophy—The Registrar, The University, Liverpool (February 3).

Lecturer or Assistant Lecturer in Biochemistry—The Registrar, The University, Sheffield (February 4).

Lecturer (Grade II) or Assistant Lecturer (Grade III), and a Research Fellow, in the Department of Theoretical Mechanics—The Registrar, The University, Bristol 8 (February 10).

Physicist or Electrical Engineer, Experimental Officer grade (with at least H.S.C. (science) or equivalent), at a Ministry of Supply Armament Research and Development Establishment, near Sevenoaks, Kent, for experimental design of electronic systems of V T. Fuzes and associated trials equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.604/5A/BN (February 10).

Lecturer/Senior Lecturer (preferably with qualifications and interest in either the history and theoretical foundations of psychology or psychometrics and individual differences) in Psychology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 11).

Experimental Officer (with at least H.S.C. (science) or equivalent), at the London Headquarters of the Ministry of Supply to carry out reorganization of electronic post-design service work in industry and to assist in implementation of packaging directives and in technical progressing of miscellaneous electronic equipment development contracts—The Ministry of Labour and National Service, Technical and Scientific Register (E), 26 King Street, London, S.W.1, quoting D.586/5A/BN (February 14).

Chair of Applied Mathematics, Chair of Atomic Physics, Chair of Physical Chemistry, Chair of Petrology, Chair of Biological Oceanography—The Dean, Faculty of Science, Alexandria University, Moharram Bey, Alexandria, Egypt (February 15).

Lecturer (Grade I or Grade II) in the Department of Physics—The Registrar, The University, Birmingham (February 18).

Chair of Pharmaceutics at the School of Pharmacy—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 27).

Head (with high qualifications in geology and experience in both teaching and research) of the Department of Geology—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (February 28).

Assistant Lecturer or Lecturer (with a degree or diploma in horticulture and sound practical experience) in Horticulture, at Canterbury Agricultural College, The University, Canterbury, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (February 29).

Lecturer in Agriculture, with particular reference to Ecological Land-use Survey, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 29).

Professor of Education, and Head of the Department of Education, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, February 29).

Senior Lecturer in Clinical Biochemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

Air Pollution Engineer (with a university degree in chemical technology or equivalent qualification and about twelve years experience in chemical engineering or allied activities) in the City Engineer's Department, Durban, South Africa—Messrs. Webster, Steel and Co., 3 St. Helen's Place, Bishopsgate, London, E.C 3 (March 16).

Director (with high scientific attainments, preferably in fields related to soils or crops combined with administrative experience either as head or deputy in the organization and running of a research institute or university department) of the Coconut Research Institute of Ceylon—The Chairman, Coconut Research Board, Department of Agriculture, Peradeniya, Ceylon (March 31).

Animal House/Laboratory Technician (male or female), to assist in experimental pathology in the Research Department—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex.

Assistant Lecturer, Grade B (with an honours degree in chemistry), in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Assistant Lecturer (honours graduate) in Zoology, and a Research Assistant (honours graduate) in Zoology—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

Associate Professor of Mathematics in the University of Alberta—Dean W. H. Johns, Faculty of Arts and Science, University of Alberta, Edmonton, Alberta, Canada.

Chemists (graduates, with or without research experience, mainly interested in physical and colloid chemistry)—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Engineers and Physicists (particularly with electronics), Experimental Officer and Assistant Experimental Officer grades, at Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth and Weymouth areas, Gloucestershire and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.214/5A.

Experimental Officer (with H.S.C. (science) or equivalent, and preferably some experience of equipment employed in machine telegraph systems including teleprinters) at a Royal Air Force Signal Establishment at Kidbrooke, to work in a small team engaged on the development of small electromechanical and electronic equipment associated with machine telegraph systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.585/5A/BN.

GEOCHEMIST (with a good honours degree in chemistry or equivalent and some experience in inorganic analysis with special reference to rock and mineral analysis) IN THE GEOLOGICAL SURVEY DEPARTMENT, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/8/09.

LECTURER (male, with a degree in agriculture and some general experience in tropical agriculture) IN AGRICULTURE at the College of Agriculture, Mauritius—Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD 63/52/06.

MATHEMATICIAN (with an honours degree in mathematics) IN THE OPERATIONAL RESEARCH SECTION for work initially concerned with applying linear programming to problems of production scheduling, selection of order, etc.—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "O.R.4".

PHYSICIST (with academic qualifications of degree standard or equivalent) in the Research Department of the Bank of England Printing Works—Staff Manager, St. Luke's Printing Works, Old Street, London, E C 1.

SENIOR TECHNICIAN (fully experienced in all branches of physics laboratory work, and, if possible, able to assist in general administration) IN THE PHYSICS RESEARCH DEPARTMENT—The Secretary Birkbeck College, Malet Street, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

United Kingdom Atomic Energy Authority. First Annual Report for the period 19th July, 1954–31st March, 1955. Pp. vii+35. (London. H.M. Stationery Office, 1955.) 2*s*. net. [1111

Ministry of Housing and Local Government. Scottish Office. The Surface Water Year-Book of Great Britain, 1945–53. (Hydrometric statistics for British rivers, together with related rainfalls, for the eight years ended 30th September, 1953.) Pp. xi+167. (London: H.M. Stationery Office, 1955.) 35*s* net. [1111

Forestry Commission. Leaflet No. 36: The Crossbill. Pp. 11. 9*d*. net. Booklet No. 4: Rusts of British Forest Trees. By J. S. Murray. Pp. 15+8 plates. 2*s*. 6*d*. net. (London: H.M. Stationery Office, 1955.) [1111

Some Tasks and Perspectives in Physical Chemistry. By Prof. R. M. Barrer. (Inaugural Lecture, Tuesday, 24th May, 1955.) Pp. 13+4 plates. (London: Imperial College of Science and Technology, 1955.) [1111

Standardised Disinfectants Co., Ltd. Technical Bulletin: Dilstan Formulations of Dieldrin for Controlling Public Health and Industrial Pests. Pp. 12. (London: Standardised Disinfectants Co., Ltd.) [1111

Presentation of Technical Information Discussion Group. Group Paper No. D G 5 Readability. By Susan R. Neuberger. Pp. 21. Group Paper No. D G.6: The Function of a Technical Writer in Industry. By P. D. Patterson. Pp. 10. (London: University College London, 1955.) [1111

Manchester Public Libraries. The 103rd Report of the Libraries Committee, 1954–55. Pp. 29+4 plates. (Manchester: Manchester Public Libraries, 1955.) [1111

Fifth Annual Report on the Fulbright Program in the United Kingdom and Colonial Territories, 1949–1954. Pp. 184. (London: United States Educational Commission in the United Kingdom, 1955.) [1611

Ordnance Survey Annual Report, 1954–55. Pp. 24+10 plates. (London: H.M. Stationery Office, 1955.) 5*s*. net. [1611

Aero Research Technical Notes. Bulletin No 153 (September, 1955): The Influence of Low Temperature on "Redux" Bonded Lap Joints. By A. Hartman. Pp. 10. (Duxford: Aero Research, Ltd., 1955.) [1611

Air Ministry: Meteorological Office. Geophysical Memoirs. No. 96 (Fourth number, Vol. 12): The Free Atmosphere in the Vicinity of Fronts: Analysis of the Observations by the Meteorological Research Flight, 1950–52. By J. S Sawyer. (M.O. 584d.) Pp. 24. (London: H.M. Stationery Office, 1955.) 5*s*. net. [1611

Bulletin of the British Museum (Natural History). Botany. Vol. 2, No. 1: New Himalayan Species of *Pedicularis*, with special reference to those from the Eastern Himalaya. By P. C. Tsoong. Pp. 1–34. (London: British Museum (Natural History), 1955.) 8*s*. [1611

Leeds City Museums. Annual Report of the Sub-Libraries and Arts (Museums) Committee to the Council for the year ended 31st March, 1955. Pp 11. (Leeds: Leeds City Museums, 1955.) [1611

Journal of Analytical Psychology. Vol. 1, No. 1. Pp. 108. Subscription rate: 21*s*. per volume (at present 2 issues). Single issues, 12*s*. 6*d*. (London: Tavistock Publications, Ltd, 1955.) [1611

Planning. Vol 21, No 388 (November, 1955): Ownership of the Press. Pp 209–224. (London Political and Economic Planning, 1955.) 2*s* 6*d*. [1611

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Secretary of State for Air, for the year April 1, 1954, to March 31, 1955. Pp. 68. (M.O. 594.) (London: H.M. Stationery Office 1955.) 2*s*. 6*d*. net. [1611

Current Status and Recent Progress of Printed Circuits in England. By Dr. Paul Eisler. (Presented at the Symposium on Printed Circuits, Philadelphia, Pa., January 20 and 21, 1955.) Pp. 10. (Reprinted from the Proceedings of the Symposium on Printed Circuits.) (London: Technograph Printed Circuits, Ltd., 1955.) [1611

British Cast Iron Research Association. Thirty-fourth Annual Report, for the year ending June 30th, 1955. Pp. i+15. (Alvechurch, Birmingham: British Cast Iron Research Association, 1955.) [2111

Institution of Gas Engineers. Publication No. 472: 16th Report of the Chairman's Technical Committee, 1954–55. Pp. 51. Publication No. 473: Recommendations to Prevent Accidents During the Cutting Out of Gas Mains for Repairs and Alterations, for Use with Cast Iron and Steel Mains with Pressures not exceeding 50 lb. per Sq. In. Pp. 10. Publication No. 474: Institution Gas Research Fellowship Report, 1953–54. The Fluidized Gasification of Coal. By Dr. B. H. Thompson and Dr. J. E. Garside. Pp. 25. Publication No. 475: 32nd Report of the Gas Education Committee, 1954–55. Pp. 25. Publication No. 476: Symposium on Coke. Pp. 69+1 plate. Publication No. 477: The Tolerance of Aerated-Burner Appliances to Variations in the Combustion Characteristics of Town Gas. By G. H. Fuidge and Dr. J. R. Dewhurst. Pp. 57. Publication No. 478: Area Technical Services. By J. E. Davis. Pp. 23. Publication No. 479: Some Aspects of Research in the Petroleum Industry. By W. M. Catchpole. Pp. 28. Publication No. 480: Official Programme, 21st Autumn Research Meeting, London, 22nd and 23rd November, 1955. Pp. 8. (London: Institution of Gas Engineers, 1955.) [2111

Other Countries

Hamburger Sternwarte in Bergedorf. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1953. Pp. 5. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1954. Pp. 8. Katalog von 8356 schwachen Sternen für das Aquinoktium 1950 beobachtet an den Meridiankreisen der Sternwarten Hamburg-Bergedorf und Heidelburg-Königstuhl. Von J. Larink, A. Bohrmann, H. Kox, J. Groeneveld und H. Klauder. Pp. xxi+69. Zweiter. Katalog der Astronomischen Gesellschaft für das Aquinoktium 1950 Örter der Sterne bis zur neunten Grosse zwischen dem Nordpol und 2° sudlicher Deklination abgeleitet aus photographischen Himmelsaufnahmen der Sternwarten Bergedorf und Bonn, unter Leitung von Richard Schorr und Arnold Kohlschütter. Zehnter Band: Deklination +20° bis +25°, Bergedorf-Bonn. Herausgegeben von der Hamburger Sternwarte. Pp. iv+288. (Hamburg-Bergedorf: Hamburger Sternwarte, 1954.) [911

The Organisation of Applied Research in Europe: Proceedings of the Conference held at Nancy, 11th–13th October 1954. (Project No. 191.) Pp. 258 (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1955.) 600 francs; 12*s*.; 2 dollars. [1111

Indian Forest Bulletin. (New Series, Botany.) No. 189: A Diagnostic Key to the Various Forms of Introduced Mesquite (*Prosopis Juliflora* D.C.) By M B. Raizada and R. N. Chatterji. Pp. 6. (Delhi: Manager of Publications, 1955.) 9 annas; 10*d*. [1111

Commonwealth Scientific and Industrial Research Organization, Australia. Bulletin No. 276: An Analysis of the Records of the Registered Australian Merino Stud Flocks. By B. F. Short and H. B. Carter. Pp. 35. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1955.) [1111

Western Australia. Report of the Government Chemical Laboratories for the year 1952. (Extract from Mines Department Annual Report.) Pp. 12. (Perth: Government Printer, 1955.) [1111

Papers and Proceedings of the Royal Society of Tasmania. Vol. 89. Pp. xiii+355+15 plates. (Hobart: Royal Society of Tasmania, 1955.) 20*s*. [1111

Scientific Institutions and Scientists in Latin America. Vol. 2. Pp. iii+363. (Montevideo: United Nations Educational, Scientific and Cultural Organization, 1955.) [1111

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Bulletin 29: Wall-Rock Alteration at Certain Lead-Zinc Replacement Deposits in Limestone, Salmo Map-Area, British Columbia. By D. H. Green. Pp. vi+33+3 plates. 75 cents. Bulletin 30: A Decrepitation Study of Quartz from the Campbell and Negus-Rycon Shear Zone Systems, Yellowknife, Northwest Territories. By R. W. Boyle. Pp. v+20. 50 cents. Bulletin 31. Mineralogy of Uranium Deposits, Goldfields, Saskatchewan. By S. C. Robinson. Pp. vii+104+24 plates. 75 cents. (Ottawa: Queen's Printer, 1954 and 1955.) [1111

Tanganyika. Records of the Geological Survey of Tanganyika. Vol. 2, 1952. Pp. 1+66+10 plates. (Dar-es-Salaam: Government Printer, 1955.) Shs. 7/50. [1611

Mitteilungen des Deutschen Wetterdienstes. Nr. 14 (Band 2): Die Agrarmeteorologen-Tagung in Frankfurt a. M. vom 14 bis 17 März 1955. Pp. 210. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [1611

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Memoir 278 (Supplement to Memoir 240): Palaeozoic Geology of the Windsor-Sarnia Area, Ontario. By B. V. Sanford and W. B. Brady. Pp. v+65. (Ottawa: Queen's Printer, 1955.) 75 cents. [1611

Imperial College of Tropical Agriculture. A Report on Cacao Research, 1954. Pp. 81. (Trinidad and London: Imperial College of Tropical Agriculture, 1955.) 12*s*. 6*d*. [1611

Changements dans la Faune des Papillons (macrolépidoptères) de Digne (Basses-Alpes). Par Gustav Lederer et Josef Leinfest. (Édition spéciale de *Entomologische Zeitschrift*. Traduit de l'Allemand et Preface par Joël Propper, avec l'Autorisation des Éditions Kernen de Stuttgart.) Pp. 28. (Clermont-Ferrand: Joël Propper, 9 Rue de Risen, 1953.) [2111

Det Kongelige Industri-, Håndverk- og Skipsfartsdepartement. Norsk Polarinstitutt. Skrifter Nr. 108: Late-Pleistocene Deposits at Kapp Wijk, Vestspitsbergen. By Rolf W. Feyling-Hansen. Pp. 21+3 plates. (Oslo: Brøggers Boktrykkeris Forlag, 1955.) 3 kronor. [2111

Catalogues

Eastman Organic Chemicals. General Price Revisions. Pp. 16. (Amendment No. 2, October, 1955.) (Kirkby, Liverpool: Kodak, Ltd., 1955.)

Loughborough Glass Company. General Laboratory Equipment. Pp. 43. (Loughborough: Loughborough Glass Co., Ltd., 1955.)

"E-MIL" Catalogue No. 7: Laboratory Glassware and Thermometers. Pp. 58. Price List for Catalogue No. 7. Pp. 24. (Treforest, Glam.: H. J. Elliott, Ltd., 1955.)

"VARIAC" Transformer Catalogue. Pp. 12. (London: The Zenith Electric Company, Ltd., 1955.)

Hilger Scientific Instruments, 1955. (CH 395/GB). Pp. 20. (London: Hilger and Watts, Ltd., 1955.)

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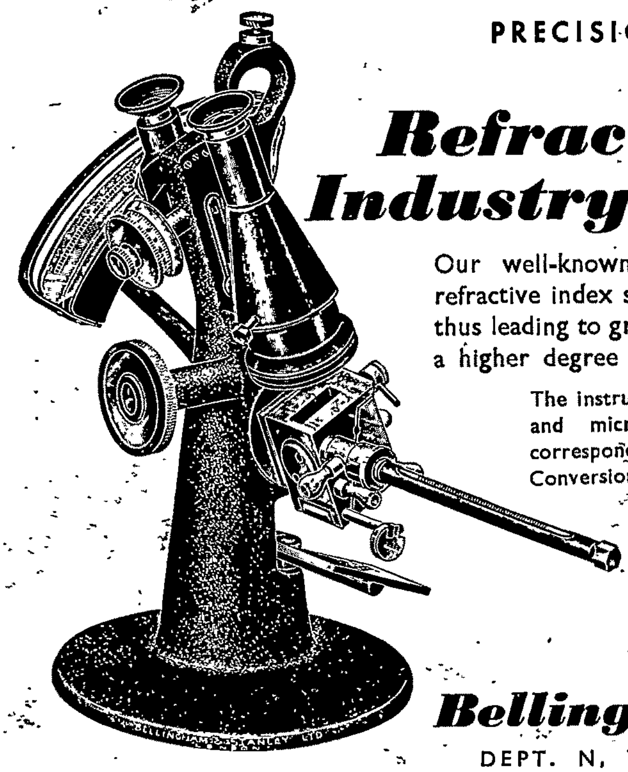

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EDUCATION OF THE ADOLESCENT

IN a report to King George's Jubilee Trust Fund on the needs of youth, made shortly before the outbreak of war in 1939, Dr. A. E. Morgan urged the importance of a system of at least part-time continued education carried on during the working-day up to the age of eighteen years. We could not afford, he maintained, to let the boy or girl slip out of our care even at sixteen, let alone at fifteen. How far even yet we permit invaluable human capital thus to run to waste was shown in the report on "Early Leaving" which was published early in 1955; and perhaps with all the more force in that this report recognized that, for some boys and girls, no useful purpose would be served by keeping them at school even after fifteen years of age.

The need for some elasticity, however, increases the importance of due attention to the needs of youth in leisure and in recreation. Although, however, there are reassuring passages in the study of the influences affecting the upbringing of young people which the Council of King George's Jubilee Trust issued towards the end of 1955 under the title "Citizens of To-morrow"*, it is disturbing to find how closely the picture painted resembles that depicted by Dr. Morgan sixteen years earlier. To-day, even more than before the War, pleasure has ousted work as the main preoccupation of life: work is no longer an absorbing means of expression, but merely the device by which we can buy the comforts we desire and expect. It is endured for the reward to be reaped thereafter, and this is as true of the juvenile as of the adult worker.

Such an attitude strikes at the very root of voluntary work and service; and if these are to continue, the outlook and attitude of youth must be changed. In this, as elsewhere, the foundations of real national fitness must, as Dr. Morgan remarked, be laid on the bedrock of youth. Elsewhere he wrote of the advisability at some points of overcoming vested interests, where they may clash with the interests of youth, of the importance of recognizing that paid leadership in clubs and youth centres is a profession and that it is essentially educational, and that the problem of finding the right leaders in sufficient quantity is a matter of national urgency. He looked to the universities for co-operation in developing appropriate facilities for the professional training of club leaders.

The study which the Trust has now published is based on the reports of four working parties which inquired, respectively, into four phases in the upbringing of young people in Britain: that of full-time attendance at school; the influence of employment in the period after leaving school; the influences of leisure time; and the period in the Services. Even more emphatically than Dr. Morgan, these reports are unanimous as to the profound and enduring influence of parents. The working parties agree that in recent years there has been some weakening of the sense of parental and personal responsibility, and that a return to Christian principles offers the best hope of fostering a renewed sense of such responsibility. Thirdly, all four reports are concerned with the problem of dealing with the gap, both in education and in life, which, for most boys, now exists between the end of school life at fifteen and entry into national service.

As regards national service itself, it is thought that there is little fundamentally wrong with the present system, and adjustments required are mostly within the scope of the Services themselves. The generally satisfactory means of educational advancement offered by the Services should, however, be more widely known; and it is also recommended that employers should be persuaded to recognize a special responsibility towards the boy of fifteen to eighteen so that during those critical years he may be given general and physical education as well as serious vocational training. Furthermore, to arrest the existing educational deterioration of those who leave school at fifteen and are not apprenticed, this working party, which discusses the period in the Services, recommends that the Government should give serious consideration to the possibility of hastening the establishment in Britain of county colleges.

Apart from raising the school-leaving age to sixteen, the establishment of county colleges—both steps for which the Education Acts of 1944 and 1946 provide—is the only legislative step suggested by the study, and if a choice has to be made between raising the school-leaving age and the establishment of county colleges, the latter should come first. Both working parties concerned with the period after leaving school stress the importance of county colleges, and agree that the time is now ripe for their establishment. That concerned with the influence of employment believes that if management, employers' associations, chambers of commerce, trade unions and local education authorities ensured the proper functioning of these colleges by doing everything possible to increase facilities for day release, most school leavers would no longer virtually cease systematic education at fifteen. That concerned with leisure-time influences is no less concerned to see county colleges introduced at the earliest possible moment, because it believes that such colleges will enable young people to live fuller and more complete lives, permitting some of the gaps in the Youth Employment Service to be stopped and making possible the general assertion of the principle that when young people begin to work they should be learners as well as earners. It does not, however, believe that such colleges will ever supersede the youth service or make it unnecessary.

This particular report has much to say about strengthening the youth service and, apart from the expenditure of more money on it, there are suggestions regarding the training of youth leaders and the development of new techniques which deserve attention. Like other of the working parties, it also suggests the establishment of a national youth advisory council, though not in quite so well-defined a form as the working party concerned with employment. The latter proposes a national joint advisory council for youth, responsible to the Lord President of the Council and charged with considering action on the recommendations of the report and continuing concern for such investigation into problems of transition from school to working life. This recommendation is endorsed by the Trust in its commentary, and is probably the most far-reaching suggestion of the whole study.

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* Citizens of Tomorrow: a Study of the Influences Affecting the Upbringing of Young People. Pp. 142. (London: Odhams Press, Ltd., 1955. Published on behalf of the Council of King George's Jubilee Trust.) 3s. net.

If the Government is not prepared forthwith to proceed with the establishment of county colleges, this recommendation at least should be implemented. It may require less immediate expenditure, but is almost certain to provide convincing evidence of the need for the expenditure on youth service and county colleges, etc., which the study recommends. Moreover, the establishment of county colleges has also recently been urged by Mr. M. L. Jacks in discussing the education of the young worker in his recent book, "The Education of Good Men"*. Mr. Jacks, seeing in the colleges of further education the precursors, on a voluntary basis, of the county colleges, emphasizes the value of the latter provided they are separated as completely as possible in terminology and all their associations from the world of school. One of their chief educational advantages is, he believes, in the opportunity such colleges afford in mixing boys and girls engaged in a great variety of occupations, and this variety should characterize every tutorial group.

Mr. Jacks believes also that the county colleges could meet the claims of religion, which he too emphasizes, provided religion is made a background to the life of the college, a normal and habitual element in its experience. Dr. P. F. R. Venables, in his recent book, "Technical Education", deplores the shelving of the county colleges as perhaps the bitterest of the post-war disappointments, and suggests we may wonder whether we will ever see a government with the wisdom and courage to establish county colleges. On a voluntary basis they will never meet the needs of more than a small fraction of the age-groups fifteen to sixteen years.

As a contribution to the provision of general education and offering a background for technical education even more than preventing the waste of human capital, it might be possible effectively to urge the development of the county colleges on the Government at the present moment. Mr. M. L. Jacks maintains that it is within the power and the duty of the schools to provide four things lacking in contemporary society: a respect for good work; a willingness for hard work; efficiency; and an ideal of service to be rendered to society in and through a man's daily work well done. All this bears profoundly on industrial efficiency and raising the level of productivity; and the survey of the relation of vocational and non-vocational further education and training which the National Institute of Adult Education published early in 1955 emphasizes particularly the value of residential education in this connexion. The very condition of living and studying together profoundly affects the flow of young people's sympathetic consciousness, and although the short-term residential colleges are still very new, they are already becoming well established.

The Committee which conducted this inquiry for the National Institute of Adult Education was greatly impressed with the value of even a short period of residence. It can easily turn interest into something much deeper, as well as transform the interest of the students for each other as people, and the Committee urged the establishment of intimate liaison between technical colleges and residential adult education colleges. In its view, residential colleges are in a unique position to mediate between the frequently divergent claims of the vocational and the non-vocational. They are ideally equipped to experiment with methods of teaching and discussion, and to discover what actual subjects can help to promote vocational and semi-vocational work of a liberal character. If the colleges succeed in the experiment with liberal vocational courses which they are conducting, the Committee hopes it will be possible to increase very considerably the number of residential colleges, so that they may make their contribution to technical education on a far wider scale.

The Committee thus suggests that a short residential course might come to be accepted as part of the vocational training of all full-time and day-release students. Concluding that lack of time excludes almost any of the values of a liberal education from vocational studies pursued at evening classes, except such as can be introduced through a broader treatment of the technical subject itself, it sees only one solution to this problem of general education for most young people: the establishment of county colleges. Only thus, it suggests, will further education be able to discharge its task of fostering a sense of pride in achievement and of responsibility in all levels of the working population.

This emphatic recommendation for the establishment of county colleges attracted little attention at the time. In the six months since the report was published, the recommendation has found strong support, however, not merely in the study published by the Council of King George's Jubilee Trust and in Mr. Jacks's book, but also in much that has happened in the industrial and economic life of Britain. Notably it would seem that the wider appreciation of the importance of an adequate general education at all levels, from that of the technician and operative to the scientist, technologist and manager, makes this an opportune moment to press the issue of county colleges as part of the provision for efficiently increasing the nation's production of technicians and technologists and scientists. It can be argued that it is an essential element in securing a continuous and increased supply of technologists, scientists and technicians who are really educated, and whose services will be far more efficiently used. Indeed, it may not be too much to urge that, unless some such step is taken, as part of a considered programme taking full account of the requirements of the nation at all levels and of the resources available, short-term as well as long-term, plans for the expansion of technological and technical education may ruin the educational system of Britain and lead to economic disaster.

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* The Education of Good Men. By M. L. Jacks. Pp. 192. (London: Victor Gollancz, Ltd., 1955.) 13s. 6d. net.

If these dangers are to be avoided, it is important that our ideas as to the county colleges should be clearly defined, and that the functions which they are to fulfil in adolescent education and their relation to technical education at least, if only indirectly to technological education and university education, can be convincingly stated. It must be realized that money spent on the county colleges means less money available elsewhere—less for the expansion of the technical colleges, for the development of a selected few into colleges of technology, for the extension of the scientific and technological departments of the universities themselves and the building of new schools. Our plans indeed at every level must be conceived with imagination, but our vision must be tempered with realism and with a sense of perspective and of the part which each unit is to play in the functioning of the whole. Mr. Jacks gives us no blue-print in his recent book, but a sense of perspective and of the relation of each part to the whole informs and illumines the full sweep of his diverse comments on the educational scheme. That he is provocative—at times deliberately so—is all to the good and adds to the value of a lively and stimulating book. It should be read by all interested in educational policy from whatever angle, and perhaps not least by those who, following Sir Eric Ashby's argument, are seeking so to reconstruct adult education as well as that of the adolescent that man can preserve his status as an individual, giving new meaning to his civic rights and illumining his political rights with understanding.

AN INTELLIGENT MAN'S GUIDE TO THEORETICAL PHYSICS

The Laws of Nature

By Prof. R. E. Peierls. Pp. 284. (London: George Allen and Unwin, Ltd., 1955.) 21*s*. net.

THIS is a book on theoretical physics, intended for a reader who may have no previous knowledge of the subject and very little mathematical equipment. The material may be divided into four sections, each occupying about sixty-five pages: the classical theory of particles and of fields in vacuum; the atomic theory of the nineteenth century; relativity and quantum theory; and sub-atomic physics (high-energy electrons, nuclei and mesons). It may be noted that two of these sections are devoted to classical physics and two to modern physics. Prof. R. E. Peierls covers a very wide range of topics, for he starts with an exposition of elementary mechanics and ends with the application of field theory to unstable particles. The general methods and aims of theoretical physicists are discussed in an introduction and a short concluding chapter.

Prof. Peierls avoids the use of mathematical processes by expressing in words the meaning of such concepts as differentiation, divergence and circulation. His treatment is naturally that of the theoretical physicist; for example, he is not directly concerned with the experiments of Faraday but translates the equations of Maxwell into the simplest words he can find and discusses the predictions derived from certain solutions. The application of theories is sometimes followed in considerable detail (for example, in the treatment of the vector model of the atom or in the discussion of different types of mesons and hyperons).

Rutherford once argued (over a tea-table) that since the table is seen by the light which it reflects and an α-particle by the light of the scintillation which it causes, therefore one sees the α-particle in the same sense as one sees the table. Rutherford could make more difficult propositions sound very convincing, and it is true that the table is a picture—a logical construct—of one type of experience and an α-particle of another. The α-particle is just as real as the tea-table and the equations of field theory are just as real as either, but the ideas of theoretical physics are both unfamiliar and subtle. A Martian, newly descended from his Flying Saucer, could be taught the language of everyday life by pointing at common objects and naming them. There would be some mistakes. Malinowski found when he learned the Polynesian languages by this semantic method that sometimes he got the word for a part or a quality of the thing indicated. This kind of misunderstanding is easily cleared up when there is a sufficient background of common simple experience. For lack of this background, a physicist who showed a non-scientist a scintillation and said 'α-particle' would probably give him the idea that an α-particle is a flash of light. Even many a professional physicist would understand little if Prof. Peierls pointed to an equation and said 'anti-proton'. His task of explaining in the language of everyday life theories that are derived from experience, which is so different from that of everyday life, is no easy one.

Two thousand years ago, Lucretius wrote a book on the laws of Nature. He wrote with a purpose—to combat the darkness of superstition by the light of a scientific understanding of natural phenomena. His burden was lighter than that of a modern writer. There was a shorter tale to tell, and Lucretius was able to include an interesting theory of ghosts and phantoms as well as some advice on love and marriage. Yet he recognized that he had no easy task in taking science to the layman. He explained that it was necessary to "smear the cup with honey" in order to persuade the child to drink the bitter medicine. He therefore wrote in verse and illustrated his argument with interesting tales. Modern writers on popular science do not break into verse, but they nearly all feel the necessity of doing something to gain the attention of an unwilling reader. They seek to show the 'wonder' of science by anecdotes, epigrams, paradoxes and daring extrapolations from the actual to the conjectural. Lucretius was read for his poetry, but his ideas made little impression on the Roman world. The modern writer is too often remembered for his style, the substance being forgotten.

Prof. Peierls seeks to convey not the wonder of theoretical physics but its logical structure. He assumes that his reader is intelligent, that he wants to understand the subject, including the most difficult parts, and that he is prepared to make a considerable mental effort. None of the usual devices of 'popular' books is employed. The author tells a plain tale in simple language. This method cannot convey the elegance of the mathematics but, by using it, the author forces his reader to attend to the substance. He depends upon that alone to sustain the interest. My first impression was that too much detail had been included and too few illustrations, so that many readers would find the book difficult. I feared that rather few non-scientists would be sufficiently interested to complete the book. As an experimental scientist, I felt the need of some evidence and asked three friends to begin the book, not to proceed further than they felt inclined, and to inform me where they stopped. All three complained that the book was difficult, that there were not enough diagrams, that the argument was very involved in places, *but* each of them had finished the book. The number is too small for statistical conclusions, but perhaps the potential readers are more numerous than I thought. There may be quite a lot of people who prefer to climb a steep intellectual mountain—with the help of a qualified guide—rather than to look at photographs of the wonderful view from the top. In any event, it is well that one distinguished physicist should try the 'direct method' of teaching his subject to the layman.

Prof. Peierls says he wrote partly to clarify his own ideas. Nearly every professional physicist who reads this book will find that there is some point at which his own mind is less clear than he believed and that the author has both revealed and resolved the difficulty. R. W. DITCHBURN

FOSSIL PLANTS OF THE CARBONIFEROUS ROCKS OF GREAT BRITAIN

Memoirs of the Geological Survey of Great Britain

Palæontology. Vol. 4, Part 1: Fossil Plants of the Carboniferous Rocks of Great Britain. (Second Section.) By Dr. Robert Crookall. Pp. iv+84+24 plates. (London: H.M. Stationery Office, 1955.) £3.

THE first step in the publication of "Fossil Plants of the Carboniferous Rocks of Great Britain" was taken by Robert Kidston in Vol. 2 of the Memoirs of the Geological Survey, published in six parts between 1923 and 1925. They represented part of Dr. Kidston's researches on Carboniferous plants carried out during his long and active lifetime. Unfortunately, his death in 1924 put an end to this project and the description of British Carboniferous plants, which was largely based on his and the Geological Survey collections, was left incomplete. The parts which he completed dealt exclusively with the compression type of fossil plant and did not include petrifactions. The compression type of fossil is the common type encountered in sedimentary rocks and is of greater importance to the geologist than the petrifactions, which are mainly of botanical interest. The six parts included descriptions of most of the fern-like plants (ferns and pteridosperms). They are excellently illustrated memoirs and compare very favourably with any publication of a similar kind which appeared at that time. Similar illustrated memoirs had previously been published by French palæobotanists—Renault, Zeiller, Bertrand and others—in the "Études des Gites Minéraux", published under the auspices of the Ministry of Public Works; and Lesquereau, White and others described the coal measure floras of North America for the United States Geological Survey.

After a regrettably long interval, publication of the work started by Kidston has now been resumed, and it is very gratifying that the Geological Survey of Great Britain intends to continue this important work. In the interval, other countries, notably France, the Netherlands and Belgium, have produced magnificent monographs of plants of their coal-bearing formations and have to a certain extent anticipated part of the work Kidston had planned to do. Dr. Robert Crookall, author of this new part, while making use of some of Kidston's manuscripts and the magnificent Kidston Collection and other collections of the Geological Survey, has produced a volume which compares very favourably indeed with the earlier ones. He has brought our knowledge of the plants that he describes up to date and has added several new species to the British Carboniferous flora. In a clear and well-written introduction he explains the changes that have taken place in the scheme of classification of Carboniferous rocks since Kidston's time; these changes are largely due to the discussions and decisions taken at the congresses on Carboniferous stratigraphy held at Heerlen in the Netherlands in 1927, 1935 and 1952.

Dr. Crookall then describes the genera *Alethopteris* and *Lonchopteris*, two closely related genera of fern-like fronds which are almost certainly the foliage of pteridosperms. This is followed by the genus *Desmopteris*, a fern-like plant of uncertain affinities. He then describes the genera *Caulopteris* and *Megaphyton*, which are parts of stems that exhibit the scars left by the abscission of large fronds. *Caulopteris* and *Megaphyton* were evidently the stems of plants, some of which were almost certainly tree ferns, while some may have belonged to pteridosperms which had the habit of tree-ferns. Dr. Crookall describes several new species, one of *Caulopteris* and four of *Megaphyton*.

The descriptions are clear, and a comprehensive synonymy is given for each species. The photographic illustrations are excellent. This work is a worthy continuation of that started by Kidston, and it is to be hoped that other parts of this important series of publications on British Carboniferous plants will appear before long. J. WALTON

THE METAPHYSICAL STRAIN IN KANT

Kant's Metaphysics and Theory of Science

By Prof. Gottfried Martin. (Translated from the German by P. G. Lucas.) Pp. viii+218. (Manchester: Manchester University Press, 1955.) 21*s*. net.

IT was Hume who urged us to burn all metaphysical books, and Kant is often regarded as supporting him in this. What Kant is prized for is his elaboration of the principle that concepts gain significance only in so far as they serve to link actual or possible sense experiences, and, from this point of view, statements about what is not so conditioned have no sense. Kant, it is true, made many references to noumena, but these can be rejected as inconsistent with his fundamental doctrine. This, however, involves modifications—especially of his ethical doctrine—so drastic as to make one wonder. Did Kant really mean that no significant statements can be made about what lies outside the range of the spatio-temporal ? Did he even mean that there can be no good grounds for accepting such statements ?

Prof. G. Martin answers no to these questions. He holds, on the contrary, that a positive attitude toward metaphysics is fundamental even in Kant's theory of knowledge. Phenomena are essentially appearances to beings whose experience arises from the unification of materials received through sense. Kant always assumes that these sense materials arise through the stimulation of the receptive consciousness by noumena. The unifying consciousness is itself a noumenon and experiences itself as such in its moral decisions. Prof. Martin draws this conclusion from Kant's ethical writings, but shows that it is already foreshadowed in the "Transcendental Dialectic". Kant argues on ethical grounds that the concepts of freedom, immortality and God are not empty, but have application to the noumenal world. He applies to noumena the categories of "unity, plurality, causality, community, possibility, actuality and necessity" (p. 198), suggests that there is some correspondence between the sensible entities in the world and things in themselves, and speaks of God as the author of things in themselves.

Prof. Martin contends that in all this Kant is not being inconsistent, but is continuing and developing a long metaphysical tradition. He illustrates this in great detail, and suggests that the best way of interpreting Kant's view is to say that the categories are applied to things in themselves—not in the basic sense in which they are applied to phenomena, but "in an analogical sense" which does not give rise to knowledge, but for which good reasons can be given. He thinks this can be defended ; but he is mainly concerned with determining what Kant's actual views were, and his study is thoroughly interesting and suggestive. His discussion of Kant's theory of science (*Wissenschaftslehre*) deals only with the fundamental points, and, while it is very clear, contains nothing new, though it is well illustrated by references to modern developments in mathematics. The translation is admirable. L. J. Russell

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QUANTITATIVE MICRO-ANALYSIS

Methods of Quantitative Micro-Analysis

Collected and edited by Dr. R. F. Milton and Dr. W. A. Waters. Second edition. Pp. xi+742. (London: Edward Arnold (Publishers), Ltd., 1955.) 70*s*. net.

THIS book is the second edition of the well-known volume which was first published in 1949. The general climate of micro-chemistry has changed greatly in the interval. In 1949 the applications of micro-techniques were few and not very widely used, but at the present day they are ubiquitous. The change is due to the advance in instrumentation and also, no doubt, to the availability of good text-books on the subject. The present volume consists of the original text by Drs. R. F. Milton and W. A. Waters, assisted by G. Ingram, J. T. Stock and K. M. Wilson, to which have been added two new parts on chromatography and micro-biological assay by S. M. Partridge with T. Swain and A. J. Amos, respectively. The general lay-out of the book is the same as that of the first edition, and the text of the first six parts is identical with the old text, except for certain additions to bring it up to date. These are mainly in Part 4 on colorimetric analysis, where a description of some of the more recent absorptiometers and spectrophotometers is grafted to the original stem. No attempt is made to evaluate the relative usefulness of the new instruments.

As methods are given that are based on the measurement of the absorption spectra of the test substances, it would not be irrelevant to ask why there is no section dealing with emission spectrography, which is perhaps the most useful and widely practised of micro-methods available to the analyst. If the authors feel that this is too specialized a field for their book, they might perhaps refer to the subject as they have done to electrophoresis in Part 5 on p. 425. Flame-photometry, too, might well have received some attention, as it is extensively used at the present time. In the section dealing with specific colorimetric determinations (Part 4), the references could be, in some instances, usefully extended. Thus the later work of Somogyi (*J. Biol. Chem.*, 19, 195 ; 1952) could be mentioned on p. 350. Under sugars, neither in the colorimetric section nor under chromatography is there a reference to the use of 2 : 3 : 5-triphenyltetrazolium chloride (Wallenfalls, K., *Angew. Chemie*, 23, 491 ; 1953). Again, under benzene, p. 359, some reference could well be made to the important work of Dolin (*Indust. Eng. Chem., Anal. Ed.*, 15, 242 ; 1943).

Part 7 deals with chromatography, and as everyone conversant with the modern literature will allow, it is quite impossible to compress this subject into eighty-three pages. The authors have kept to their usual plan of a short theoretical introduction followed by a good description of apparatus and technique, terminated by selected samples of detailed procedures. On p. 628, par. 3, they make some somewhat disparaging remarks about the accuracy of paper chromatography. These comments would, perhaps, have been better expressed as criticisms of the methods used for the final evaluation of the separated substances, for surely their separation on the paper is complete, even if no method exists for their accurate determination. In the inorganic field, the well-known book of Pollard and McOmie could, with advantage, be included in the references at the bottom of p. 628.

Part 8 is a description of methods of biological assay. The introduction follows the general plan of the book and is brief but adequate. The section dealing with the calculation of results is, perhaps, rather too mathematically profound for the brief treatment given to the rest of the subject. While the methods of E. C. Wood are, without doubt, of great value, it could well be stated that calculations based on simple graphs, used with intelligence, are capable of giving good results. Otherwise, analysts might reject these methods as being too complicated when, in fact, they are relatively easy to carry out.

The book as a whole is well produced, with bold chapter headings and satisfactory sub-headings. Both the author index and the subject index are easy to use. In the years to come, "Milton and Waters" will doubtless be a useful book for those engaged in micro-chemistry ; but if a third edition is contemplated, additions to the existing work will not be enough. The time will then have arrived when nothing but a complete re-writing will suffice.

E. Q. Laws

Proceedings of the 1954 Glasgow Conference on Nuclear and Meson Physics

Edited by E. H. Bellamy and R. G. Moorhouse. (Conference sponsored by the International Union of Pure and Applied Physics.) Pp. ix + 352 + 5 plates. (London and New York: Pergamon Press, Ltd., 1955.) 63*s*. net.

THIS record of the 1954 Glasgow conference on nuclear and meson physics sponsored by the International Union of Pure and Applied Physics is divided into eight sections. The first four of these sections, which deal with nuclear constitution, properties and problems, occupy some two-thirds of the volume, while Part 5 collects the papers on π-mesons and Part 6 contains a few papers under the heading of field theory. The last two sections, dealing respectively with high-energy experimental techniques and with heavy mesons and hyperons, although short, are far from being the least interesting sections. Some particularly striking photographs illustrate Hildebrand's paper on bubble chambers.

Generally, each section of the book is introduced by one or two review papers; these give a comprehensive survey of the state of nuclear and meson physics in July 1954. Of some ninety other papers, the majority report on experimental results current at the time of the conference and discuss the implications of these results. As presented in the book, individual papers range in length from a few lines to several pages, and, although the space allocated to the various papers is not always an indication of their relative value, the editors and the publisher must be congratulated in making available a very adequate and readable account of the proceedings of the conference. Some significant points emerge in the edited version of the discussion which follows many of the papers.

To the many who may wish on occasion to use this book for reference purposes, the lack of an index will constitute a handicap. Paper titles, as listed at the beginning of the volume, are not in general a sufficient guide to the content of the papers. I feel that the extra labour required to index the subject-matter adequately would have made a useful book more valuable. J. C. BOWER

A History of Red Tape

An Account of the Origin and Development of the Civil Service. By Sir John Craig. Pp. vii + 211 + 12 plates. (London: Macdonald and Evans, Ltd., 1955.) 18*s*. net.

SIR JOHN CRAIG'S engaging account of the origin and development of the British Civil Service, as its sub-title indicates, goes farther back than E. W. Cohen's standard book, but makes no attempt to cover the decade and a half since that book was published, nor can it claim to be as serious a historical study. It is instead a readable and entertaining essay in which the author makes no attempt to disguise his own views and prejudices, particularly against the Trevelyan–Northcote reforms. On that question, and on the recruitment to the Civil Service by open competition, his highly critical remarks should be read in the light of Sir Edward Bridge's observations on the reforms of 1854 in a recent issue of the *Political Quarterly*, or of Prof. K. C. Wheare's lecture on "The Civil Service in the Constitution" to the University of London in 1954. Nevertheless, they remind the reader that there is another side and sound a note of caution to over-enthusiastic advocates of changes in methods of recruitment which R. K. Kelsall's recent study might stimulate. Sir John presents an immense array of facts in a most attractive guise and from an unusual angle, nor is the detail ever allowed to confuse the reader or his own prejudices to distort the picture. To the discussion on the adequacy of the Civil Service to the needs of to-day or the changes required in organization or elsewhere to increase its efficiency, his book makes no contribution except in so far as it gives a clear understanding of how the Civil Service came to be, and a warning as to directions in which change or reform requires caution and great care. There are an interesting list, up to the end of the nineteenth century, of literary men who held posts in the Civil Service, and a short bibliography that is remarkable no less for the inclusions than for the omissions. R. B.

Ferromagnetic Domains

By Dr. K. H. Stewart. (Cambridge Monographs on Physics.) Pp. xi + 176 + 7 plates. (Cambridge: At the University Press, 1954.) 25*s*. net.

IN his preface, Dr. K. H. Stewart states that "this book attempts to give a coherent outline of the fundamentals of domain behaviour . . .", and in the reviewer's opinion he has succeeded in giving a clear survey of the subject. It must be pointed out that the book was published more than a year ago, with the preface dated October 1953, and that there are few references to papers published after 1952.

An introductory chapter deals with the domain hypothesis and its implications, and then magneto-crystalline anisotropy, magnetostriction and the effects of stresses on magnetic properties are dealt with in some detail. There follow chapters on domain arrangements, with particular reference to single crystals, on the widths of, and energies in, domain walls, and on the factors affecting domain wall movement. The final two chapters briefly discuss time effects in magnetization and thermal energy changes involved in magnetization processes.

This is essentially a review of a subject which has expanded considerably in post-war years, and in only 170 pages a reader must expect some aspects to be dealt with most briefly. In particular, experimental detail—for example, the technique of producing domain powder patterns—has been reduced to the minimum. The book is well written and produced, and is fully illustrated with clear, though often rather small, diagrams. It will be of value to many, especially those whose interests lie on the fringe of this field and whose knowledge might otherwise end there. The information can easily be brought to the present date by consulting, for example, recent *Proceedings of the Physical Society*.

A Cuckoo in the House

By Maxwell Knight. Pp. ix + 80 + 6 plates. (London: Methuen and Co., Ltd., 1955.) 7*s*. 6*d*. net.

MR. MAXWELL KNIGHT took a young cuckoo from the nest of its foster parents and brought it up by hand. It became quite domesticated and very confiding. It was allowed full freedom and flew where it pleased, but remained with him until migration time, when after a display of restlessness it disappeared. In this little book, illustrated with some excellent photographs, he tells about the bird, its disposition and behaviour, discussing at the same time various cuckoo problems and bird problems in general. F. P.

THE THERMAL HISTORY OF THE EARTH

By Prof. J. A. JACOBS and D. W. ALLAN
Department of Physics, University of Toronto

ABOUT two years ago, a detailed study of the thermal history of the Earth was begun at the University of Toronto. First results of this investigation have been presented at several meetings[1]. It should be emphasized that this study does not pretend to have determined the temperature and heat-flow at different times and depths within the *actual* Earth, nor has it included every possible physical mechanism which may have played a part in the Earth's thermal regime. What has been determined is a method of calculating the temperature and heat-flow at a number of times in the past and at depths within a particular type of Earth model, namely, that of an Earth cooling by conduction alone, and in which the radioactive substances are distributed in concentric shells of uniform concentration. A number of Earth models of this type have been investigated covering a wide range of possible Earth structures and evolutions.

Briefly, what has been done is that the equation of heat conduction for a radioactive Earth has been solved with the aid of FERUT, the electronic computer at the University of Toronto. Details of the computation have been given elsewhere[2]. It is easy to show that the problem can be broken into two parts: the cooling of the Earth from its initial temperature, and the heating up of the Earth due to radioactivity.

The initial temperature depends, of course, on the origin of the Earth. Broadly speaking, there are two schools of thought: those that postulate a hot origin and those that postulate a cold origin. If the Earth had a hot origin, its thermal history may be traced from the time of solidification, the initial temperature being close to the melting point. If the Earth was formed by the cold accretion of dust particles, then, quite apart from radioactivity, it would heat up due to compression, although it may not have become completely molten. Fig. 1 shows four initial temperature curves that have been considered: (I) the melting point curve due to Bullard[3], with a temperature at the centre of the Earth of about 8,000° C.; (II) the melting point curve due to Uffen[4], with a temperature at the centre of the Earth of about 5,500° C.; (III) the melting point curve due to Jacobs[5], with a temperature at the centre of the Earth of about 4,500° C.; (IV) a temperature distribution due to a cold origin. If the heating effects of compression, the formation of an iron core, etc., raised the temperature to the melting point, cases I, II or III would apply. If these effects were not large, it is plausible that there would not be much variation of temperature with depth, and a constant value of 1,000° C. has arbitrarily been chosen. Variations from this value can easily be allowed for.

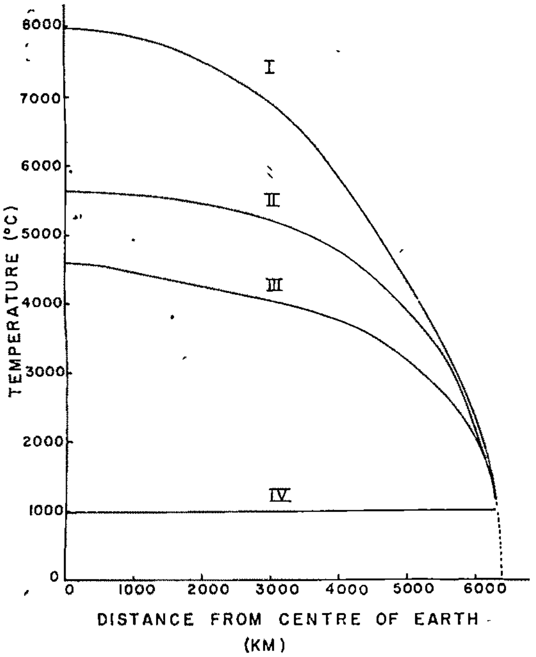

Fig. 1. Initial distribution of temperature

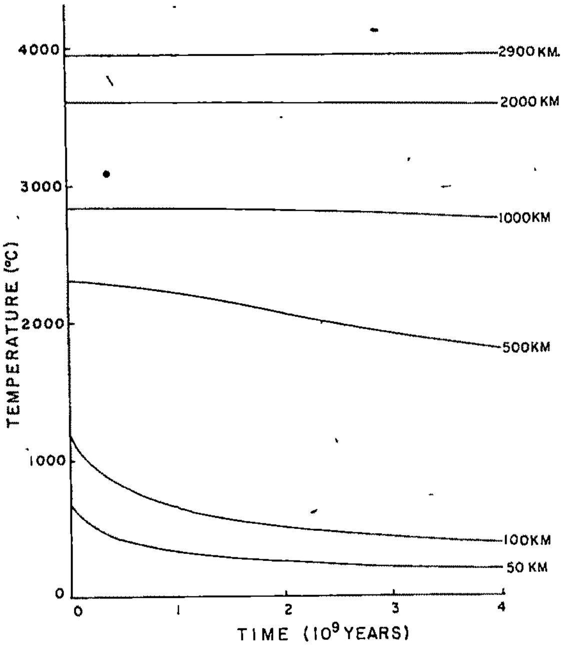

Fig. 2. Temperature–time distribution at various depths for a non-radioactive Earth (Model III)

Very similar features appear in the cooling of the Earth from any one of these initial temperature distributions. Fig. 2, which is for Model III, is representative of all four cases, and demonstrates how slowly temperatures change at great depths. At these depths thermal conditions are not greatly different from their initial values. Near the surface, on the other hand, cooling is considerable, and the surface heat-flow after four thousand million years is but little affected by the values taken for the initial temperature distribution in the first few tens of kilometres.

The second part of the problem, the heating of the Earth due to radioactivity, is far more complex, and

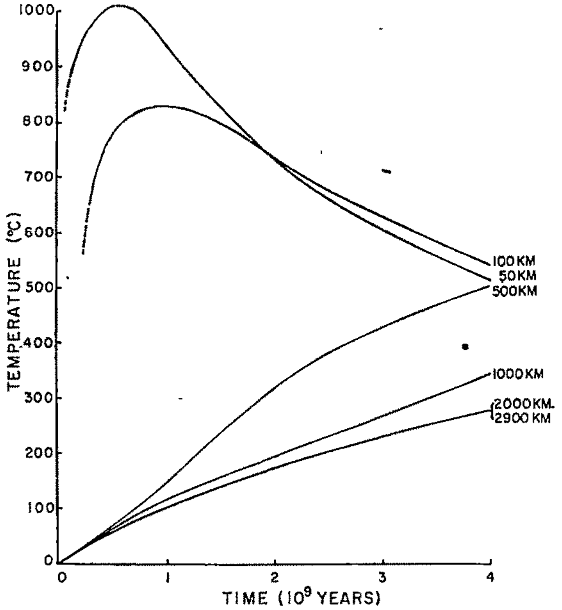

Fig. 3. Temperature–time distribution at various depths for a radioactive Earth (Model *B*)

a complete solution would have been impossible without the aid of an electronic computer. The method of solution allows for any desired concentration in nine shells. It is thus possible to approximate fairly accurately to quite varied distributions of radioactivity.

Four models have so far been investigated, all with the time at which cooling by conduction began taken as four thousand million years. This may be slightly low, since the age of the Earth is now generally believed to be about 4½ thousand million years[6]. However, an increase of 500 million years would not change the general behaviour of the various models considered.

Model *A* is a simplified one, and does not attempt to fit the details of crustal structure. This simplified model consists of three shells: a thin crustal layer 20 km. thick of granite–granodiorite composition, a uniform mantle of dunite, and a dense core of the composition of iron meteorites. Apart from the simplified crustal layer, this model is identical with one proposed by Bullen. Model *B*, originally due to Adams and Williamson, is considerably more detailed. A structure of four 15-km. layers is taken for the crust, with the top layer of granite–granodiorite composition, and the remaining three layers of composition changing from acidic to basic. From 60 to 1,600 km. the material of the mantle is identified as dunite and from 1,600 to 3,000 km. it is taken as of the same composition as pallasitic meteorites. The core is again identified with iron meteorites. The temperatures at different depths in the Earth at different times in the past for this model are shown in Fig. 3. It can be seen that at depth there is a continual increase in temperature, whereas near the surface, after a very rapid rise, the temperature begins to decrease with time. Model *C* is a modification of Model *B*, reducing the radioactivity in the surface layers. For this model a structure of two 15-km. layers is taken for the crust, instead of the four of Model *B*. Thus the layer of dunite extends from 30 km. to 1,600 km. Finally, for the sake of comparison, Model *D* was constructed, which allows for a uniform distribution of radioactivity. Although the same continual increase in temperature at depth with time occurs, the rapid rise followed by a decrease near the surface is absent in this case. Instead, near the surface, temperatures gradually increase with time, but at a much slower rate than at depth. This is due, of course, to the removal of the high concentration of radioactivity in the crustal layers, which is a feature of the other models. It should be noted that the identification of the Earth's mantle with chondritic meteorites is now thoroughly discredited[7], and no model with the relatively high concentrations which such an identification would entail has been considered.

The complete thermal picture of the Earth requires adding the cooling of the Earth from its initial temperature to the heating up of the Earth by radioactivity, that is, combining any of the four models I, II, III or IV with any of the four models *A*, *B*, *C* or *D*. This allows for sixteen possible combinations, and it is not practicable to reproduce them all here. However, many similarities between the models exist. Fig. 4 gives the temperature distribution for Model III *B*, which is representative of a hot origin of the Earth. In spite of the extremely low concentrations of radioactivity in the deep mantle and core, there is still a heating up there of two or three hundred degrees. Near the surface, conditions appear to have been greatly different in the far past from those existing at present—in fact, there may even have been remelting of material near the surface (down to about 100 km.) during the first thousand million years or so. If so, this could explain the now fairly well established fact that the Earth as a whole is about 4½ thousand million years old[6], whereas no rocks have been found much older than about three thousand million years. (A similar suggestion was made by W. D. Urry some years ago[8].) However, this brief temperature rise at the beginning soon ceased and cooling commenced. The rate of cooling was greater in the past than it is now, and this suggests that orogenetic activity may have decreased

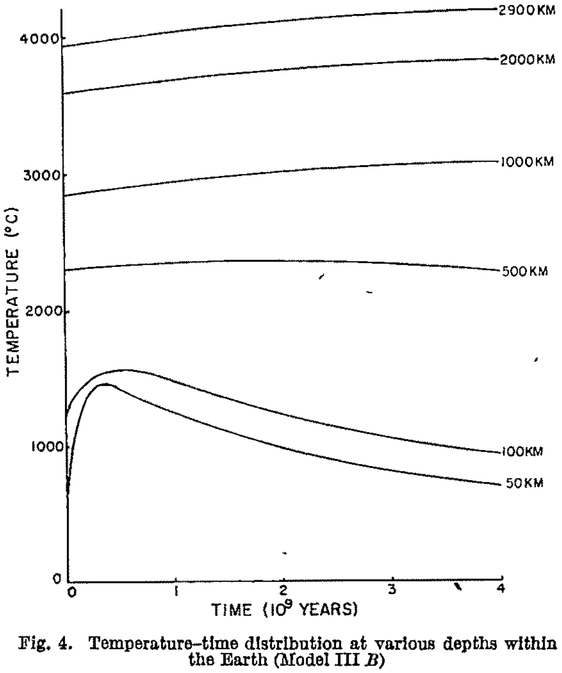

Fig. 4. Temperature–time distribution at various depths within the Earth (Model III *B*)

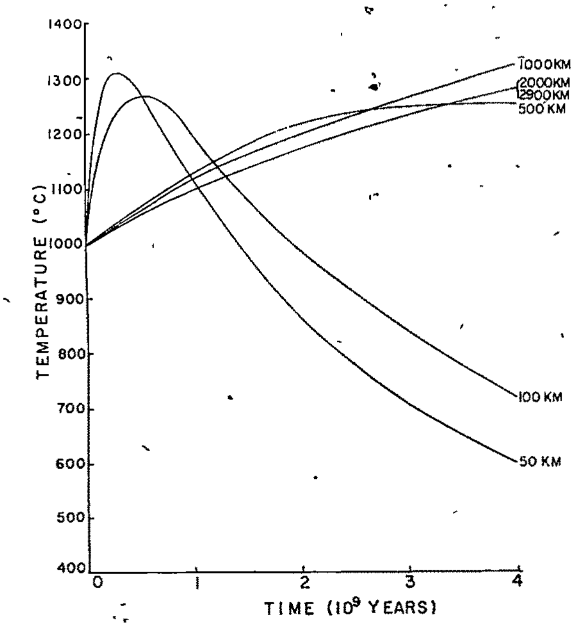

Fig. 5. Temperature–time distribution at various depths within the Earth (Model IV *B*)

with time, and perhaps have been caused by different processes in the far past. The present temperatures at depths of 50–100 km. differ by as much as 200° C. between Models III *A* and III *B*. These models are representative of conditions beneath the oceans and continents, and such a temperature difference may well exist and have an important bearing on orogenesis. Fig. 5 gives the temperature distribution for Model IV *B*—an Earth with a cold origin. Here the thermal history is very dependent on the value assumed for the constant initial temperature. As shown in Fig. 5, if this is taken as 1,000° C., there is heating at depth and an initial temperature rise near the surface, as before. For a value of 2,000° C., there is no initial rise near the surface.

In conclusion, two points stand out from the investigation so far carried out. First, all the models of the Earth studied indicate that the temperature at depth has continued to increase throughout geological time, the temperature at the core boundary having increased most probably by about 300° C. Secondly, although radioactivity plays a major part in the thermal history of the Earth, the initial distribution of temperature dominates thermal conditions at depth and near the surface for the first thousand million years or so. The cosmological questions involved in the origin of the Earth cannot unfortunately be shelved. The discovery of radioactivity, although helping to solve many geophysical problems, cannot in itself wholly explain the Earth's thermal regime.

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PRODUCTION AND UTILIZATION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

DURING September 13–16 a conference on "The Production and Utilization of Electromagnetically Enriched Isotopes" was held in the Cockcroft Hall at the Atomic Energy Research Establishment, Harwell. This was the first meeting to have been arranged on the subject since details were declassified of the calutrons which are now used for enrichment of the isotopes of all the elements. The meeting was attended by Dr. C. P. Keim, Dr. C. E. Normand, and Mr. Boyd Weaver (Stable Isotope Division, Oak Ridge National Laboratory, United States); representatives of separator groups at Copenhagen, Amsterdam, Paris (Commissariat à l'Énergie Atomique, Saclay), Stockholm, Upsala and Gothenburg; members of interested groups in Egypt, Yugoslavia, Belgium and Western Germany; representatives of the nuclear physics departments of a number of universities in Great Britain; members of the group concerned with electromagnetic separation at Harwell; and other interested research workers. An unusually lively meeting resulted. The programme covered the following fields: ion sources, collector problems, chemical aspects and target preparation, utilization, analysis of isotopic abundance, the design of electromagnetic separators, and the use of the separator for active materials as a tool in nuclear research.

The conference was particularly concerned with the stable isotopes other than those of the elements hydrogen, carbon, nitrogen and oxygen, which are enriched by other methods and the application of which has been abundantly dealt with in a variety of reviews. Mr. D. W. Fry, chief physicist of the Atomic Energy Research Establishment, welcomed the delegates and briefly reviewed the twenty-eight papers to be given

Ion Sources

At the session on ion sources, held under the chairmanship of Dr. P. C. Thonemann (Harwell), the first paper was by Dr. Normand, of the Oak Ridge separator project, who described the ion sources used in the calutrons. At first the ion source at Oak Ridge was heated by resistance-type (calrod) heaters embedded in the cast-copper charge oven and arc-chamber support block. The service temperature-limit for heaters of this type restricted the operating temperature to about 700° C. or less, even when the casting of the charge oven was surrounded by stainless-steel heat shielding. The substitution of graphite components for the copper source castings, and of graphite strip heaters for the embedded calrod heaters, resulted in a source capable of operating at regulated temperatures up to approximately 1,000° C. In order to vaporize metals of the platinum and palladium groups directly into the ionizing arc, a third type of source was developed in which heating was by means of high-energy electron bombardment.

Prof. J. Kistemaker then described the ion sources of the Amsterdam separator, which is a 180° machine having an ion output of up to 10 m.amp. In particular, he gave a description of the five types of breakdown of the high voltage used in the acceleration of the positive ions from the ion source. Mr. O. E. G. Almén described developments of ion sources in Scandinavia. At present the magnetic type is used exclusively, with the magnetic field either parallel with, or perpendicular to, the direction of the extracted ion beam. A feature of the Copenhagen source is the use of a vacuum lock for the introduction of the source material so that separation can be made with very short-lived isotopes.

Great interest was aroused by the description, by Dr. R. Bernas (Paris), of a new sputtering-type ion source suitable for the elements of low vapour pressure. In this method the element is sputtered into the arc chamber using a primary argon discharge. This source is still under development, but is extremely versatile and has valuable possibilities for the separation of radioactive elements produced, for example, by bombarding a foil in an accelerator. Dr. R. H. Dawton then reviewed experimental work at Harwell during the past few years on a number of ion sources, including filament sources, radio-frequency types, a sputtering type, a Kunsman source, and sources depending on thermal ionization. Some of these sources have been realized in practice and are being used with the new sector separator recently constructed at Harwell.

Collector Problems

For the second session, on collector problems, Dr. J. Koch (Copenhagen) was in the chair, and the proceedings opened with a description by Dr. Normand of the unit used for collecting heavy ion beams at Oak Ridge. These beams may amount to more than 100 m.amp. at 30 kV., and the difficulties were concerned with the space available as well as the problems of dealing with the energy dissipation and collector erosion. The special constructions which are used to minimize losses by evaporation and sputtering were described and also the arrangements used to prevent cross-contamination of isotopes. A more detailed description was given of the refrigeration system necessary for mercury collection, and of the special collector arrangements. Dr. M. L. Smith then dealt with experience at Harwell in the same problem, discussing particularly the chemical contamination of isotopes. He also described arrangements suitable for the collection of the very volatile elements such as sulphur and chlorine, the gases oxygen and nitrogen, and the rare gases.

The problem of the collection of mercury was returned to by Dr. Ranc (Saclay atomic energy group), in whose system the source is supplied with mercury vapour while collection is achieved on gold foil cooled with liquid nitrogen. To obviate contamination from the mercury vapour existing in the tank at room temperature, a secondary liquid-air trap is placed near the source and provided with a slit, so that only the directed mercury ions can pass.

Chemical Aspects and Target Preparation

In the session on chemical aspects and target preparation, under the chairmanship of Mr. Boyd Weaver (chief chemist of the Oak Ridge Stable Isotope Group), Dr. K. O. Neilsen (Copenhagen) considered the penetration of ions into solid lattices. This problem is important in connexion with the preparation of gas targets and is also of interest to several other studies such as that of the recoil atoms from nuclear reactions and, in particular, the field of radiation damage. The theoretical conclusions obtained from his work were compared with experimental studies by nuclear reactions which enable the distribution in depth to which the ions have penetrated to be found.

Other methods of preparing separated isotopic targets for nuclear reaction studies were described in the next paper by Dr. Smith. He commented on the advantages of a central station for isotopic target preparation, considered the requirements for nuclear targets and described some typical techniques. The most versatile is vacuum evaporation, which besides its application to salts can also be used for evaporation of the refractory metals such as magnesium and silicon to give elemental deposits by using tantalum filaments as a source on which the oxide is reduced. This method can also be used for the preparation of metallic targets of the alkali and alkaline-earth metals, and special handling techniques were described by Dr. Smith for these. Direct deposition in the separator is used for various gases and for boron, which stays down with less than 10 per cent sputtering on a variety of metallic backings.

Mr. Boyd Weaver then described in some detail chemical aspects of the work on electromagnetic separation, dealing first with the preparation of charge materials. So far, more than fifty elements have been separated, and in most cases some special chemical operations have been necessary or helpful in the supplying of suitable charge materials for the separators. Whenever possible, a variety of forms of each element has been prepared in order to make comparisons between halides, oxides and elements. Improvements in operating efficiency have been attained by applications of such techniques as vacuum dehydration and pelletizing. Half the elements still unseparated consist of the rarer rare earths. In order to make as much as a kilogram of each of these available, various methods of separation have been explored. Separation by continuous counter-current extraction between nitric acid and tributyl phosphate has been developed and applied to the preparation of unusual quantities of these elements.

Turning to the processing of the enriched material in the collectors, Mr. Weaver pointed out that these are always contaminated by a large number of other elements which have to be removed in order to obtain the pure material needed for nuclear research. The purifications require an unusual type of quantitative analytical chemistry, in which the emphasis is on separation rather than on measurement of quantities. Purification schemes suitable for quantities from milligrams to grams have been developed for each of the elements.

Applications of Electromagnetically Enriched Isotopes

In this session the chairman, Dr. Keim, gave a wide-ranging review of the achievements of the stable-isotopes programme in the United States, which, so far, has involved the dispatch of more than 2,600 consignments of stable isotopes to users in sponsored establishments of the Atomic Energy Commission, government agencies, universities and industries. Dr. Keim pointed out, however, that the contributions which stable isotopes are making to basic science and in a growing number of practical applications are not widely appreciated. This is largely because stable isotopes are at present of greatest value to the research physicist in fundamental investigations which receive little publicity. There is also a reluctance to use enriched samples, as they appear to be expensive, although, in fact, only small quantities may be needed, while other savings may justify their use. They are, too, more difficult to use than radioisotopes, but improvements in mass-spectrometry techniques will help here.

Dr. Keim quoted the immense range of work already published and went on to describe a few particular applications of stable isotopes. These included: their use as starting materials in the assignment of masses to artificially produced radioisotopes and in investigations of their disintegrations; the determination of neutron absorption, scattering, and total cross-sections at all neutron energies; atomic spectroscopy, especially in the study of hyperfine spectra, isotope shifts, nuclear spins, etc.; the determination of nuclear energy-levels, and studies of isomerism; superconductivity, self-diffusion, coefficients of expansion and other solid-physics studies; β-spectroscopy using enriched isotopes like potassium-40 and beryllium-10; use for pile and cyclotron bombardments to produce radioisotopes of high purity and high specific activity, and to produce certain isotopes otherwise unavailable at a reasonable cost; use as tracers in isotope-dilution analysis, a technique which is now being increasingly applied in geology, agriculture, metallurgy and biology.

Dr. W. D. Allen (Nuclear Physics Division, Harwell) then described the investigations which have been carried out with materials supplied by the separator group at Harwell. He illustrated his lecture by details of a few particular investigations out of many which have been carried out during the past five years using the six hundred and fifty consignments which have so far been dispatched by Harwell to users in many countries. Dr. Allen first described reaction studies with the van de Graaff and Cockcroft–Walton machines and then gave a detailed review of a variety of studies using neutrons, describing, in particular, the current work on fast-neutron capture in the Zephyr reactor. This work refines the earlier studies by D. J. Hughes of the variation of cross-section with atomic weight which has some cosmological implications and also throws more light on the magic-number nuclei.

Dr. Allen considered a variety of other topics, including β-ray studies; (n,p) reactions using 14-MeV. neutrons; several other reaction studies; and photo-disintegration. In a forecast of future work with electromagnetically enriched isotopes he said that the work on neutron cross-sections in all energy-ranges is only just beginning. Studies in Coulomb excitation show much promise; the work with 1-MeV. high-tension sets in many universities will continue and will gradually extend to the masses in the range oxygen-16 to calcium-40. He also mentioned tritium and helium-3 reactions and the very interesting subject of double β-decay.

Dr. J. C. Kluyver (University of Utrecht) then described the investigations he has been making on (p,γ) reactions using enriched isotopic targets of magnesium and silicon. It is imperative to use enriched targets for this study in order to assign correctly each proton-capture resonance. With a non-separated target, this assignment is very difficult as aluminium-25 and -26 have nearly equal half-lives, and the long-lived aluminium-26 may easily be confused with the stable aluminium-27 as product nucleus. As natural magnesium contains 79, 10 and 11 per cent of the isotopes of weight 24, 25 and 26, respectively, isotopic targets of magnesium-25 and -26 are nearly tenfold enriched, and a corresponding gain in the γ-ray yield is obtained. Also, the analysis of the weak ^{25}Mg (p,γ) resonances is greatly facilitated by the reduction in the intensities of the forty-times stronger ^{26}Mg (p,γ) resonances in their neighbourhood. From this work the energy-level schemes of aluminium-26 have been worked out. The use of isotopic targets of other elements in (p,γ) reactions will have similar advantages.

Dr. H. G. Kuhn (University of Oxford) then gave a polished account of applications in spectroscopy and in solid physics. He said that the differences in the masses of isotopes give rise to vibrational and rotational isotope effects in molecular spectra. Their study, either by optical or microwave methods, can be an important aid in the analysis of spectra. In atomic spectra the mass effect is predominant in the lighter elements, and its study is necessary for isolating the more important 'volume effects'.

A great variety of interesting spectroscopic effects are caused by differences, between the different isotopes, of their values of nuclear spin (I), magnetic moment (μ), electric quadrupole moment (Q) and distribution of charge inside the nucleus. Investigations of these effects are often very difficult, and sometimes impossible, unless highly enriched isotope samples are available. Light sources containing certain pure or highly enriched isotopes can produce very highly monochromatic light. This property makes them suitable for use as wave-length standards, for interferometric measurements of gauges of great length and for purposes of adjustment of interferometers of long path.

Most properties of solids depend on the atomic masses, and the study of isotope effects can be a powerful means of testing the validity of theories. Such effects are usually small and difficult to measure, but some variable results on the transition points of supraconductivity and on the rate of change of electrical resistance of metals with temperature have already been obtained. Apart from their bearing on the theories of conduction and supraconductivity, results of this kind are likely to contribute generally to the knowledge of the structure of solids.

Isotopic Abundance Analysis

The session on isotopic abundance analysis, with Prof. J. H. E. Mattauch (Max-Planck Institut für Chemie, Mainz) in the chair, was one of the most vigorous of the conference. It opened with an account by Dr. Keim of work at Oak Ridge, where the mass-spectrometry section is concerned with analysis of samples from the separator group and also with a variety of research problems in collaboration with many institutions. During the past few years the tendency has been to move to techniques for the less-volatile elements requiring high source-temperatures, and so special furnace and thermal ionization methods have been especially developed. Techniques of small-sample loading employing micro-pipettes and a microscope were described, and the advantages and problems of working with extremely small samples of a few micrograms were discussed. Details were given of a range of instruments developed in the group, including one made by the General Electric Corporation. Mr. G. H. Palmer then described the work at Harwell in this field. He said that, as in Oak Ridge, the emphasis has been on handling solid samples rather than gases, and described the precautions necessary for this kind of work. In particular, he discussed the difficulties of quickly comparing samples and obtaining ion beams of constant intensity. He then described a new mass spectrometer which has been developed at Harwell, in association with Metropolitan-Vickers Co., Ltd., especially for solid analysis and which incorporates both furnace and triple-filament assembly types of sources together with a variety of detection devices. In a selective review of Harwell work, he described results obtained with lithium, lead and uranium. Mr. Palmer then went on to read a paper by Prof. G. D. L. Schreiner and Dr. R. T. Jamieson (Johannesburg) on age determination by isotopic-dilution techniques. This was a valuable and detailed discussion of the theoretical basis and the errors in the technique, with particular emphasis on the rubidium–strontium method.

Among the papers at this session was a notable contribution by Dr. H. Hinterberger (Mainz). He first dealt with the principles and mass-spectrometric techniques used in isotopic-dilution methods, and then went on to survey work in this field. After a discussion of the potassium–argon method used in the determination of the age of the Earth, he described his own recent contribution with the newly developed rhenium–osmium method. This very interesting work is probably a unique example of the success of mass spectrometry over the counting methods.

The last paper of the session, by Dr. A. H. Gillieson (Chemistry Division, Harwell), discussed methods other than mass spectrometry by which measurements may be made of isotopic abundance. The methods dealt with can be briefly listed as: neutron source methods (neutron absorption, radioactivation); optical methods (emission spectroscopy, absorption spectroscopy, refractive index); and mass methods (density). Evidently there are several alternatives to mass spectrometry which should be considered in practical problems.

Design of Electromagnetic Separators

This session, with Prof. Kistemaker in the chair, brought excellent papers from three leading workers in the field, the first being Dr. Normand, who gave a detailed and beautifully illustrated review of the Oak Ridge plant with technical details of the installation. The present equipment includes two small and two large calutrons which are operated for seven days a week on three shifts, and it is being planned to extend the facilities by adding two more large calutrons shortly.

Dr. Dawton then discussed the design considerations which led to the construction of the new high-resolution separator at Harwell. This machine, which is intended for enrichment of the isotopes of the transuranic elements and of fission products where high activities may be encountered, is a 4-ft. radius, 90° separator of the Nier type and is as fully automatic as possible. A detailed description was given of the remote-handling device for removal of the collectors containing the enriched product without exposure to air. Recent experimental results on the properties of plutonium of particular importance to its electromagnetic separation were also described.

Dr. Koch gave a masterly review of the Scandinavian separators in which, speaking for the groups in the three Swedish laboratories as well as for his own laboratory at Copenhagen, he described all four instruments. These separators have much in common, and a best basic design for use in nuclear studies has clearly been developed by these workers during the past fifteen years. The application to research on short-lived isotopes by integrating the separator with other tools such as the cyclotron and β-ray spectrometer to make a unified assembly which can attack most powerfully nuclear problems of all types was demonstrated. Dr. Koch concluded by making a plea for the preparation of the widest variety of stable and radioactive isotopes in the state of highest purity.

Two papers were presented to the conference at the last moment, and these fitted best with the session on design. The first was a theoretical paper by Dr. H. Bruck (Saclay), who showed that, for a magnetic separator of the usual sector type, the use of the alternating gradient principle in magnet design instead of the usual arrangement of a uniform magnetic field so far employed gives greater dispersion. In effect, one can have higher dispersion for the same radius, or the same dispersion for a smaller radius. The last paper was a possibly prophetic contribution beautifully presented by Dr. O. Osberghaus on the use of alternating-gradient electrical focusing for mass separation. In this system, using an arrangement very similar to that used on high-energy machines for beam ducting, a direct-current and radio-frequency voltage are applied to alternate plates. An experimental unit using this system has been successfully run at Bonn, and a larger one is now being constructed. This device is limited to small ion beams because of the lack of space-charge stabilization, but it seems that the principle may be useful for beams of up to 100 μamp. Dr. Osberghaus, who is working with Prof. W. Paul at Bonn, envisages two systems, one in which a selected mass is passed alone and the other in which a selected mass can be rejected.

Separation of Active Material

The last session, under the chairmanship of Dr. Bernas, consisted of two papers, though the earlier paper by Dr. Koch had, in fact, largely dealt with the same subject. Dr. G. Andersson reviewed nuclear studies in Scandinavia carried out with electromagnetically enriched radioisotopes. He described first the use of the separator for the preparation of samples of known masses for beta-ray spectroscopy and, in particular, for work on the rare-gas isotopes which are studied after trapping in foils. Extensive work on the radioactive nuclides of krypton and xenon has been done at Stockholm by this technique.

Dr. Bernas then dealt with his work at Saclay, where he has constructed a medium-sized separator particularly suitable for the elements of light and medium mass. This instrument can separate tens of milligrams of a given element in a day, while being sufficiently flexible to separate in rapid succession the radioactive isotopes of widely differing elements. Actual experience with this instrument has shown that both modes of operation are possible and successful; they provide alternative experimental approaches to the particular problems, and Dr. Bernas discussed their relative merits. He also described in some detail the work on technetium, which is prepared by cyclotron irradiation of a molybdenum target and then mass-separated. An interesting example of the application of the separator to alpha-particle spectroscopy was also described.

A lively discussion followed every paper, and it was felt that the conference had had some important results in directing attention to a great variety of applications of mass spectroscopy, and in describing many applications of electromagnetically enriched isotopes. Hitherto, the more spectacular application of radioisotopes and the relative ease of their techniques of use has overshadowed the uses of stable isotopes. It was felt that the present conference would show the rich field of work still waiting to be done in the latter field. In summing up, one might say that three main types of activity could be clearly recognized at the conference: the work of the two groups at Oak Ridge and Harwell in the provision of enriched isotopes for basic research of all kinds; the work of several European groups in the application of medium-sized isotope mass-separators to the direct study of a great range of nuclear problems; and lastly the large numbers of research workers who essentially are applying the enriched isotopes provided by Oak Ridge and Harwell to a great variety of researches. An important result of the conference was that the common interests of these groups were clearly recognized and great stimulus given to their work. It is hoped that on publication of the proceedings a much fuller appreciation of this new field will be generally gained. The proceedings, including lectures, discussion and illustrations, will be published shortly by Butterworths Scientific Publications, Ltd., London.

M. L. SMITH

MANAGEMENT AND HUMAN RELATIONS

AN attendance of nine hundred members at the annual conference of the Institute of Personnel Management at Harrogate during October 7–9 is an indication of the growing importance attached to the personnel function of management in British industry. Those attending came from very large and small manufacturing firms, departmental stores, nationalized industries, public corporations, insurance and other commercial concerns, educational institutions and the Armed Forces. A number came from overseas. At the plenary sessions speeches of a high order were given, and at the various sectional meetings the investigations now being made into the behaviour of people in industry by a number of research organizations were discussed.

Sir John Hunt, leader of the British Mount Everest Expedition in 1953, opened the conference with a challenging paper on the needs of youth in a Welfare State. There are, he said, many signs that the spirit of young people is either flagging or misdirected; there is too much apathy and hooliganism abroad. A great deal of fine work is still being done to help young people find their feet and set them on the road to good citizenship, and yet it would be foolish to be complacent and suppose that more could not and should not be done. Something is lacking in the opportunities offered, in the guidance given: What is this lack? First, the incentive to achievement is generally inadequate. If it is accepted that one of the needs in every individual is a sense of purpose, then the opportunity of achievement is an essential step in providing that purpose. Secondly, there is a great need for leaders, both in numbers and in quality. The paid-official alone will not do, and the need is for more volunteers, because they bring to young people a variety of experience of contemporary life. Ideally, leaders should have graduated from a similar background to members of the group —the best leadership is leadership from within the group, not from above it. The main source of youth leaders should be ex-members of the organizations themselves rather than older men implanted from outside and from a different environment.

A scheme should be devised which embodies incentives and sets certain targets or standards of achievement. How can such a scheme be made attractive and how can it work? Can a scheme of wide application be devised which might draw in more young people? Sir John suggested that it should be planned under four headings: the development of a hobby—a technical, scientific or artistic skill; the development of physical fitness—this calls for moral as well as physical stamina; outings, whether on foot or cycle or in a small boat—these are of tremendous value to the character training of young people and can be extended progressively until they assume the character of expeditions; and the instilling of the spirit of service—this is best caught by example, and the example must come from the leader.

Sir John was followed by Sir Richard Coppock, general secretary of the National Federation of Building Trade Operatives, who said that, in the main, the weakness of the building industry is on the managerial plane. He was particularly concerned about the missed opportunities for consultation between management and worker. The experience the workers possess is the basis of Britain's prosperity and is unequalled in any board-room in the country. Things do not go wrong on the drawing-board, he maintained, but when machines are being run and built, and he quoted the Comet aircraft as a good example of this. Half the difficulties in his industry arise because the employer does not enlist the goodwill of his men by telling them all the facts. The great problem facing management is how to handle men. One of the most vicious things they can do, when an unofficial strike takes place over some petty tyranny, is to say: "You must all go back at once. We cannot see you". This, said Sir Richard, puts the trade-union official in a most humiliating position—he is humiliated before negotiations have even begun.

Some management problems in the British Broadcasting Corporation were discussed by the director-general, Sir Ian Jacob. The Corporation employs

13,823 men and women, made up of 3,230 monthly paid staff, 3,950 secretarial and clerical staff and 3,643 manual staff. They belong to some fifty nationalities and more than a hundred professions which, with the wide geographical spread, create peculiar problems. The executive management is carried out by a board which consists of the director-general and six other directors. The directors of Sound Broadcasting, Television and External Services have purely functional duties, that is, they are responsible for a field of output and for the staff directly concerned with that output. The director of administration and the director of technical services have responsibilities which permeate the whole Corporation, though each has a considerable direct area of responsibility in addition. The sixth director is the chief staff officer to the director-general on policy matters.

The Corporation has no criterion of profit by which to test the success of the methods employed by its various parts, and it must therefore endeavour to regulate administration by giving to directorates the guidance emanating from specialist departments that are centrally established. One of these is the Central Establishment Office, which continuously investigates, in close co-operation with the heads of the departments concerned, staffing, organization and methods. Between two and three hundred technical assistants are recruited for the engineering staff each year, while for the programme and administrative staff a small number of young men and women are recruited straight from school or from university, though the majority enter at a later stage. The main need with regard to staff is for people who have attained a certain degree of experience and skill in the world and who enter the Corporation in response to public advertisement.

In such a diverse and dispersed body as the Corporation, a system is necessary which enables people to move easily from one compartment to another, for otherwise promotions would tend to remain within departments and a general rigidity would ensue. This problem is solved by a promotion system affecting the whole organization, a flexible grading system, and a scheme of bonuses for outstanding work and creative skill. Such a large organization gives rise to considerable problems of communication, but these are minimized by regular meetings up and down the chain of command and staff representation. Considerable staffing difficulties have been caused by the formation of the Independent Television Authority, and drastic measures have been used to deal with them. With the ending of the Corporation's solitary position in the country, broadcasting, and television in particular, are now moving into a new phase in Great Britain.

The development of research into the human factor in industry was outlined by Mr. A. B. Waring, chairman of Joseph Lucas (Industries), Ltd. This had, in 1953, led to the setting up of the Joint Committee on Human Relations in Industry, with himself as chairman, to advise the Department of Scientific and Industrial Research and the Medical Research Council on research in this field. The majority of the projects it has accepted fall under four broad headings: incentive schemes with reference to the social factors associated with them; technological change with reference to the human implications involved; management organization with reference to staff supervision and functional specialists; promotion and training. There are also special projects such as relations between office staffs and factory workers and the effects of ageing on adaptability to work.

It is possible, he said, to approach the subject of human relations in industry from a basic theory that any community left to its own devices will establish for itself in the course of time a *modus vivendi* which will satisfy the majority of its members so that the pattern of relationships among them and their general contentment will remain more-or-less constant. But when violent changes are imposed by wars, the impact of other civilizations or the upheavals due to the changes that industrialization brings about, the pattern of society becomes distorted and discord ensues. Changes in the pattern of work and employment brought about by changes in the circumstances of trade and by ever-increasing mechanization can result in disturbances ranging from suppressed resentment to open resistance. Man, being a reasoning animal, is prepared to accept change when it is properly presented and when he is satisfied that he will benefit or that his future depends on it.

The best human relations will exist in those factories in which leadership qualities are high and well founded and are regarded as being no less important than technical and administrative ability, and where both leaders and led work in circumstances that maintain continuously both their status and their morale. Mr. Waring suggested that before any project of research into human relations in industry is undertaken, it should first pass the test of whether or not it falls into the category of a deeply rooted problem of general significance; if not, and if it can be classified as a problem resulting from inadequate local management, it is unlikely to be a subject for basic research and may well be dealt with through management training and reorganization or through investigation by industrial consultants. But where, in a branch of industry, there is a general malaise evidenced by labour unrest with no apparent sensible justification, or where in specific instances the support of workpeople is withheld or there is either open or suppressed resistance the reasons for which are obscure, research is the obvious and perhaps most valuable method of approach.

Mr. Waring stressed the importance of choosing subjects for research in human relations most carefully; otherwise there is the danger of regarding such research as a type of industrial patent medicine. It is equally important that its practitioners should be worthy of their tasks. T. H. Hawkins

OBITUARIES

Sir Malcolm Watson

Sir Malcolm Watson, director during 1933–42 of the Ross Institute of Tropical Hygiene (London School of Hygiene and Tropical Medicine), died on December 28 at the age of eighty-two.

The successive steps which led to modern conceptions of the epidemiology of malaria were: (1) Manson's hypothesis that mosquitoes transmit the disease; (2) Ross's confirmation that mosquitoes do transmit, and his own, most important, contribution showing that not all of them do so—not the grey mosquito, not the brindled mosquito, only the dapple-winged one; (3) Grassi's entomological addition that the mosquitoes which transmit malaria all belong to the genus *Anopheles*; and, finally, (4) Stephens and Christophers', and James's, fundamental rules: (*a*) some species only of the genus *Anopheles* are of practical importance in malaria transmission, and (*b*) each of them has its own preferential breeding places.

Malaria control, as an activity directed against mosquitoes, had taken no account of these rules, which I have called fundamental because they became, in Watson's hands, the basis of antilarval measures. Anti-mosquito work, in the early days, consisted of measures directed against the breeding places of mosquitoes, irrespective of their genus or species. As often as not more larvæ were killed belonging to the genera *Culex* or *Aedes* than to *Anopheles*. The waste of effort was compensated, to some extent, by the fact that the earlier successful campaigns were directed against urban malaria (Ismailia, Havana, Port Swettenham), with the advantage of the population to be protected living within a comparatively small area.

That was Watson's experience in Malaya. He had successfully dealt with the malaria epidemic in Port Swettenham, the newly opened maritime port of the rubber-growing districts, which threatened to become useless because of malaria. Watson saved it from being closed again; but he was at a loss how to act when he was requested to apply his method to the rural areas where rubber was grown, and where the labourers employed on the estates were seriously affected by endemic malaria. It was clearly impossible to remove, or to oil, all breeding places of mosquitoes in a large rural area, as had been done in a small urban area: the expense would have been prohibitive.

At this juncture Watson remembered the Stephens–Christophers–James rules, and the way they had been established. He applied his predecessors' method of research, which has become the pattern of the so-called malaria survey: the preliminary stage of every anti-malaria campaign. This survey includes two main sections. The first consists of three parts: (1) determining the distribution of malaria in the district; (2) collecting adult anopheles and identifying them, so as to be able to compile a list of the anopheline species of the district, and to establish the distribution of each one of these species; (3) comparing the data afforded by (1) and (2), in order to find out whether or not a correlation can be established between the distribution of malaria and of one of the local anopheline species. If such a correlation exists, the species involved is suspect of being the local vector of malaria. The second section of the survey consists of two parts: (1) determining the natural rate of infection with malaria parasites of each one of the local anopheles, in order to check the results obtained in the first section; (2) identifying the principal breeding places of each anopheline species. When the principal local vector has been identified in this way, and it has been proved, moreover, that this species has more or less specialized breeding habits, which induce it to select a certain type of breeding place in preference to all others, it becomes possible successfully to suppress the breeding of that one species, by dealing with its preferential breeding places, while leaving undisturbed all other collections of water, and the larvæ of the species breeding therein. This method of selective larval control, which since then has been called 'species sanitation', was first elaborated by Watson on the rubber estates in the flat swampy land of the coastal area of western Malaya, where *Anopheles umbrosus* was proved to be the main vector, and next in the hilly country, where *Anopheles maculatus* takes over this function. It proved much less expensive than the indiscriminate larval control applied in cities, and so it rendered possible "rural sanitation in the tropics", the highly appropriate title selected by Watson for his first book.

Watson's method of species sanitation has conferred untold benefits on many countries to which it was applied, notably on the former Dutch East Indies (now Indonesia). So it is not inappropriate that the editors of *Nature* should have invited a Dutchman to pay posthumous homage to this benefactor of humanity.

N. H. SWELLENGREBEL

Dr. V. E. Nash-Williams

DR. V. E. NASH-WILLIAMS died suddenly at the age of fifty-eight on December 15. He had been keeper of archæology in the National Museum of Wales and lecturer in archæology (more recently head of the Department of Archæology) in the University College, Cardiff, since 1926. For those long years he had held two posts. The second, the teaching of archæology in the College, had, in recent years, expanded from a subsidiary to an honours course as a result of his work.

Dr. Nash-Williams's earliest excavations were a series made in the 'twenties and 'thirties on the Roman legionary fortress of Caerleon. Those which proved to be his last were on the civil settlement which he had long supposed to lie outside the fortress walls in an area still, by good fortune, not built over; the other legionary fortresses of Britain provide no similar opportunity. His suppositions were proved to be correct by his excavations of 1954 and 1955, excavations which he had hoped to continue for many years, for the area is a large one and the promises were good.

He had also conducted important excavations at the Roman town of Caerwent and on the Early Iron Age hill-forts at Llanmelin and Sudbrook in Monmouthshire, and on the monastic site and the Roman villa at Llantwit Major and the Roman auxiliary fort at Neath, in Glamorgan. The results of these and other works are to be found in publications of the National Museum of Wales, or in *Archaeologia, Archaeologia Cambrensis* and the *Bulletin of Celtic Studies*.

A field survey of the Roman military sites in Wales led in 1954 to his book "The Roman Frontier in Wales", an up-to-date review of the evidence of the Roman occupation, and a work now indispensable to any serious student of Roman Britain. A comprehensive inventory and survey of the more than four hundred early Christian crosses and monuments of Wales form the subject of his largest work, "The Early Christian Monuments of Wales", published in 1950. It is richly illustrated and does for Wales what Romilly Allen and Anderson's book did for Scotland. This work alone is a memorial of his industry and scholarship.

Dr. Nash-Williams believed that if archæology was to be a live subject, there must be active excavations on one hand, and on the other a continuous exposition of the results to the public. In this, as in other ways, his practice matched his principles. His untiring work in the field and in writing, teaching and lecturing caused his subject and his interests to be widely known, and they, and his personal qualities, made him greatly esteemed. He possessed humility and a charm of manner and was a devout churchman. In each of the World Wars he served in the Army, in the first in the infantry and in the second in the R.A.S.C., from which he was seconded to the Historical Section (Military) War Cabinet Offices, for preparatory work on the official history of the War.

The archæological world has lost a mature and industrious scholar and we in the National Museum of Wales mourn the loss of a distinguished colleague and a friend. The deepest sympathy is extended to his widow, his sons and his mother.

D. Dilwyn John

Mr. P. Y. Millns

Peter Yorke Millns, a brilliant research student of astronomy in the University of Manchester, lost his life on the Aletsch Glacier near the summit of the Jungfrau in the Swiss Alps on December 19.

Peter Millns, who was twenty-two years of age, graduated in physics in the University of Manchester with first-class honours in June 1954. He then joined the Department of Astronomy of the University to do research in nebular photography with high-speed Schmidt cameras in monochromatic light. With the help of Dr. A. Burawoy, of the College of Technology, Manchester, Millns developed in a short time an important application of dye filters for astronomical photography, and his first contribution to this subject was presented at the Manchester symposium on astronomical optics held last April. Quest for transparent skies led him repeatedly to Europe's highest observatory at Sphinx, Jungfraujoch (3,576 m.), and there he met his untimely end in a mountaineering accident during leisure-time. The accident has deprived science and the University of Manchester of a brilliant young scientist and a well-liked colleague.

Zdeněk Kopal

NEWS and VIEWS

Archæology of the Roman Empire at Oxford: Prof. I. A. Richmond, F.B.A.

Next October there will come into existence in the University of Oxford a chair in the archæology of the Roman Empire, and Prof. I. A. Richmond, himself an Oxford graduate, has accepted an invitation to be its first occupant. Prof. Richmond, who is fifty-three, is at present professor of Roman–British history and archæology at King's College, Newcastle upon Tyne, where he has been for the past twenty years. He is a leading authority on Roman Britain, and has excavated in many widely separated places in England and Scotland. Most recently he has been engaged with Dr. J. K. St. Joseph at Inchtuthil in work not yet finished which will give a complete picture of an unaltered Flavian legionary fortress, the general headquarters of the governor Agricola. Prof. Richmond early in his career, in 1930, produced the standard work on the City Wall of Imperial Rome. His most recent book is the masterly history of Roman Britain published last year by Penguin Books, Ltd., which ends with an admirable twelve-page bibliography. Prof. Richmond is a Fellow of the British Academy and an honorary graduate of the University of Edinburgh; in May he is to receive an honorary degree from the University of Leeds. In the University of Durham he has served with distinction as dean of the Faculty of Arts and as Public Orator. He is widely known as a skilful lecturer of exceptional clarity of speech. Joined to his patient devotion to study and investigation are a warmth of human sympathy and gaiety of heart which will endear him, as it has endeared him to his many friends at Newcastle and elsewhere, to the society of All Souls College, Oxford, of which he will be a Fellow when he takes up his new professorship next autumn.

Nicholas Kulchitsky (1856–1925)

The eminent histologist, Nicholas Kulchitsky, was born at Kronstadt a hundred years ago, on January 30, and it is almost exactly thirty-one years since he met with the accident in London that led to his death at the age of sixty-nine. Kulchitsky was appointed to the chair of histology at Kharkov in 1893, retiring from it in 1910 in order that the younger members of his staff might have better opportunities for promotion. He held a number of appointments in Russia before the revolution of 1917, finally becoming Minister of Education. There followed a period of considerable hardship until he arrived in England in 1921. He joined the staff of the Anatomy Department at University College, London, on the invitation of Sir Grafton Elliot Smith, continuing to teach and to follow his research work until his death in 1925. Kulchitsky's scientific work extended over a wide field of histological investigation, ranging from studies on the intestinal epithelium to the comparative anatomy of nerve-endings in muscle. He will always be remembered for his discovery of the cells of the intestine that at one time carried his name. Nowadays these cells are known as argentaffin or enterochromaffin cells, and their function is still not clear. They have been thought to be neurosecretory or concerned with the absorption of vitamin B_{12}; but many workers consider that Kulchitsky's own suggestion that they produce secretin may well be correct. He was an admirable technician, and his name is continually recalled to neurologists by his modification of the Weigert method that made possible the better staining of myelinated nerve fibres.

Benjamin Franklin in Britain

Benjamin Franklin made his first visit to London in 1724, when still an unknown lad. His second visit, lasting from 1757 until 1762, was made as a delegate of the General Assembly of Philadelphia, and during these five years he was in close touch with the Royal Society, of which he had been elected Fellow in 1756, and the newly founded Society of Arts (see also *Nature* of January 14, p. 60). When Prof. E. N. da C. Andrade delivered the Trueman Wood Memorial Lecture to the latter Society on January 18, he took as his subject "Benjamin Franklin in London". After giving a brief account of Franklin's early life, and his electrical experiments, Prof. Andrade turned to his visits to England, and described his close association with scientific circles in London during his second and third visits to England. The latter extended from 1764 until 1775. Over nearly two decades, Franklin was closely associated with the administration of both the Society of Arts and the Royal Society, attending many committee meetings of the former and serving four times on the Council of the latter. A Franklin Commemorative Medal was presented to the Royal Society of Arts during the meeting.

Franklin was a member of many other scientific societies, including the Royal Society of Edinburgh. At a meeting held in the rooms of this Society on January 16, lectures were given by Prof. A. D. Ritchie, professor of philosophy in the University of Edinburgh, and Dr. W. P. D. Wightman, reader in the history and philosophy of science in the University of Aberdeen, on "Franklin's Political Career and Philosophical Outlook" and "Franklin as a Natural Philosopher", respectively. Both lecturers commented on Franklin's wide interests and great gifts. When he visited Edinburgh in 1759, he was made a burgess by the Town Council, and became a member of the Philosophical Society, the forerunner of the Royal Society of Edinburgh itself. The latter Society elected him as one of its first honorary fellows. The meeting opened with the presentation by Mr. E. D. Kuppinger, American Consul-General in Edinburgh, of a Franklin Commemorative Medal to the Society.

Geological Society of London: Awards for 1956

The Geological Society of London has made the following awards for 1956: *Wollaston Medal*, to Prof. Arthur Holmes, professor of geology in the University of Edinburgh, for his world-wide interests in petrology and petrogenesis and the application of radioactivity to the problem of geological time; *Murchison Medal*, to Dr. F. M. Trotter, assistant director of H.M. Geological Survey, for his studies of the structure and stratigraphy of the Carboniferous rocks of England and Wales, especially in relation to coal and iron; *Lyell Medal*, to Dr. L. R. Cox, of the British Museum (Natural History), for his palæontological researches, especially on the Mesozoic and Tertiary molluscs; *Wollaston Fund*, to W. B. Harland, of the University of Cambridge, for his researches on the structure and stratigraphy of Spitsbergen; *Murchison Fund*, to Dr. W. W. Black, of the University of Cambridge, for his research work on the sedimentation and contemporaneous structures of the Carboniferous Limestone; *Lyell Fund*, a moiety to Dr. W. S. Pitcher, of King's College, London, for his researches on the igneous and metamorphic rocks of Donegal and on the Tertiary and Pleistocene deposits of south-east England, and another moiety to H. R. Tainsh, chief geologist of the Burmah Oil Company, for his researches on the geology and oil resources of Burma.

Two New Research Reactors at Harwell

The United Kingdom Atomic Energy Authority has announced that two new reactors (or atomic piles) are now operating at Harwell—ZEUS (zero-energy uranium system) and ZETR (zero-energy thermal reactor)—both of which are for research purposes only and run at very low power-levels. ZEUS has a cylindrical core, roughly 20 in. in diameter and 20 in. long, which is made of uranium very highly enriched in the rare isotope uranium-235; the enriching was carried out at the Atomic Energy Authority's factory at Capenhurst, near Chester. The core is surrounded by many tons of uranium in which plutonium is formed gradually as the pile runs. The very low power-level of 100 W. at which the reactor is operated is such that no cooling is required, although the rate of the nuclear reaction is adequate for making experimental measurements. It has been built to check the nuclear calculations on which depends the design of the fast reactor of about 60 MW. which is being built at Dounreay in the north of Scotland, and in many essentials it is a full-scale version of the Dounreay reactor. The other research reactor, ZETR, uses a nuclear fuel in solution and is intended to provide information about the quantities of fuel which will be required for large-scale reactors using such solutions. Plutonium has already been studied in this reactor; uranium-235 is being studied now and uranium-233 is to be studied later this year. Natural water is used as a solvent at present; but in the summer heavy water is to be used.

The Derbyshire Earth Tremor of January 10

An earth tremor, accompanied by a low rumbling sound, occurred in Derbyshire on January 10 and was felt in many places in Derbyshire, Leicestershire, Rutland and Nottinghamshire. Up to a distance of some ten miles from the epicentre, windows and crockery rattled, and cases occurred of beds moving and pictures falling from walls. At Woodhouse Eaves in Leicestershire, the tremor appeared to come from the north. The shock was reported from Derby, Leicester, Nottingham, Burton-on-Trent, Ashton-on-Trent, Melton Mowbray, Rothley, Coalville, Heanor and Castle Donington. It was recorded on the Milne–Shaw horizontal seismograph at Bidston Observatory, near Liverpool, at 08h. 12m. 14s. G.M.T., and on the short-period vertical seismograph (made at Kew) at Kew at 08h. 12m. 21s. G.M.T. The shock was also recorded at Durham University Observatory and at Rathfarnham Castle, Dublin. It was just recorded at the Royal Observatory at Edinburgh, but not at Aberdeen. From the readings it appears that the epicentre was to the south-east of Derby (near 52° 50′ N., 1° 25′ W.), and the initial time was 08h. 11m. 51s. G.M.T.; the depth of focus was probably about 12 or 13 km. There may have been an aftershock from the same district a little after 10 a.m.; but the recording of this is doubtful owing to microseisms, and also waves arriving from an earthquake in the Pacific.

The earliest earthquake noted from Derbyshire occurred in the year 1084, and there were further earthquakes in November 1678; October 31, 1734; July 10, 1738; and June 26, 1748; but the largest shock was on November 18, 1795, about 11.10 p.m. On that occasion, chimneys were thrown down at Derby, Nottingham and Ashover, and the shock was felt as far away as York, Liverpool, Bristol, London and Norwich. A shock with its epicentre four miles south-east of Derby was felt on November 13, 1872, about 4.10 p.m. Earth tremors occurred at Winster in Derbyshire in 1952. That of February 22 at 9.20 a.m. had intensity VI on the Modified Mercalli Scale. More feeble shocks occurred on February 24, March 17 and two on April 15. The tremors in 1952 were probably due to geological fault adjustments along the branch faults which are a continuation of the Crich–Cromford–Bonsall fault belt. A further slight tremor occurred at Winster on November 15, 1954. The shock rattled doors, windows and crockery, and a crump-like sound preceded the tremor.

Royal Society and Nuffield Foundation Commonwealth Awards

Awards under the Royal Society and Nuffield Foundation Commonwealth bursaries scheme have been made as follows : Dr. A. Bose, reader in physics, Indian Association for the Cultivation of Science, Calcutta, to study the techniques of paramagnetic resonance at the Clarendon Laboratory, Oxford (January 1956–January 1957) ; Dr. H. B. S. Cooke, senior lecturer in geology, University of the Witwatersrand, to study African fossil mammal collections in the British Museum and the Powell–Cotton Museum with the view of taxonomic determination of ungulate cranial and skeletal material in Africa, and also to study modern methods of age-determination applied to Quaternary deposits and related fossil material (January–June) ; R. G. Cooke, senior lecturer in organic chemistry, University of Melbourne, to study modern techniques in the isolation of natural products and in the determination of molecular structure at the University of Cambridge (February–August) ; G. C. Israel, senior lecturer in physical chemistry, University of Hong Kong, to enable him to study modern methods of research in chemical kinetics and mechanisms at University College, London (September 1956–March 1957) ; Prof. L. C. King, professor of geology, University of Natal, to carry out field studies in Australia on the sequence of cyclic denudational landscapes, on pediplanation and on the relation of soils to landscape evolution (January–March) ; A. D. McKay, Matopos Research Station, Southern Rhodesia, to study problems and techniques in pasture research and ecology in semi-arid areas of Australia with particular reference to management and use of natural grasslands (for about four months from September) ; Dr. K. G. McNeill, lecturer in natural philosophy, University of Glasgow, to work with the research group on the 23-MeV. betatron at Saskatoon (June–August) ; G. B. Masefield, University demonstrator in tropical agriculture, Department of Agriculture, Oxford, to observe the characteristics of nodules on the roots of annual leguminous crops at four widely dispersed centres in the typical wet-tropical environment of Malaya (June–September) ; S. Smith-White, senior lecturer in botany, University of Sydney, to discuss at Oxford, the John Innes Horticultural Institution and elsewhere his researches into cytological conditions in the Australian flora and other matters (for about twelve months from January) ; Dr. A. M. Stephen, lecturer in organic chemistry, University of Cape Town, to work at Edinburgh, in a study of carbohydrates, with emphasis on polysaccharide structure determination, and also of biochemical aspects of carbohydrate metabolism (January 1956–January 1957) ; M. W. Tracey, Rothamsted Experimental Station, to study the methods in use and being developed at Melbourne for the study of cellulase and the microbial degradation of keratin (January–December).

Manchester Literary and Philosophical Society

THE Council of the Manchester Literary and Philosophical Society proposes to publish a history of the Society from its foundation in 1781. Unfortunately, the Society's home was destroyed by enemy action in December 1940, and there perished with it not only the Society's Library but also all its Minute Books and other records. The Council wishes, therefore, to enlist the help of any former members or other persons who possess or know of any material which throws light, however dim, upon the history and development of the Society at any period. It would be grateful for any bibliographical references to allusions to the Society, however obvious they may seem to be. Any original material forwarded would be copied and returned with the minimum of delay. It is proposed to issue the history at the time of opening the Society's new building, the construction of which will shortly begin. Communications should be sent to Dr. W. H. Brindley (honorary librarian) or F. Willett (honorary editorial secretary) at the Society's present address, Portico Library, 57 Mosley Street, Manchester 2.

Agricola's Position in Science

PRESIDENT HERBERT C. HOOVER had an extraordinary career as a mining engineer in Asia, Europe, Africa and America before he became the thirty-first president of the United States in 1929. In 1912 he and the late Mrs. Hoover published their translation from the Latin of Agricola's classic work, "De Re Metallica". The introduction to their work has been reprinted in a recent issue of the *Scientific Monthly* (81, No. 5 ; November 1955). Mr. and Mrs. Hoover suggest that, in his departure from the peripatetic school of the Greeks by making use of observed facts, Georgius Agricola must rank as one of the truly great pioneers of science.

Electric Fencing against Game

EXPERIMENTS in Africa to keep wild animals inside reserves or away from areas required by man are described in *Oryx* (3, No. 3 ; November 1955). In the first experiment one strand of steel wire was mounted at a height of 15 in. around the outside of a plot roughly a hundred acres in area. The power unit for the fence was an ordinary electric fencer of the type used by farmers for fencing cattle and was run from a six-volt car battery. This was effective against bush-pig and bush-buck and against baboons when erected in the manner described above. It was not effective against monkeys. In a second experiment a strand of steel wire was erected 40 in. high and was intended to be a barrier to the movement of large animals along the west side of Lake Manyara. Unfortunately, the results of the experiment were masked by conditions which could not be controlled but were still encouraging enough to indicate that electric fencing is a possible method of restricting the movement of game.

Geological and Geomorphological Research in the South-West of England

A CONFERENCE of geologists and geomorphologists was held in the University of Exeter during January 5–7, with the object of encouraging the development of research in the South-West of England by promoting contact between those engaged in it. There are about seventy geologists and geomorphologists directly or indirectly doing research on problems of the area, and, of these, fifty-two were present, including fourteen postgraduate students at universities ; nine of those attending were geomorphologists and geographers rather than geologists. The formal sessions were not intended for the announcement of work done but for the discussion of matters of general interest. The chief topics discussed were : the palæontology of the Devonian, the stratigraphy of the Culm, the pegmatites, the folding and faulting, the Lizard and Start boundaries, and high-level surfaces on Exmoor and Dartmoor. It was agreed by all that the conference had been highly successful, and it is hoped to arrange a further conference next year.

Bradford Symposium and Exhibition on Radiochemistry

The Bradford Chemical Society, in conjunction with the Department of Chemistry and Dyeing of the Technical College, Bradford, and the Yorkshire Council for Further Education, is arranging a symposium on radiochemistry and an exhibition of radiochemical and chemical apparatus, to be held in the Technical College, Bradford, during February 17–18. The symposium will take the form of a short course on the subject, and four lectures will be given, as follows: basic principles of radiochemistry (Dr. G. B. Cook), measurement of beta- and gamma-radiation (Dr. D. Taylor), estimation of isotope concentrations (A. A. Smales) and applications to chemical problems (Dr. D. R. Stranks). The symposium and exhibition will be open, without charge, but to help in the arrangement of accommodation for lectures and demonstrations, intending visitors are requested to inform Dr. W. R. Moore, of the Department of Chemistry and Dyeing, Technical College, Bradford, to whom all inquiries should be addressed.

The Night Sky in February

New moon occurs on Feb. 11d. 21h. 38m., U.T., and full moon on Feb. 26d. 01h. 41m. The following conjunctions with the Moon take place: Feb. 5d. 05h., Saturn 3° N.; Feb. 6d. 07h., Mars 0·2° N.; Feb. 9d. 22h., Mercury 1° S.; Feb. 15d. 11h., Venus 6° S.; Feb. 25d. 11h., Jupiter 6° N. Mercury rises about 7h. at the beginning of the month and is then too close to the Sun for observation, but at the middle and end of the month it rises at 6h. 10m., in the former case more than an hour before sunrise and may be visible for a short period though it lies rather low for good observation in the British Isles. Venus sets at 20h. 10m., 20h. 45m. and 21h. 30m. at the beginning, middle and end of the month, respectively; its stellar magnitude varies between −3·5 and −3·6 and the visible portion of its illuminated disk between 0·793 and 0·705 during the month, its distance from the Earth during this period varying from 113 to 96 million miles. Mars rises shortly before 4h. during February. Its eastward motion through Ophiuchus into Sagittarius and its position a little south of μ Sagittarii at the end of the month is easily observed, though it lies rather far south for good observation during this time; its stellar magnitude varies from 1·5 to 1·2, due to its distance from the Earth decreasing from 170 to 147 million miles during February. Jupiter rises early in the evening and is visible throughout the night, setting at 8h. 30m., 7h. 30m. and 6h. 30m. on February 1, 15 and 29, respectively, and is a conspicuous object (stellar magnitude −2·1) in the constellation Leo, in which it has a westward motion. Saturn rises at 2h. 55m., 2h. 05m. and 1h. 15m. at the beginning, middle and end of the month, respectively, and lies a little north of β and γ Scorpii, but is too low for good observation in the British Isles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 1d. 01h. 32·0m., *q* Vir. (*R*); Feb. 14d. 18h. 25·5m., 19 Psc. (*D*); Feb. 19d. 20h. 10·9m., 51 Tau. (*D*); Feb. 19d. 20h. 55·7m., 56 Tau. (*D*); Feb. 20d. 00h. 34·4m., 247*B* Tau. (*D*); Feb. 20d. 19h. 42·7m., *n* Tau. (*D*); Feb. 20d. 23h. 47·6m., o Tau. (*D*); Feb. 23d. 22h. 25·6m., 29 Cnc. (*D*); Feb. 24d. 23h. 57·7m., ω Leo *m* (*D*). *R* and *D* refer to reappearance and disappearance, respectively.

Announcements

The first award of the William Froude Medal of the Institution of Naval Architects has been made to Sir Thomas Havelock, lately professor of mathematics in the University of Durham (King's College, Newcastle upon Tyne). The William Froude Memorial Fund was launched by the Institution in 1952 to enable a plaque to be placed on the site of the original experimental tank at Torquay and to publish Froude's technical papers. These have been done, and from the small balance still remaining in the Fund the Institution will offer this gold medal from time to time for "some outstanding contribution to naval architecture and shipbuilding".

The Zoological Society of India has awarded the Sir Dorab Tata Gold Medal to Dr. M. L. Roonwal, forest entomologist in the Forest Research Institute, Dehra Dun, for his contributions to zoology during 1952–54. Dr. M. L. Roonwal's work has been concerned with termites and Teredinid boring bivalves in relation to forestry, and also with phase-transformation and population dynamics of the desert locust.

Prof. P. W. Richards, professor of botany in the University College of North Wales, Bangor, and Mr. H. Wardale, a Northumberland hill farmer, have been appointed to the National Parks Commission. Brigadier P. B. E. Acland, Dr. Nancy G. Davies and Mr. W. B. Yapp have been re-appointed members of the Commission. Prof. R. C. McLean has resigned.

Prof. E. G. White, professor of veterinary preventative medicine in the University of Liverpool, has been appointed a member of the Agricultural Improvement Council for England and Wales to fill the vacancy created by the death of Prof. F. Blakemore.

Dr. Jesse E. Hobson, director since March 1948 of the Stanford Research Institute, Menlo Park, California, is resigning because of ill health. Dr. Hobson, who is an electrical engineer, was director of the Armour Research Foundation for four years prior to his appointment to the Stanford Research Institute. At that time the staff of the Institute numbered less than fifty and its research budget 250,000 dollars a year; it is a tribute to Dr. Hobson's leadership that during the past eight years the Institute has grown to a staff of twelve hundred and a budget of 10½ million dollars.

Mr. Ralph H. Atkinson has retired as head of the Platinum Metals Section of the Research Laboratory at Bayonne, New Jersey, of the International Nickel Company. A graduate of the University of Cambridge, Mr. Atkinson was a lecturer in chemistry and metallurgy at Cambridge before joining the Mond Nickel Company in 1923 as assistant manager of its platinum metals refinery. He moved to Canada early in 1940 and has held a number of appointments there and in the United States, mainly with affiliated organizations of the International Nickel Company. His research at Bayonne has been on metallurgical and electrochemical problems in connexion with the applications of the platinum family of metals, with special regard to the soldering and casting of palladium.

A memorial service for Prof. A. O. Rankine, emeritus professor of physics in the Imperial College of Science and Technology, London, who died on January 20, will be held in the Queen's Chapel of the Savoy, London, W.C.2, on February 2 at noon.

FIRST INTERNATIONAL CONGRESS ON DOCUMENTATION OF APPLIED CHEMISTRY

THE First International Congress on Documentation of Applied Chemistry was held in London at the Institut Français, South Kensington, during November 22–25, and at the final session its claim to the title "First" was substantiated when the members, by a substantial majority, agreed to recommend that the International Union of Pure and Applied Chemistry, which sponsored the meeting, should sponsor the "Second" in about three years time. It was abundantly clear that this Congress had not been called any too soon. As the president of honour, Lord Cherwell, said, when he spoke at the opening session, he was appalled, in general, at the rate of change going on in the world and, in particular, at the rate at which scientific literature is increasing; he charged the Congress with the task of finding the best ways of putting this mass of information at people's disposal.

The first morning session was devoted to the international scene, with Dr. L. H. Lampitt as chairman. A general survey was given by Prof. H. R. Kruyt, whose broad outlook on international matters is so well known; he made a plea, not new but still as urgent as ever, for abstracting, which is a service to the whole world, to be organized on an international footing. Prof. G. A. Boutry then spoke on the Abstracting Board of the International Council of Scientific Unions, which has done so much for speeding up the publication of abstracts. Its work, however, is not well known to chemists as its initial efforts have been directed towards physics abstracting, but it is now concerning itself with chemical abstracts. Prof. Boutry said that authors' summaries are used in the case of about a third of the world's physics papers; this led to considerable argument as to the value of authors' abstracts and to a general discussion on the various purposes for which abstracts were required, the abstracting of 'letters to the editor', of patents and of 'semi'-publications (brochures, technical advertisements, etc.).

When Dr. Lampitt introduced Dr. N. Grell, who read a communication from M. R. Grégoire, of the Organization for European Economic Co-operation, he said that relatively few people know what the European Productivity Agency is or what it does. Dr. Grell gave an interesting survey of the work of the Agency, the aim of which is to improve the standard of living through increased productivity, and of its publications, notably its "Technical Digests". To M. Jean Gérard's criticism that this information is not of the kind required by research workers, Dr. Grell emphasized that their readers range from scientists to factory workers. Prof. P. Auger, of the United Nations Educational, Scientific and Cultural Organization (Unesco), then gave a résumé of the scientific programme of his Organization, Dr. Lampitt emphasizing how difficult it had been to "get the 'S' put into UNESCO". The incentives for peace, said Prof. Auger, are one language and one fight: science is always a universal language; and the common fight is that against the adverse forces of Nature. Unesco's aim, he said, is to strengthen the links between the world's scientists, to organize the meeting of scientists and to create international bodies. This stimulating paper led to a long discussion on *rapprochement* with the U.S.S.R., which the chairman had to restrain; but, to an onslaught on lack of collaboration, led by Dr. D. J. Urquhart, Prof. Auger replied laconically, "There is hope", while the spokesman for the Russian delegation hinted that co-operation is on the way.

The afternoon session, under the chairmanship of Sir Alfred Egerton, reviewed the national scene, and this was a full afternoon's programme as papers were read by the representatives of seven nations. Prof. J. Wyart (France) advocated, not without criticism, machine-made abstracts to improve further an already improving situation in French documentation; Prof. E. Velander (Sweden), reading a paper on behalf of Mr. E. Engel, who was ill, reported excellent co-operation on documentation between the Scandinavian countries; and Dr. J. M. Meyer showed how a small country like Switzerland has to rely on international documentation and how valuable *Chemical Abstracts* and *Chemisches Zentralblatt* are to his country. Dr. M. G. Mellon (Purdue University), in his review of the situation in the United States, pointed out that he now teaches a course in chemical literature for which up to a hundred and fifty students enrol and that such courses are now held in about twenty-five out of several hundred American colleges; one speaker afterwards pressed for students to be taught the value of abstracts. Dr. U. V. Panov (U.S.S.R.) promised co-operation between Russia and the West, the difficulties of transliteration being freely admitted, while Dr. A. Gorter (Holland) lamented the limited application of the Dutch language in documentation.

Only Dr. D. J. Urquhart among the national speakers stirred up controversy, when speaking for Great Britain. Claiming that chemistry is in the vanguard of scientific information, he contended that the quantity of literature will outgrow our intellectual resources and that sooner or later there will be a shortage of scientists. The under-developed countries will then contribute more, and he appealed for a *lingua scientifica* in order to cope with it.

Prof. Velander was chairman of the first session on the second day, when the whole day was given up to particular problems. An excellent start was made with Prof. R. R. Shaw's vivid description of his "Scarecrow Press", strangely enough a serious publishing concern aiming at printing scholarly books where the required edition is as low as 1,500–300 copies, or even as low as twenty-five copies, and would not therefore be considered by ordinary publishing firms. He described how he had aimed at cutting costs to the minimum, and he contended that for scientific books the authorship, editing, etc., should be free and that only the actual production of the book should be charged. Instances were given where valuable but highly specialized books are at a prohibitive price. Dr. E. B. Hughes, deputy chief chemist of J. Lyons and Co., speaking on abstracts, said how important it is to get the abstracts to the chemist, and he advocated selective abstracts, as the average research chemist cannot afford volumes like *Chemical Abstracts*, valuable as they are. He introduced a wistful note in lamenting the passing of the high-quality abstracts of the Chemical Society of thirty-five years ago. Dr. V. V. Serpinsky, editor of the *Russian Chemistry Abstracts Journal*, speaking on the same subject, emphasized how young his journal is, but he believed that it will ultimately make a useful contribution. In the discussion on abstracts that followed, doubt was again expressed on the value of authors' abstracts, and the need was stressed for experience and specialized training in abstracting: Dr. Grell favoured 'digests', bigger than abstracts, and therefore on a more limited scale.

Dr. B. Agard-Evans, Ministry of Works librarian, discussed special documents, having in mind pamphlets and the like, the technical content of which is often important and yet often lost. His organization, he said, in spite of much expense and labour, covers only about 25 per cent of such publications from abroad.

At the next session, with Prof. A. Nasini (University of Turin) in the chair, Prof. M. Lora-Tamayo (University of Madrid) described with great effect the problem of language, with examples of the technical terms in the steel and other industries in English, Spanish and other tongues; any language, he said, even if safeguarded in its purity, is confronted with invasion of foreign technical terms. Dr. J. E. Holmstrom (Unesco) talked on multilingual technical dictionaries which he held to be indispensable, although he warned the Congress that existing ones are deficient in many respects and that the creation of new ones is difficult. To this end Dr. R. S. Cahn stressed that of nineteen thousand papers on chemistry in 1954, 60 per cent were in English, 13 per cent in German, 9 per cent in Russian, 7 per cent in French, and smaller proportions in Japanese, Italian, Spanish, Portuguese and others. The theme of the paper by Dr. E. Pietsch (director of the Gmelin Institute) was whether man can produce a store of facts greater than the human brain by extrahuman systems; he elaborated many of the mechanical methods, electronic systems, punched-card systems, microfilms and so on, and gave examples of the use of International Business Machine cards.

Dr. E. J. Crane (editor of *Chemical Abstracts*) said, on the subject of indexing, that for every thousand words of abstracts there now has to be seven hundred words of index. He insisted that trained abstractors are essential, for though machines are useful, they have to rely on accurate information being fed to them. A discussion on subject-indexing followed, and Dr. Crane intimated that the new building for *Chemical Abstracts* would have facilities for research into methods. The session ended with a paper on library and technical information services by Miss Elin Törnudd (Finland), the only woman contributor. "The customer is always right," she said, and inquiries have shown that 90 per cent of potential users of the lists of titles in her information bulletins in Finland do in fact use them; 70 per cent are in favour of not translating titles, except those in Russian. This was confirmed by one speaker on fuel abstracts, who said that speed in publication of titles is more important than the actual abstracts.

Prof. W. A. Noyes (editor of the *Journal of the American Chemical Society*) adroitly controlled from the chair a fast-moving session on the third morning of the Congress. After Prof. A. Scortecci's paper on the role of governments in organizing documentary information services, Prof. Noyes asked whether such services should be centralized, but Prof. Scortecci contended that separate subjects are so specialized that they should be left to the specialists. He agreed, however, that a general classification of information is desirable but that special fields require special classifications. Dr. R. E. Fairbairn (Imperial Chemical Industries, Ltd.), in the absence of the author, Mr. J. D. Rose (of the same firm), read a paper on the role of industry. In a provocative speech he contended that abstracts are too late for current information and that inadequate indexing makes search for past information unreliable; in spite of a protest from Dr. Crane, he insisted that abstract indexes are anything up to five years late. A spirited discussion followed on what the users of abstracts in industry really want, and it was generally agreed that the great need is for current information services.

A stimulating paper on the role of professional and learned societies was given by Dr. Cahn, editor to the Chemical Society, in which he demanded the reorganization of publishing methods, cuts in costs, greater support from industry and a users' conference; the financial position of professional societies is serious, he said, although there is no shortage of manuscripts for publication. The last paper of the session was a thoughtful contribution by Dr. J. Knox (Department of Scientific and Industrial Research) on "How can Further Co-operation Take Place ?", to which M. Jean Gérard replied at length.

The final session opened with a paper by Mr. A. W. Marsden, director of the Commonwealth Bureau of Dairy Science, on the often-forgotten subject of chemistry applied to agriculture and on the information services provided by the Commonwealth Agricultural Bureaux. He was followed by a talk by Mr. N. M. Javaronkov, of the Russian delegation, the theme of which—collaboration—was taken up enthusiastically by the meeting. A small voice mentioned, for the only time during the whole Congress, the possibility of Esperanto to overcome language difficulties.

A brilliant summary of the proceedings of the Congress was given by Mr. F. P. Dunn, honorary publications secretary of the Society of Chemical Industry, in which he concluded with a list of the suggested resolutions put forward by various delegates during the six sessions. Dr. L. H. Lampitt, chairman of the final session, sought the advice of the meeting as to what positive action the Congress should take to implement the results of its discussions. A vigorous minority wanted to discuss the eight individual resolutions one by one, but the meeting decided, by a substantial majority, to put up two resolutions: first, that the International Union of Pure and Applied Chemistry, the sponsoring body, should call a second Congress in about three years time; and secondly, that Mr. Dunn's summary of the proceedings and the headings of recommendations enumerated by him be referred to the Organizing Committee of the Congress for submission to the Union.

There is no doubt that this Congress served a very useful and, above all, a timely purpose. The increase in scientific literature, on applied chemistry alone, is terrifying and, although at this Congress much time was wasted by some boring repetition and by many people grinding their personal axes, the general feeling that international co-operation and the application of the most modern methods of documentation are the solutions was echoed by Sir William Ogg, the chairman of the Congress Council, in his valedictory address. Two points he made were that, although English used to be international and is still nearly the *lingua scientifica*, scientists must learn more languages, not only Russian, and that consideration should be given to the fact that, whereas in the U.S.S.R. scientific documentation is a State matter, in Great Britain it is dependent on industry and the business houses.

The success of the Congress was borne out by the attendance of more than three hundred delegates, about one-third of whom were from overseas. There was a full programme of excellent social events.

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING IN LONDON

ABOUT a thousand science masters met in London at the Royal College of Science, South Kensington, for four days in the week between Christmas and New Year, the occasion being the annual meeting of the Science Masters' Association. Residential accommodation was provided, as usual, at Queen Elizabeth College, Campden Hill Road, which also entertained visitors in its laboratories on two evenings. Teachers were present from the Netherlands, Natal, Pakistan and India, and Unesco sent an observer.

For his presidential address, Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, chose the theme "Science and Education". He began by saying that his life had been spent in the study of ecology, from varied approaches, and that this might have been no bad preparation for suggesting ways in which the disciplines derived from different studies might be integrated. The greatest danger to real education, he said, is to mistake the provision of information for the imparting of knowledge; it is much easier to acquire strands of information than to weave them into a harmonious whole. Science teaching should therefore stress the structural unity of all knowledge. He recalled that the test he applied when he taught botany students was to ask whether their studies made a walk in the country more interesting; if not, they should try some other subject. He thought that a similar test might well be applied to all learning: Does it make life richer and more colourful?

A marriage of science and the humanities is essential to the success of the civilization of the future, and in order to achieve this, Sir Edward thought that the scientist should write good English and that the humanist should take the trouble to understand him. He deplored the passing of the general use of the Bible, which had set a standard of English expression, not less valuable because often unconsciously acquired. Science, he went on, should set itself not only to amass facts but also to create good citizens; but it should beware of exaggerating the importance of what is measurable, since some most significant things are not to be measured. Good science teaching should avoid the pitfalls of doctrinaire politics and ensure a sense of proportion and a balanced judgment, though these are not qualities gaining publicity in the more sensational newspapers. Sir Edward also said that the need in schools is to stress the fact that to live is more than livelihood, and that only by habitual zest in one's working hours can one ensure the zestful enjoyment of one's leisure. "To go slow in the one is the surest way of finding that time hangs heavy in the other". On the science teaching in schools there rests a great responsibility, but there are also the potentialities of a great achievement.

Each morning of the meeting began with two simultaneous lectures, those on the first morning being by Prof. L. J. Audus (Bedford College, London) on the attempts made during the Second World War by biologists in Japanese prisoner-of-war camps to stem the onset of deficiency diseases; and by Dr. C. C. Butler (Imperial College of Science and Technology, London) on the story of cosmic rays. The lectures on the second morning were by Prof. R. M. Barrer (Department of Physical Chemistry, Imperial College, London) on crystals as molecular sieves, and by Prof. F. A. Vick (Department of Physics, University College of North Staffordshire) on electrical aspects of contacts between solids. On the last morning lectures were given by Prof. R. J. Harrison (London Hospital Medical College) on recent research on whales and seals, illustrated by a film, and by Mr. H. W. Thorp (Department of Chemical Engineering, University College, London) on chemical engineering, which was also illustrated by films; a third lecture, later on the same morning, was by Mr. A. B. Soper (Cable and Wireless, Ltd.) on Commonwealth telecommunications.

Some of the most popular functions were the demonstrations and discussions. A lecture-demonstration on experiments with radioactive isotopes suitable for schools had to be repeated four times, the first version being attended by more than two hundred, who somehow got into a lecture theatre built for seventy; it was given by M. C. Nokes (Harrow), J. S. Strettan (Raynes Park Grammar School), T. A. H. Peacocke (St. John's School, Leatherhead), G. E. Perry (Kettering Grammar School) and W. G. Rhodes (Firth Park Grammar School, Sheffield). Another most popular demonstration was by K. A. Murch (Chichester High School for Boys) on ciné and ciné-micrography in the teaching of natural history.

A very valuable and provocative discussion, under the chairmanship of Mr. F. W. Kaye, was that on science in secondary modern schools—progress and prospects; it was initiated by A. E. J. Trinder (Alexandra Secondary Modern School, Bromley), and many members took part. The discussion on the last morning was on first-year failures in the universities, and for this Dr. H. F. Boulind (general secretary of the Association) was in the chair. It was introduced by Dr. E. R. Roberts (Department of Inorganic Chemistry, Imperial College) and by Prof. F. A. Vick. Representatives of the various colleges of the University of London had been invited to be present, and several spoke. It was generally agreed that the schools need to concentrate on trying to make pupils think, rather than on giving instruction for examinations, but how this is to be done was not so apparent. It is hoped that a tape-recording of the discussion may later be put into print. The third discussion was one by the Science and Religion Group of the Association, which was welcomed by the Rev. D. W. Cleverley Ford, vicar of Holy Trinity Church, Prince Consort Road, London, S.W.7. Many members spoke, and the proceedings ended with a gratifying increase in the numbers of the Group.

Evening functions included a lecture in the Courtauld Hall of Queen Elizabeth College by Mr. T. D. Bourdillon, on "Everest, 1953". Mr. Bourdillon, who was a member of the successful 1953 Everest Expedition, showed and explained the oxygen equipment and other gear which he used; his lecture was illustrated by most beautiful slides.

As usual, a main feature of the meeting was provided by the exhibitions of apparatus and books by manufacturers and publishers; these, together with the exhibition of teaching apparatus devised by members, were bigger than ever before, and strained the accommodation of the Royal College of Science to the utmost. The Home Office contributed a display of apparatus used in Civil Defence work by technical reconnaissance officers, and also lent a control set and 'walkie-talkies' so that officers of the Association could maintain contact with the secretary's office from any part of the College. Some sixteen firms were visited by members during the afternoons, as also were the High Pressure Laboratories of the Chemical Engineering Department at the Imperial College. In addition, on each afternoon scientific films were shown, some of which were introduced by Dr. J. A. Harrison (Educational Foundation for Visual Aids).

The meeting created a record for attendance, and the Association must count itself as singularly fortunate in this year's president, Sir Edward Salisbury, who insisted on sharing in all the activities; his zest showed that he was not content with precept in his address, but followed it with action during the meeting.

FARMING HISTORY IN GREAT BRITAIN

FARMERS, industrialists and scholars from all over Great Britain attended a joint meeting of the British Agricultural History Society and the Association of Agriculture, which was held in the University of London on December 3. Sir James Scott Watson, president of the History Society, took the chair, and three papers were read, one in the morning and two in the afternoon. This event, which is one of the two annual meetings convened by the Agricultural History Society, is usually open to non-members on payment of the conference fee.

The morning paper, read by Dr. H. Hamshaw Thomas, president of the History of Science Society, dealt with the life and writings of Richard Bradley, F.R.S., who lived in the early years of the eighteenth century. The paper gave much food for thought, for Bradley came very close to some of the most modern scientific discoveries. By a series of experiments he found that variegated leaf colours could be induced in healthy plants by grafting scions of discoloured plants. The variegation, which is really a virus disease, was, he found, transmitted through the circulation of the sap. Similarly, he was able to produce the breaking of tulip bulbs, which was forgotten or neglected until Sir Daniel Hall, all unknowingly, so it is thought, repeated Bradley's experimental work on modern lines. Besides his achievements in pure science, Bradley was a severely practical man. Through correspondents and personal observation he collected and recorded a great mass of information about the farm practice of his day. As Dr. Hamshaw Thomas said, a complete description of English farming methods of the early eighteenth century can be compiled from his work. Until the present day, Bradley has been regarded as somewhat of a charlatan, but Dr. Hamshaw Thomas's work has done much to retrieve his reputation.

After lunch the first paper was by Prof. Cyril Tyler, of the University of Reading, who dealt with the historical development of feeding standards for livestock, a subject that must be very close to the hearts of farmers in these times. Prof. Tyler ranged over the ages from classical times until the present day, describing the theories of the ancients and the slow progress that was made in gaining real knowledge of the subject until von Thaer's work in the early nineteenth century. It was unfortunate that von Thaer chose such a variable as good hay for his basic unit, but his work pointed the way. Many German and British chemists followed in his steps and, with slowly increasing knowledge, have to-day been able to lay down simple and practical rules for the breeder, dairy farmer and meat producer alike. It is a fascinating story and demonstrates, if that is necessary, that the findings of science are of universal application.

The third paper was rather more recondite and dealt with pollen analysis and its bearing on agricultural history, being given by Mr. J. W. Franks, of the Department of Botany, University College, Leicester. Mr. Franks demonstrated how what happened in districts now covered with peat or fen can be discovered by cutting down through the layers. The depth of the layers and other indications show how long they have taken to accumulate. In these layers of peat the pollen of the various flora that flourished is embedded and preserved, and by carefully collecting this pollen, identifying it and counting it, the flora of that particular age can be deduced. If man was living in the place when the pollen was deposited, his activities in growing cereal or other crops, or the effect of grazing animals, will be shown by the different pollens recovered.

All three papers dealt with subjects that were well worth while, and the conference was a great success. Those interested in this field should write to the Honorary Secretary, British Agricultural History Society, Mr. J. W. Y. Higgs, at the Museum of English Rural Life, 7 Shinfield Road, Reading.

GOVERNMENT RESPONSIBILITY IN INDUSTRIAL RESEARCH

THE extent and character of the responsibility taken by governments for research varies enormously. In the scientifically more advanced countries, the government attitude ranges from the benevolence combined with restricted actual participation to be found in Germany and the United States to the complete control of science exercised in the U.S.S.R. Even within the British Commonwealth, where there is a common tradition of government, the countries have developed different ways of reaching the level of research activity essential in a modern State. Some of the differences and the reasons for them were brought out in a discussion on "Government Responsibility in Industrial Research" held at the Society for Visiting Scientists on December 6 under the chairmanship of Sir Henry Tizard. The principal speakers were Dr. E. W. R. Steacie, president of the National Research Council of Canada, and Dr. B. K. Blount, deputy secretary of the Department of Scientific and Industrial Research, and there were contributions from a number of Commonwealth countries and the United States.

Dr. Steacie said that the structure of research in Canada differs markedly from that in Britain or the United States. As a pioneer country, the primary industries developed first, and long before there was a National Research Council research organizations were set up in government departments to deal with their problems. In the initial stages the Canadian secondary industries were mostly branches or subsidiaries of firms in the United States or in Britain, and any research was done by the parent company. This has resulted in a very minor amount of research being done by industry, and a correspondingly greater proportion having to be done by the government for industry.

The National Research Council, charged mainly though not exclusively with the responsibility for industrial research, was set up in 1916 by the Canadian Government at the suggestion of the British Government. At that time there was little secondary industry in Canada, and most of the plants established to meet the needs of the First World War disappeared at its end. It was not until the Second World War that major development of secondary industry took place. In some ways development in Canada has paralleled that in the United States, but "one war behind". In the latter, industrial expansion took place in a period when research by industry was developing in the world generally, but Canadian expansion is happening at a time when there is already a great deal of research abroad. Canada has never gone through a period when there was a large body of research in industry. While there is now a tendency even for subsidiary companies to set up research organizations, the major responsibility for keeping Canada abreast of the times through research falls on government organizations.

It is always difficult to get accurate figures for research expenditures; but the amount allocated in 1954 by the Canadian Government for research in the primary and secondary industries and health was about 43,000,000 dollars, excluding military and atomic energy research; this does not include expenditures by either Provincial authorities or universities. No exactly comparable figures are available; but roughly the Canadian Government is spending twice as much per capita on civil research as the United States Government. On the industrial side, however, the contribution is extremely small. The figures are very unreliable; but they do support the thesis that what is wanted in Canada is a large increase in research in industry rather than by government.

Dr. Steacie went on to describe the organization of research in Canada and the ways in which assistance is rendered to industry. The Department of Agriculture operates large research and demonstration establishments with an annual expenditure of about 17,000,000 dollars. The mining industry is served by the Department of Mines and Technical Surveys, and the ore-dressing laboratory of this Department is particularly noteworthy because the free service which it gives in investigating suitable methods of treatment for the ores from new mines has done so much to aid the development of Canadian resources. The National Research Council, on its own initiative, undertakes long-term research for secondary industry and undertakes shorter-term research under contract for individual firms or groups. The proportion of the expense borne by the industry varies with the circumstances. The research councils of the Provinces work mainly on the shorter-term problems of local industry, sometimes on contract, and in some respects fill the place taken by the large specialized consulting firms and sponsored research in the United States. Research associations, so successful in Britain, are practically non-existent in Canada, partly because of the high proportion of subsidiary firms and partly because of the scattered distribution of industry. Only the pulp and paper industry operates its own co-operative laboratories.

Canada, like every other country, is faced with the problem of getting technical information into the hands of industry. The needs of primary industry are looked after by the appropriate government departments. For secondary industry, lacking research associations as a channel for disseminating information, the Research Council has set up a Technical Information Service which works closely with the Provincial research councils and other bodies in active measures to bring the benefits of new and existing technical information to industry.

Dr. Blount contrasted the Canadian and British conditions, pointing out that Canada is a country with large resources and capable of feeding itself, and that industry in Britain is long established compared with Canada, with a high proportion of craft industry where the best techniques have been found by trial and error over a long period. Even in such industries, however, the need for research is growing because of changing conditions, particularly with regard to raw materials and the need for increased scientific control with the gradual disappearance of the traditional craftsman. The small size of most of the firms gives the opportunity for real help through research associations.

While the figures are not very reliable, the total expenditure on research of all kinds in Britain is probably about £300,000,000, or about one-fifth of the corresponding figure for the United States. It is almost impossible to estimate the government expenditure on research applicable in civil industry, since much of this is included in the budgets of the Armed Services. It is fairly certain, however, that the expenditure by industry is at least equal to that by government, in contrast to the Canadian situation.

After Dr. Blount's talk there were many contributions to the discussion, including a notable one by the chairman himself; but in general three topics were considered: research in India, the difficulty of assessing research effort, and research associations. In India, as in Canada, attention was first given in the past to the primary industries, namely, agriculture and forestry. Now, industrial research is increasing in importance, the expenditure having risen from £50,000 in 1940 to about £900,000. Government research will probably always be dominant in India because of the creation of State industries.

The need for more reliable figures on research expenditures was stressed, particularly as a guide for the distribution of effort in view of the great cost of development and full-scale exploitation as compared with research. Several speakers referred to the value of studying the man-power rather than expenditure, especially in attempting to compare the situations in different countries.

Research associations have been successful in New Zealand where there is a preponderance of small industries; but in Australia they are few in number and indifferently successful. In the United States the place of research associations is taken by the large institutions undertaking sponsored research. Several speakers told of the interest of large firms, and were of the opinion that the smaller firms which the research associations are particularly designed to help are often "poor members". There was general agreement that the best place to do industrial research is in industry and that, ideally, government and co-operative efforts should cover those fields not adapted to research by individual firms.

AFRICAN HONEY-GUIDES

AMONG the strangest forms of animal behaviour is that of the honey-guides, African birds distantly related to the American woodpeckers, which 'guide' men, baboons and ratels (honey-badgers) to the nests of wild honeybees—supposedly so that these nests can be broken open.

A study of the behaviour is described by Dr. Herbert Friedmann, U.S. National Museum curator of birds, in a bulletin issued by the Smithsonian Institution, Washington. Dr. Friedmann has observed at least twenty-three instances of the habit and has collected other well-authenticated data from African associates.

Dr. Friedmann describes the behaviour as follows : "When the bird is ready to begin guiding, it either comes to a person and starts a repetitive series of churring notes or it stays where it begins calling these notes and waits for the human to approach it more closely. If the bird comes to the person to start leading him, it flies within 15 or 20 feet from him, calling constantly and fanning its tail. If it waits for the potential follower to approach it for the trip to begin, it usually perches on a fairly conspicuous branch, churring rapidly, fanning its tail, and slightly arching and ruffling its wings so that at times its yellow shoulder bands are visible.

"As the person comes to within 15 to 50 feet from it, the bird flies off with an initial conspicuous downward dip, and then goes off to another tree, not necessarily in sight of the follower ; it is more often out of sight than not. It waits there, churring loudly until the follower again nears it, when the action is repeated. This goes on until the vicinity of the bees' nest is reached. Here the bird suddenly ceases calling and perches quietly in a tree nearby. It waits there for the follower to open the hive and usually remains until the person has departed with a collection of honeycomb, when it comes down to the plundered bees' nest and begins to feed on the bits of comb left strewn about. The time during which the bird may wait quietly may vary from a few minutes to well over an hour and a half."

African natives regard the bird as an almost infallible guide to honey. They try to attract it by grunting like a ratel or chopping on trees to imitate the sound of opening a nest. Dr. Friedmann suggests that the habit is purely on an instinctive level and is not a deliberately associative act. It presumably originated before the advent of human beings, perhaps starting with the ratel, that still co-operates with the bird, and whose place in the association the African natives have deliberately tried to take. The honey-guide does not seem interested in the honey *per se*, or in the grubs of bees found in the nests. It has an insatiable appetite for the beeswax, which it will take wherever it can be found. With various collaborators, Dr. Friedmann is now carrying out an intensive study of the mechanism of wax digestion.

THE NATIONAL TRUST

ANNUAL REPORT

THE sixtieth annual report of the National Trust, presented to the annual general meeting in Manchester on November 24—the first to be held out of London—records that there are now a hundred and twenty historic houses in the care of the Trust, which owns more than 220,000 acres and has a membership of more than fifty thousand, compared with a membership of seven thousand in 1945 when the Trust had sixty-three houses and owned 107,000 acres, and in 1914 a membership of 725, 5,500 acres and a handful of historic houses. The National Trust Act of 1937 specifically extended the purposes of the Trust to include the preservation of furniture, pictures and other works of art, and since that date the Trust has become responsible for many important collections associated with the country houses under its care. Its responsibility for works of art is likely to increase since the Finance Act of 1953 empowered the Treasury to accept, in payment of death duties, chattels associated with historic houses in the ownership of the Trust. The annual report gives some account of the work of the Trust in this field, and at the annual general meeting Prof. A. B. Blunt, surveyor of the Queen's pictures and director of the Courtauld Institute, who has for some years been the Trust's honorary adviser on paintings, also described some of the maintenance problems that arise.

The report emphasizes that the Trust does not regard its primary duty, in respect of its farmlands and the preservation of the unspoilt landscape committed to its care, as in any way conflicting with the interests of good farming, and the policy of modernizing the farms continues steadily. Deeds of dedication have now been completed with the Forestry Commission in respect of some 4,699 acres of the Trust's 30,000 acres of woodland, including 1,095 acres at Clumber, where, with the release by the Army of 850 acres, the whole property is now open to the public. For the first time since 1947, the accounts show a small surplus (£979) on the maintenance and administration of the Trust's general properties ; but, although the income from annual subscriptions increased by some £5,000, legacies and donations are at present decreasing annually, and a large increase in membership is essential if the Trust is to do no more than watch over a fraction of the property requiring its care.

The Trust aims at a membership of seventy thousand before the end of 1956, and, in stressing the urgent need for such an increase, Lord Chorley warned the annual general meeting of the great danger of complacency. The danger to the great country houses is more acute than ever, and at present the Trust can only accept such houses if an endowment for all time is offered with the house. Lord Derby, who also addressed the meeting, stressed the voluntary standing of the Trust and made it clear that the Trust depends on private support and not on national contributions. He said that he was impressed by the small amount of litter left by the public when they visit Knowsley, in contrast with the amount left at many of the Trust's properties where admission is free. Reference was also made at the annual meeting to the launching of a scheme of corporate membership, by which it is hoped to enrol organizations such as industrial firms.

SYNTHESIS AND BLEACHING OF RHODOPSIN

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Biological Laboratories, Harvard University

THE purpose of this communication is to demonstrate in two exemplary experiments certain basic relationships among the principal components of the rhodopsin system.

Rhodopsin is synthesized in solution by incubating together in the dark neo-*b* (7-*cis*) retinene[1] and the rod protein, opsin. It bleaches in the light to a mixture of all-*trans* retinene and opsin[2]. This sequence of reactions is recorded in Fig. 1.

The synthesis of rhodopsin is shown at the left. A solution of cattle opsin in 2 per cent aqueous digitonin was used as blank; the spectrum of opsin, or of the opsin moiety of rhodopsin, is therefore excluded from the record. The same concentration of opsin was mixed with neo-*b* retinene in 2 per cent digitonin, and the spectrum recorded at once in a Cary spectrophotometer (curve 1). Although completed within 20 sec. after mixing, this spectrum already displayed a hump at about 500 mμ owing to the formation of a trace of rhodopsin. Spectra were recorded periodically thereafter in the dark, at the times shown in the legend of the figure. (The light involved in the spectrophotometry is too weak to bleach rhodopsin or to retard its synthesis appreciably.) The concentration of rhodopsin ($\lambda_{max.}$ 498 mμ) rose regularly, while that of neo-*b* retinene ($\lambda_{max.}$ 380 mμ) fell. The reaction was complete in about two hours. The small absorption band at about 350 mμ remaining in the final product (curves 8 and 9) is due primarily to the β-band of rhodopsin[3]. When opsin is in excess, as here, the synthesis of rhodopsin removes neo-*b* retinene almost entirely from solution.

The rhodopsin synthesized at the left of Fig. 1 is bleached at the right. Curve 9 is re-drawn at the right as curve 1. The solution was exposed for measured intervals to the orange light of a 160-W. microscope lamp passing through a Jena *OG*2 filter, which transmits all wave-lengths longer than 550 mμ. This region of the spectrum, though it bleaches rhodopsin, is not absorbed by, and so does not isomerize, the retinene formed as product[2]. Immediately following each exposure, the absorption spectrum was recorded in the dark. After a total irradiation of 180 sec. (curve 6), the solution was exposed for 45 sec. to the same source passing through a Corning 3387 filter, which transmits all wave-lengths longer than about 440 mμ (curve 7).

As the irradiation progressed, the rhodopsin maximum fell regularly, and the retinene maximum rose. By curve 7, the solution had been bleached completely, and again contained nothing but retinene and opsin. The retinene formed by bleaching rhodopsin, however, is not the same as enters its synthesis. In such non-isomerizing lights as here employed, the product of bleaching is primarily all-*trans* retinene[2]. This possesses a much larger specific extinction than neo-*b* retinene. Fig. 1 (right) suggests that we had finished with much more retinene than we began; but what in fact happened is that this sequence of reactions isomerized the initial neo-*b* to all-*trans* retinene.

One can regard such a cycle of synthesis and bleaching of rhodopsin as an enzymatic isomerization, catalysed by opsin. In this sense, opsin acts as an isomerase activated by light—a photoisomerase. Neo-*b* retinene is its substrate, and rhodopsin the light-sensitive enzyme-substrate complex.

Fig. 1 contains further internal evidence that the pathway of rhodopsin synthesis differs from that of bleaching. The absorption spectra at the left display a sharp common or isosbestic point at about 422 mμ,

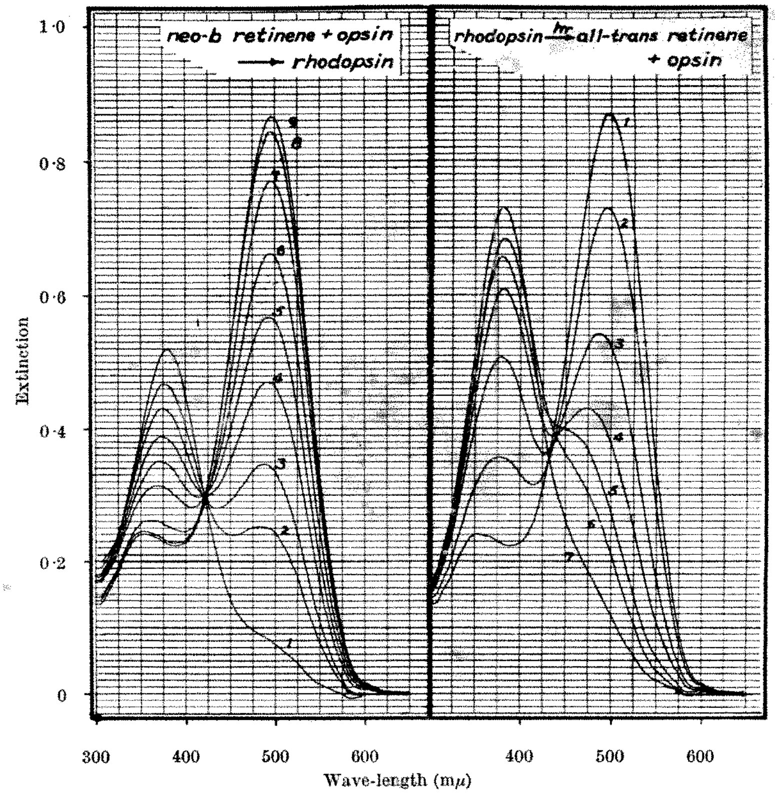

Fig. 1. Synthesis and bleaching of rhodopsin in solution (22·5° C., *p*H 7·0). Left, a mixture of neo-*b* retinene and cattle opsin incubated in the dark, and absorption spectra recorded periodically: (1) at 0·3 min., (2) at 2·5, (3) 5, (4) 10, (5) 18, (6) 30, (7) 60, (8) 120, and (9) at 180 min. The absorption band of neo-*b* retinene (λmax. 380 mμ) falls regularly, whereas that of rhodopsin (λmax. 498 mμ) rises. Right, the rhodopsin formed at the left (1) is exposed to light of wave-length >550 mμ for various intervals, and spectra recorded immediately. The total irradiations are (2) 5 sec., (3) 10, (4) 15, (5) 30, and (6) 120 sec. The residue was exposed for 45 sec. longer to light of wave-length >440 mμ (7)

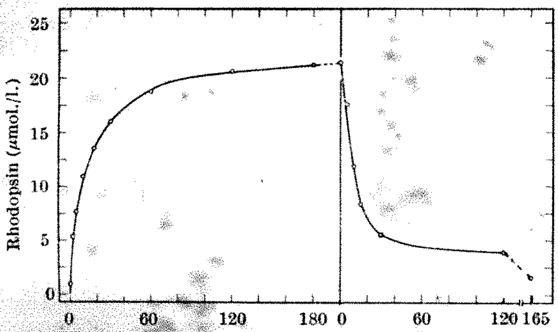

Fig. 2. Kinetics of synthesis and bleaching of rhodopsin, from the data of Fig. 1. Left, synthesis: the points are experimental, the line the theoretical curve for a bimolecular reaction. Right, bleaching: the points are experimental, and an arbitrary line is drawn through them

an indication that only two molecular species—neo-*b* retinene and rhodopsin—are involved in the recording. The curves at the right have no such common point. Bleaching is known to be a more complex process than the over-all equation above these curves expresses. It involves the orange intermediates, lumi- and meta-rhodopsin[4], and the final formation of new complexes between opsin and all-*trans* retinene (see below).

We have spoken of the absorption bands in the ultra-violet as those of neo-*b* and all-*trans* retinene. This is not quite correct. In such solutions, retinene condenses rapidly with amino-groups of opsin and other substances to form Schiff bases which behave as *p*H indicators[5]. These vary in $\lambda_{\text{max.}}$ from about 366 mμ at *p*H 9 to about 390 mμ at *p*H 5, and at all *p*H's involve some distortion of the retinene spectrum.

If this factor is momentarily disregarded, we have as molar extinctions in digitonin solution: rhodopsin, 40,600[6]; all-*trans* retinene, 38,300[6]; and neo-*b* retinene, 21,200[6,7]. Therefore we expect that, as neo-*b* retinene forms rhodopsin, $E_{\text{max.}}$ should rise $40{,}600/21{,}200 = 1\cdot9$ times; in Fig. 1 (left) it rises 1·7 times. We expect that as rhodopsin bleaches to all-*trans* retinene, $E_{\text{max.}}$ should fall $38{,}300/40{,}600 = 0\cdot92$ times; in Fig. 1 (right) it falls 0·84 times. These discrepancies are small but cumulative: the isomerization of neo-*b* to all-*trans* retinene should raise $E_{\text{max.}}$ $38{,}300/21{,}200 = 1\cdot8$ times. In Fig. 1 the final retinene maximum at the right is 1·4 times higher than the initial retinene maximum at the left. The over-all yield of the reaction, regarded as an isomerization, appears therefore to be low. One reason for this may be the distortions of retinene spectra by proteins, mentioned above. Another undoubtedly is some degree of isomerization, unavoidable in the course of bleaching. Even such orange lights as used in the present experiment, though not efficiently absorbed by retinene, are absorbed by, and isomerize to some degree, lumi- and meta-rhodopsin[2]. As a result, the product of bleaching always contains small amounts of geometrical isomers other than all-*trans* retinene.

The synthesis of rhodopsin in solution from neo-*b* retinene and opsin follows the course of a second-order (bimolecular) reaction[2]. In the present instance, the initial concentration of opsin, determined in a separate experiment by incubating with excess neo-*b* retinene and measuring the rhodopsin formed, is 28·96 μmoles per litre; and of neo-*b* retinene, 21·35 μmoles per litre. The extinctions of rhodopsin in Fig. 1 (left) are computed from the simultaneous equations:

$$x = E_{500} - 0\cdot069\,y\,; \quad \text{and } y = \frac{3\cdot77\,E_{375} - E_{500}}{3\cdot70}$$

in which E_{375} and E_{500} are the extinctions at 375 and 500 mμ; *y* is the extinction at 375 mμ specifically due to neo-*b* retinene, and *x* the extinction at 500 mμ specifically due to rhodopsin. The latter quantity, divided by 0·0406, yields the concentration of rhodopsin in μmoles per litre.

This has been plotted in Fig. 2 (left). The line which accompanies these points is computed from the equation for a bimolecular reaction:

$$kt = \frac{2\cdot303}{a-b}\log_{10}\frac{b(a-x)}{a(b-x)}$$

in which *k* is the rate constant, *t* the time in minutes, *a* and *b* are the initial concentrations of opsin and neo-*b* retinene, and *x* is the concentration of rhodopsin. In the present experiment (22·5° C., *p*H 7·0), *k* has the value 0·0026 litre per μmole per min. (4·33 litres per mole per sec.).

The bleaching of rhodopsin is first-order, provided that the light reaction is limiting, that is, that the 'dark' reactions which remove lumi- and meta-rhodopsin are complete at all stages of bleaching. This condition is not fulfilled in the present experiment. The kinetics of bleaching therefore cannot be treated precisely in this instance. The concentrations of rhodopsin have been estimated from the spectra of Fig. 1 (right) by using simultaneous equations like those above, but differing somewhat in numerical coefficients since all-*trans* retinene replaces neo-*b* retinene in the bleaching mixtures. The points so obtained are plotted in Fig. 2 (right), and an arbitrary line is drawn through them.

The data of bleaching in Figs. 1 and 2 (right) reveal a further complexity. Curves 1–6 in Fig. 1 (right), and also the corresponding points in Fig. 2, form a regular sequence which describes the bleaching of rhodopsin in light of relatively long wave-lengths (> 550 mμ). The final exposure (curves 6–7) involves two important changes: a large increase in the intensity of the light; and the inclusion of much shorter wave-lengths (> 440 mμ). The first change

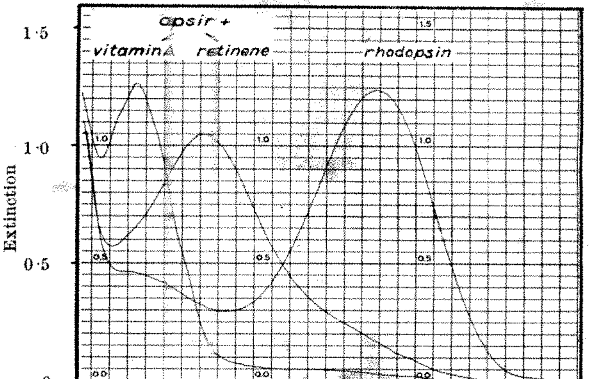

Fig. 3. The bleaching of rhodopsin in solution (23° C., *p*H 7·0). A solution of cattle rhodopsin (λmax. 498 mμ) was bleached in orange light to a mixture of all-*trans* retinene and opsin (λmax. 383 mμ). On adding potassium borohydride, the retinene was reduced to all-*trans* vitamin A (λmax. 325 mμ)

increases the rate of bleaching, the second its character. Whereas the bleaching from curves 1 to 6 involves a maximum fall of extinction at 503 mμ, that from curves 6 to 7 is maximal at a much lower wave-length, 474 mμ. The initial exposure to light of wave-lengths greater than 550 mμ, while bleaching rhodopsin, had permitted the formation of artefacts which absorb at lower wave-lengths: some *iso*-rhodopsin ($\lambda_{\max.}$ 487 mμ)[2], and an orange-yellow, light-sensitive pigment with $\lambda_{\max.}$ about 440 mμ. The latter is formed in small amounts when retinene is incubated with a number of proteins, including opsin and egg albumin, either in the dark or in lights of sufficiently long wave-length to spare it. Small amounts of this artefact form in the course of every bleaching of rhodopsin in orange or red light.

In the retina, the retinene formed by bleaching rhodopsin ordinarily is reduced to vitamin A. This is accomplished by the enzyme, alcohol dehydrogenase, working together with reduced cozymase (DPN–H)[8]:

$$\underset{\text{retinene}}{C_{19}H_{27}CHO} + DPN{-}H + H^{+} \overset{\substack{\text{alcohol}\\ \text{dehydrogenase}}}{\rightleftharpoons} \underset{\text{vitamin A}}{C_{19}H_{27}CH_2OH} + DPN^{+}$$

This reduction can be carried out conveniently in solution with potassium borohydride. A solution of cattle rhodopsin was bleached in a non-isomerizing orange light to a mixture of all-*trans* retinene and opsin (Fig. 3). (In measuring these spectra, digitonin solution served as blank; hence the rising absorption below 310 mμ owing to opsin. In Fig. 1 opsin was in the blank, and its absorption therefore did not appear.) On adding a droplet of potassium borohydride solution in water to the bleached product, the retinene was immediately reduced to vitamin A ($\lambda_{\max.}$ 325 mμ). The molar extinction of all-*trans* vitamin A in aqueous digitonin is about 45,600. Therefore in going from retinene to vitamin A, $E_{\max.}$ is expected to rise 45,600/38,300 = 1·19 times. In Fig. 3, it rises 1·20 times. This simple procedure therefore completes in solution and quantitatively the sequence of reactions by which rhodopsin bleaches.

The final spectrum in Fig. 3 includes a very small 'tail' of absorption, maximal near 450 mμ. This is the artefact already mentioned, formed whenever rhodopsin is bleached in orange or red light.

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EVIDENCE FOR A REVERSIBLE FIRST-ORDER PHASE TRANSITION IN COLLAGEN–DILUENT MIXTURES

By R. R. GARRETT and Prof. P. J. FLORY

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THE view that thermal shrinkage in collagen is primarily a process of melting, though not widely accepted, is nevertheless supported by a variety of observations[1]. Transition from a predominantly crystalline to an amorphous state is indicated by the X-ray diffraction work of Astbury[2]. An increase in volume on shrinkage of water-swollen collagen has been reported by Weir[3] and in heat content by Küntzel and Doehner[4] and by Wöhlisch and de Rochemont[5]. Theis[6], Lennox[7], and others have observed that the temperature of the transition is lowered systematically by dilution. The shrinkage process has been variously described, however, as a degradation (or hydrolysis) to gelatin, or as a 'denaturation process' similar to the phenomenon of protein coagulation[8] rather than as a true phase transition. In this communication we report observations on the volume changes occurring during thermal shrinkage and recrystallization of collagen, which in our opinion offer convincing evidence of a phase transition appropriately characterized by a melting point.

Collagen was prepared from beef tendo achillis which had been extracted to remove globular proteins, fats, and certain of the mucopolysaccharides. After having been cut into sections 0·01 in. in thickness, it was dried to constant weight, and portions were swollen in ethylene glycol vapour to the desired concentrations by weight. 7- to 20-gm. samples were introduced into dilatometers of 0·50 mm. capillary radius, which were then sealed, evacuated, and filled with mercury as a confining liquid.

The filled dilatometers were heated rapidly to a temperature within three or four degrees of the transition temperature, T_m, after which the heating rate was reduced to three degrees per day. Equilibration was rapid above T_m. The liquidus was therefore established in a comparatively brief period, transformation to gelatin thus being avoided. Less than 5 per cent water-leachable material was found on removal of the sample from the dilatometer, indicating negligible formation of gelatin during the melting process.

The volume–temperature curves were found to resemble those for the melting of many crystalline copolymers and to exhibit a similarly broad melting range[9–12]. A typical plot is shown in Fig. 1 for the composition having a weight fraction of collagen, $w_2 = 0{\cdot}700$. The ordinate, Δy, represents the difference between the dilatometer scale reading observed for the melted sample (or calculated for that temperature assuming a linear liquidus) and the scale reading observed for the partly crystalline sample. The point at which Δy reaches zero, and hence at which melting is complete, should correspond to the melting point, in accordance with interpretations established for other polymer systems[13,14]. The 'rounding off' of the curve (Fig. 1) in this region is suggestive of copolymer melting[15].

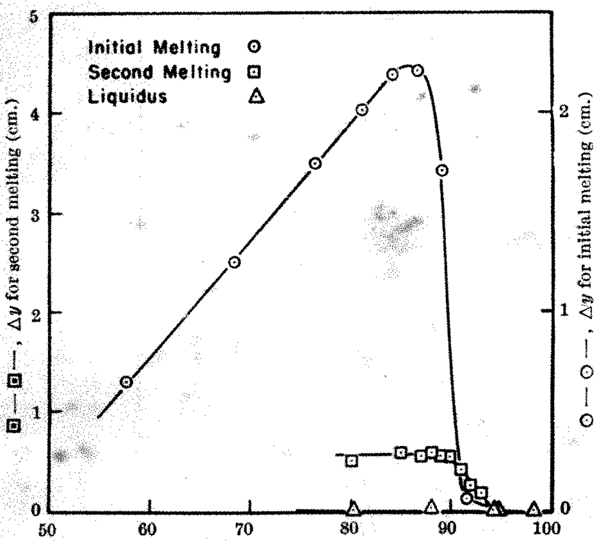

Fig. 1

When the more dilute samples were supercooled some fifteen to forty degrees below T_m, a slow recrystallization proceeded over a period of one or two days as evidenced by a small but unmistakable volume decrease of the order of magnitude of 10^{-4} c.c./gm. of collagen. Upon subsequent heating, re-melting occurred at the same temperature, T_m, observed initially, or at most a few degrees below it. Small discrepancies, when observed, are attributable to the formation at low recrystallization temperatures of crystallites which are less perfect than those existing in native collagen and hence melt at a lower temperature. Similar behaviour is commonly observed in other polymeric substances[16].

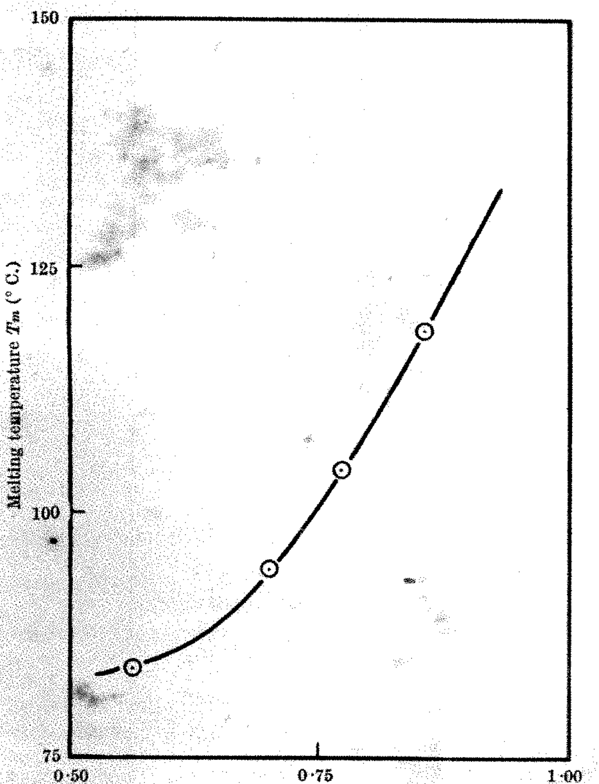

Fig. 2

An extrapolation of the curve shown in Fig. 2 to $w_2 = 1$ yields a value of about 145° C. for $T°_m$, the melting temperature of unswollen collagen. The heat, ΔH, and entropy, ΔS, of fusion of crystalline collagen may be calculated from the melting point depression by glycol, using procedures which have been successfully applied to phase transitions in other crystalline polymers[13,14,17]. The values so obtained are, respectively, 24 cal./gm. and 0·055 cal./deg./gm., where the density of collagen was taken to be 1·35 gm./c.c. The corresponding molar quantities per structural unit derived from the average molecular weight of the collagen structural unit of 94 gm./mole, are 2,200 calories and 5·3 cal./deg. The former appears to be somewhat less than the value to be expected for the dissolution of one hydrogen bond per residue.

The number of bonds freed by melting to assume random rotational configurations may reasonably be estimated as two per residue. The entropy change per bond thus becomes 2·6 cal./deg./bond, a value somewhat higher than that observed for most other polymers. Such a value for the entropy indicates that a high degree of order exists in the crystalline regions and that the collagen molecule assumes a random configuration in the liquid state.

The volume-temperature behaviour of collagen thus exhibits the features characteristic of crystal-liquid transitions in other polymeric substances: a well-defined melting temperature which is determined only by the composition of the collagen-diluent mixture and is independent of the previous thermal history of the sample; a time-dependent recrystallization, suggesting the necessity for some sort of re-nucleation to precede crystalline growth, as has been found for polymers generally; and the virtual recovery after recrystallization of the initial melting temperature. The conformity of collagen to these criteria characterizing a phase transition suggests the further application to collagen and other fibrous proteins of methods previously applied successfully to the study of polymer crystallization.

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LETTERS TO THE EDITORS

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Absorption of 3·5-m. Radiation in the Optical Emission Nebula, *NGC* 6357

In the course of a radio survey of bright emission nebulæ with the 1,500-ft. Sydney cross-aerial, some fourteen nebulæ were studied at a wave-length of 3·5 m. Six were probably observed in emission, seven were undetectable, and one, *NGC* 6357, was observed in absorption. The observation of *NGC* 6357 is the first reported case of absorption of radio waves by an emission nebula; it leads to an estimate of the electron temperature of the nebula based almost entirely on radio data. In this preliminary communication the observation and its consequences are discussed briefly; a more complete account of the survey will be given elsewhere.

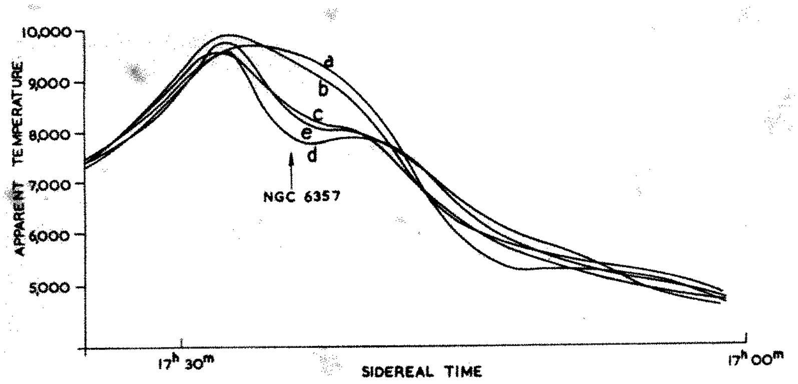

Fig. 1. Tracings of records obtained at five declinations superimposed to display the absorption effect at the position of *NGC* 6357. Declinations: (*a*) − 35° 11′; (*b*) − 34° 51′; (*c*) − 34° 31′; (*d*) − 34° 11′; (*e*) − 33° 51′

The radio telescope has a pencil-beam response, 50′ between half-power points, and is used as a transit instrument. It may be used to scan through a small angle in the meridian plane, recording five separate declinations quasi-simultaneously. In Fig. 1 are shown tracings of five such records straddling the nebula position and superimposed to display the effects of absorption. The position of the nebula is 17h. 18·4m., − 34° 03′ (1900), and the angular size is 63′ × 43′ [1]. Maximum absorption is estimated to occur at a position of 17h. 18·7m. ± 0·2m., − 34° 05′ ± 5′ (1900), in good agreement with the nebula position and in even better agreement with a radio measurement at 9·4 cm. by Haddock, Mayer and Sloanaker[2].

It is easily seen that the electron temperature of a mass of ionized gas observed in absorption must normally be less than the apparent brightness temperature at its centre (if both the nebula and background are irregular, with comparable scale factors, this is not necessarily true, but it appears safe to ignore such a possibility here). The brightness temperature at the nebula position is 7,800° K., with an estimated maximum calibration error of ± 20 per cent, or 1,600 deg. K. Thus the electron temperature of the nebula is probably less than 7,800° K. and almost certainly less than 9,400° K. An estimate of the actual temperature may be made if some other properties of the nebula and the galactic radio emission are known. It can be shown that if absorption between the nebula and observer is negligible, the electron temperature T_e is given by the equation:

$$T_e = T_a - (T - T_a)\left\{\frac{\Omega_0}{\Omega_n(1 - \varepsilon^{-\tau})} - 1\right\} - \alpha D$$

where T_a is the apparent brightness temperature measured at the nebula position; T is the brightness temperature in the absence of the nebula, estimated by interpolation; Ω_0 is the equivalent solid angle of the nebula after smoothing with the aerial beam; Ω_n is the actual solid angle and τ the optical depth (assumed uniform) of the nebula; α is the apparent brightness temperature of the galactic radio emission per unit distance in the direction of the nebula, and D is the distance to the nebula.

We take the following values: $T_a = 7{,}800°$ K.; $T = 8{,}800°$ K.; $\Omega_n = 1{\cdot}9 \times 10^{-4}$ steradian (corresponding to a size of 63′ × 43′); $\Omega_0 = 3{\cdot}6 \times 10^{-4}$ steradian (obtained by smoothing Ω_n with the aerial beam); $\varepsilon^{-\tau} \approx 0$ (consistent with the measurements of flux density at 9·4 cm.); $\alpha \approx 0{\cdot}5$ deg. K./parsec (estimated from the integrated brightness through the galaxy); $D = 1{,}000$ parsecs (distance of the assumed exciting star, − 34° 11671).

The corresponding electron temperature is 6,500° K., which is of the same order as, but rather lower than, 10,000° K., the temperature usually assumed for such nebulæ; the value could be even lower if the nebula were 'patchy'. A quantitative optical study of the nebula might prove very interesting.

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Frequency Variations in New Zealand of 16 kc./s. Transmissions from *GBR* Rugby

We have made comparisons of the received frequency of the British Post Office Station at Rugby (*GBR*), distant 19,000 km., with the frequency of one of our standard crystal oscillators, following the receipt of information[1] that *GBR* is controlled by the British Standard Frequency source.

Equipment for this purpose consists of a narrow-band tuned amplifier on 16 kc./s. followed by a mixer to which is also fed a large 16 kc./s. signal derived from one of our oscillators. Any beat frequency present in the mixer output is recorded continuously on a paper chart. For convenience, our oscillator is adjusted to be about 3 parts in 10^7 fast; thus the beat frequency recorded is about 17 c./hr.

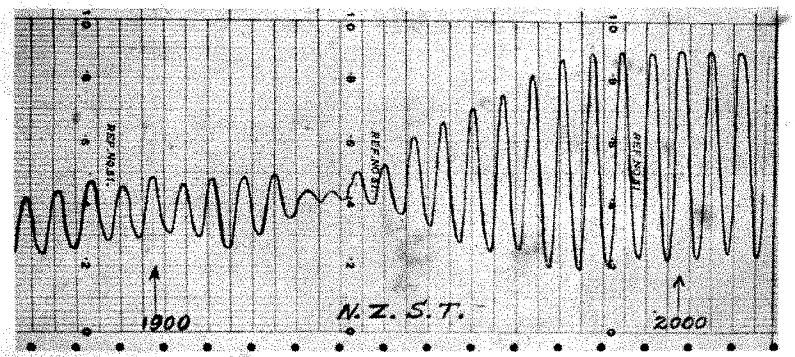

Fig. 1

Since the ratio of mean signal to peak noise of *GBR* at the receiving site is approximately − 20 db. for a bandwidth of 400 c./s., the beat frequency is passed through a low-pass filter with a cut-off frequency of 0·01 c./s. before being applied to the recorder, so that a high signal/noise ratio is maintained on the chart.

A sample record is shown in Fig. 1. It shows the beat frequency between *GBR* and our standard, the amplitude of the record being proportional to the amplitude of the signal received from *GBR*. The relative variations in frequency are derived from the number of cycles occurring in a given time. It is possible to determine the frequency of *GBR* in terms of the frequency of our own oscillator to within about one part in 10^9 in a 1-hr. period. However, our oscillator at times shows frequency variations greater than this.

Fig. 2 is a plot of the apparent frequency variations of *GBR* against our oscillator for the day on which the record of Fig. 1 was obtained, together with a plot of relative amplitude of the signal. On another day the received frequency about 1800 G.M.T. was observed first to increase above, and then decrease below, the mean frequency, although the magnitude of frequency shift was similar. At present the received frequency of *GBR* appears to be constant within the accuracy of measurement (4 parts in 10^9) over the periods 0900–1700 G.M.T. and 2100–0600 G.M.T.; but around 1900 and 0730 G.M.T.—the times at which the amplitude of the signal from *GBR* goes through its minima—there are marked changes in frequency of the order of 2 parts in 10^8. The portion of chart reproduced in Fig. 1 covers one of these periods. The accuracy of measurement in the steady periods may be limited by the short-term stability of our own oscillator rather than by the instability of the transmission path. The frequency of *WWVH* as received and measured at the same site[2] shows variations at least one order greater than those of *GBR*, both diurnally and over short periods.

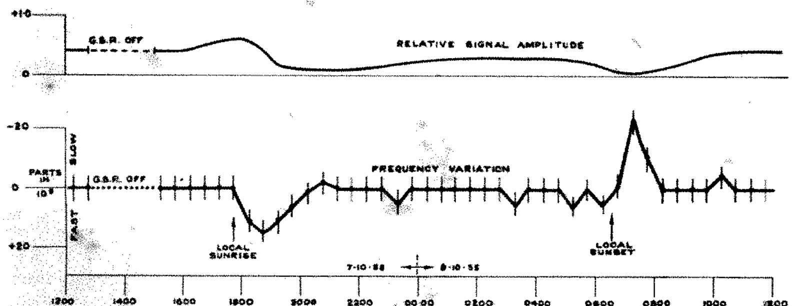

Fig. 2

Pierce, Mitchell and Essen suggest[1] the possibility of a world-wide basis for frequency comparison. We feel that our results are evidence for this possibility, and we hope to carry out long-term observations of *GBR* to that end, providing that the frequency control of *GBR* continues as at present.

We acknowledge the encouragement given to this work by Mr. W. H. Ward and the assistance of Mr. F. Ellis in instrumentation.

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Production of Self-Reversal of Thermo-remanent Magnetism by Heat Treatment of Ferromagnetic Minerals

IT has been already reported by us[1] that the reverse thermo-remanent magnetism of the Haruna rocks is due to magnetic interaction between two different constituents of very small size in ferromagnetic mineral grains, which are mainly composed of ilmenite–hæmatite solid solutions. The production of reverse thermo-remanent magnetization of the Haruna and the similar rocks can be intensified by suitable heat treatment of the samples. This is illustrated in the upper and middle diagrams in Fig. 1.

The samples examined here are the ferromagnetic minerals separated out from the Haruna rock (upper diagram) and the Sokota rock (middle diagram). Both these minerals are mainly ilmenite and hæmatite solid solutions, the Curie points of which range from 100° C. to 320° C. When these samples are kept for a time at about 680° C. in the atmosphere and then quenched to room temperature, their reverse thermo-remanent magnetism becomes markedly increased. In Fig. 1, the abscissa shows various temperatures at which the heat treatments were carried out and the ordinates the intensity of total thermo-remanent magnetism that was acquired by cooling from 400° C. in the geomagnetic field after the heat treatment. The full lines in these diagrams represent the result of the heat treatment during 10 min. at the respective temperatures, while the broken lines show the final result of the same heat treatment maintained for a sufficiently long time. It is clear that the heat treatment at about 680° C. is most effective for intensifying the reverse thermo-remanent magnetism, and that these samples become

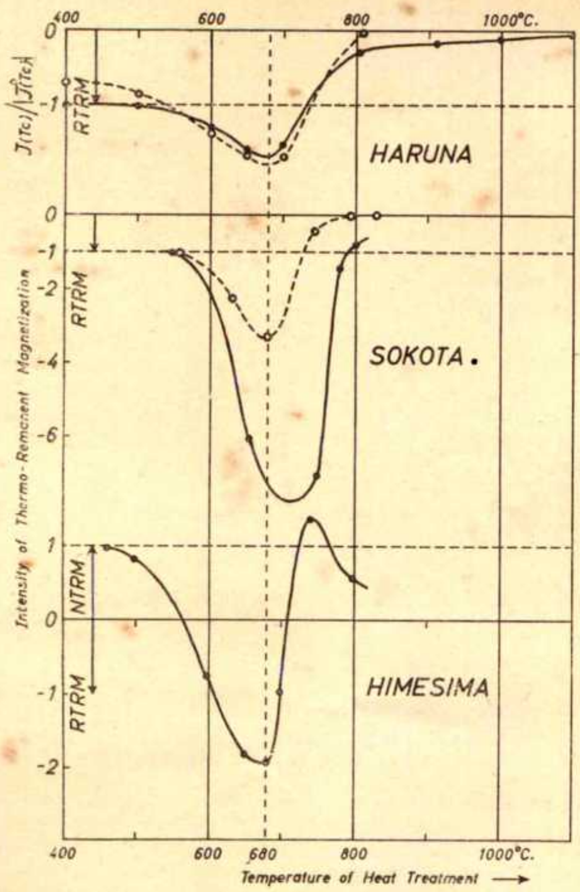

Fig. 1. Total thermo-remanent magnetization, $J(T_c)$, of ferromagnetic minerals after heat treatments at various temperatures in units of the intensity of total thermo-remanent magnetization of their original state, $J^0(T_c)$

magnetically unstable in the atmosphere at temperatures higher than about 850° C.

The same heat treatment procedure was applied on the ferromagnetic minerals separated out from Himesima rocks, which also are mainly composed of ilmenite–hæmatite solutions, their Curie points ranging from 230° C. to 250° C., but which show only the normal thermo-remanent magnetization in their original state. The result of heat treatments of this sample is illustrated in the lower diagram in Fig. 1. This shows clearly that the heat treatments at temperatures of 600°–700° C. result in the definite characteristic of the reverse thermo-remanent magnetism, the effect being a maximum again at about 680° C.

The composition of these samples was determined by chemical, magnetic and X-ray analyses, and the electron-microscope examination of fine structures of these samples before and after the heat treatment is now proceeding. Preliminary results suggest that the heat treatment at about 680° C. of these samples results in growth of the lamellar structure of intergrowth of two constituents, so that their mutual interaction becomes sufficiently strong to produce reverse thermo-remanent magnetism. Actually, an electron-photomicrograph of the original Himesima minerals showed the presence of the lamellar structures[2], but their characteristic thermo-remanent magnetism is just the same as that of Towada rock[3], namely, positive superposition of thermo-remanent magnetizations of the two constituents, suggesting that the magnetic coupling between the two constituents is very poor. After the heat treatment at about 680° C., the magnetic interaction seems to become much stronger, owing to development of the lamellar structure. This proves the possibility of changing the property of normal thermo-remanent magnetism of rock minerals to that of the reverse thermo-remanent magnetism by the artificial heat treatment. The opposite process, namely, from reverse to normal thermo-remanent magnetism, might also be possible with suitable conditions.

We believe that this kind of work on rock magnetism should be extended to many other rock samples, especially in relation to the interpretation of magnetic orientation of rocks for the purpose of palæomagnetism.

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Correlation Patterns in the Chromospheric Granulation

UBEROI[1] has recently discussed a simple method of measuring the spatial correlation of the brightness fluctuations between neighbouring regions in the solar photosphere. He pointed out that, if two identical enlargements of a photograph of the solar photosphere are superimposed and one rotated from the matched position, the product of the outer radius of the circular pattern then visible and the angle of rotation gives a measure of the distance, beyond which the correlation becomes insignificant.

We have applied this technique to study chromospheric granulation using photographs taken in $H\alpha$ with a Lyot monochromator of band-width 0·7 A. Fig. 1 shows the circular correlation pattern produced

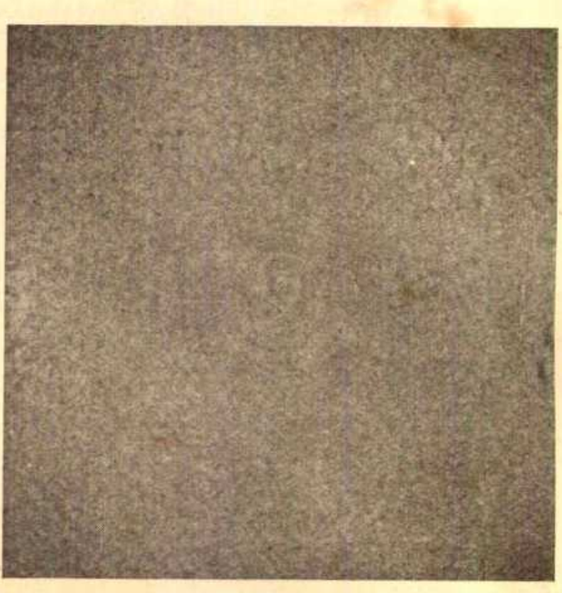

Fig. 1

from two enlargements of a chromospheric photograph taken on December 7, 1954, at 5h. 13m. U.T., this being a day of low solar activity. It is evident that the pattern shows no marked asymmetry. The correlation is found to become insignificant at distances greater than about 3 × 10^4 km., which agrees closely with the mean linear dimension of the larger elements of the chromospheric fine structure as estimated from the original photograph.

Because of the relatively long life-time of the chromospheric fine structure, it is also possible to obtain correlation patterns from photographs taken up to several hours apart. A preliminary study of the decrease in the correlation distance as the interval between the photographs is increased has led to the conclusion that the correlation is not very pronounced after a period of five to six hours.

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Absorption of Ultrasound in Light Gases

Numerous workers during the past thirty years have made measurements of the absorption of ultrasound in the lighter gases (that is, oxygen and gases of lower density). The majority of the workers used interferometric techniques developed from that described by Hubbard[1]; a smaller group used optical methods[2]. An examination of absorption values obtained for the lighter gases shows that both the discrepancies between results of different workers and the range of results of individual workers are such that it is difficult to deduce any reliable data: few give any estimate of the possible errors in their results. Although Pumper[3], Krasnooshkin[4] and Bell[5] have shown that the acoustic interferometer may produce anomalous results, due to effects not previously considered, this fact has apparently not been fully appreciated. It would seem that the best published results using these techniques cannot be relied upon to better than ± 20 per cent.

Recent measurements of absorption in nitrogen and oxygen in the frequency-range 60–70 kc./s. by Parker, Adams and Stavseth[6], using a direct transmission pulse system, appear to be more reliable.

We have developed a pulse method for measuring the absorption directly at 1 Mc./s. (over a pressure-range of 0·2–2·0 atm.) which yields results to an estimated accuracy of ± 5 per cent for a single measurement. Since the major errors in the method are random, the usual statistical techniques can be used to obtain values to a higher accuracy.

Measurements in oxygen show that the absorption coefficient is 1·240 ± 0·025 times the 'classical' Stokes–Kirchoff value[7], while in nitrogen the absorption is 1·235 ± 0·015 times 'classical'. These values agree well with 1·19 ± 0·05 for oxygen and 1·22 ± 0·07 for nitrogen obtained by Parker, Adams and Stavseth[6].

All the 'error' values quoted above are the 1 per cent limits of a normal distribution.

The technique is being further developed for measurements of both absorption and velocity at frequencies up to 20 Mc./s.

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Electrochemistry of Stainless Steel in Sulphuric Acid

In a study of the electrochemical behaviour of stainless steels, the electrode potential has been continuously recorded during the transformation of an air-stable oxide film to the surface state that exists in dilute, aerated sulphuric acid at temperatures between 25° and 90° C. Several definite inflexions or stages in the process have been observed which are similar in certain respects to the oscillograms obtained by Bonhoeffer and Vetter[1] in the activation and re-passivation of carbon steel in nitric acid. With stainless steel, the processes are much slower than those observed with carbon steel, so that the details of the several stages may be more readily studied. Thus, Fig. 1 shows the results obtained at 85° C. when a niobium-stabilized steel (type 347) was heated in air at 445° C. for 2 hr. and then placed in an aerated 0·1 *N* mixture of sulphuric acid and sodium sulphate which had a *p*H of 1·46. A vibrating-reed electrometer measured the potential between the steel electrode and a reference electrode kept at 24° C., so that all potentials to be given include a small potential due to the thermal gradient in the bridge. Dissolved iron was determined at intervals spectrophotometrically by use of thioglycollic acid[2].

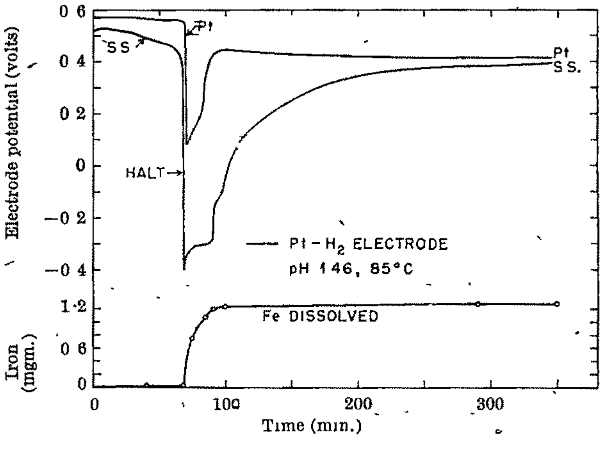

Fig. 1. Potential-time curves for stainless steel (S.S.) and smooth platinum (Pt) electrodes in aerated sulphate solution. The dissolution curve is also shown. The potential of a platinized electrode in a hydrogen atmosphere under otherwise the same conditions is indicated at − 0·3 V.

A barely detectable amount of iron dissolved during the initial passive phase. During the slow debasing, the colour became paler, and a sudden large drop in potential followed the disappearance of the last visible film, with a brief inflexion around 0 mV. versus the saturated calomel electrode (S.C.E.) as this occurred. This phase corresponds to the 'reductive-dissolution' studied by Pryor and Evans[3]; its completion left very active metal exposed and the potential fell to about − 400 mV.

From its minimum value the potential rose slightly while corrosion proceeded rapidly. What followed next was dependent upon a combination of factors which include the corrosion resistance of the specimen, the acidity, the temperature, the partial pressure of oxygen, and the geometry of the system with respect to the availability of oxygen at the interface. Fig. 1 illustrates the changes observed when using conditions that resulted in spontaneous recovery to a noble potential. Characteristically, the abrupt ennobling always began close to − 295 mV.; this point we have designated the 'critical recovery potential' for the conditions specified. The ennobling was interrupted by a brief inflexion in the region of − 140 to 0 mV., beyond which the potential rose slowly until it approached the potential indicated by a smooth platinum wire in the same solution. The ennobling process was found to be accelerated by iron (III) and copper (II) ions, among others, and experiments with radioactive iron and copper showed that both went into the film that formed during this stage of the process.

Certain specimens did not become ennobled spontaneously under the conditions indicated. In such cases, it was possible to induce the ennobling process artificially by (*a*) increasing the partial pressure of oxygen, (*b*) lowering the temperature, (*c*) raising *p*H, (*d*) adding a very small amount of an oxidizing agent such as ferric ions, cupric ions or hydrogen peroxide, or (*e*) applying briefly a small positive polarizing potential. In all such cases, if the stimulus was adequate but sufficiently small, the critical recovery potential was observed as before. Whenever, and for whatever cause, the sample passed the critical recovery potential, corrosion dropped suddenly to a very low value, as shown by the iron dissolution curve in Fig. 1.

The empirical hydrogen potential was determined for the conditions represented in Fig. 1, and at a total pressure (water vapour plus hydrogen) of 740 mm. The value obtained was − 300 mV. In the hydrogen atmosphere the stainless steel corroded rapidly at − 400 mV. and the corrosion-rate increased when the electrode was connected to the platinized electrode.

So long as the corrosion-rate is sufficiently high, oxygen is unable to depolarize the hydrogen completely and oxidize the interface. If dE/dt is positive, however, the potential will ultimately reach the critical recovery potential (approximately the hydrogen potential), hydrogen in and on the metal now becomes anodic, and by reaction with oxygen doubtless goes into transient peroxy compounds, with the sudden rise of potential observed. The subsequent brief inflexion probably represents a balance between the thermal decomposition of the peroxide and its formation from the hydrogen diffusing from the interior of the metal.

The experiments give a clear meaning to the measurements of Edeleanu[4], who found that an 18–8 stainless steel had a maximum corrosion-rate in 20 per cent sulphuric acid at 25° C. when held at a potential of about − 250 mV. Upon duplicating his experimental conditions, the 'empirical' hydrogen potential was found to be − 217 mV. Clearly, the maximum corrosion-rate should occur when the depolarization by oxygen or by an applied potential is as nearly complete as it can be without raising the electrode to the hydrogen potential. If it goes higher, hydrogen ions cease to be reduced, thereby permitting the spontaneous ennobling by reduction of oxygen.

Fuller details of this work, which was done for the U.S. Atomic Energy Commission, will be published elsewhere.

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Purification of a Metal by Zone-refining one of its Salts

The technique of zone refining has been applied very successfully to the purification of metals and elements[1], especially in the semi-conductor field where very high purity is essential. With some elements, however, it happens that certain impurities have segregation coefficients (ratio of solid to liquid solubility) of the order of unity, and consequently are not swept efficiently by the molten zone.

In general, it may be possible to overcome this difficulty by carrying out the zone-refining process not on the element itself but on some suitably chosen salt (or compound) in which better segregation may be obtained. It would be necessary to choose a salt which crystallizes readily and has a convenient melting point. It must also be such that the metal can be recovered readily and without risk of recontamination.

This technique has been successfully applied to the purification of gallium. Zone-refining of the metal was not effective, as will be seen by comparing the first two columns of Table 1. The experiment was then tried of zone-refining the trichloride, which is a clear crystalline solid with a melting point of 75° C. The trichloride was formed by direct reaction of the gallium with commercial chlorine. Twenty passes of a liquid zone through an ingot of this material gave visible purification, the front end becoming transparent and practically single-crystal, whereas the rear end became highly discoloured and poly-

Table 1. Spectrographic Analysis of Impurities found in Gallium

Impurity	Gallium as purchased (parts in 10^6)	After zone-refining gallium metal: 40 zone passes (parts in 10^6)	After zone-refining gallium trichloride: 20 zone passes (parts in 10^6)
Cu	20	20	No trace (Limit 1 in 10^6)
Fe	70	60	
Ca	20	10	
Mg	20	20	
Si	70	70	
Al	10	5	
Ag	10	5	

crystalline. The clear end was cut off and dissolved in demineralized water and the metal then recovered by electrodeposition. More than 80 per cent of the metal could be recovered in this way. Spectrographic analysis of this material showed no trace of impurities, the approximate limit of detection, as determined by control experiments, being 1 in 10^6. That the electrodeposition by itself was not effective in the purification had been shown by earlier experiments.

The spectrographic work was carried out by N. Rain, of this Laboratory. Acknowledgment is made to the Admiralty for permission to publish this communication.

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The Lupulone and *iso*Humulone Complex

At about the same time that we announced the existence of prehumulone[1], the presence of a fourth lupulone in hops was suggested by Howard, Pollock and Tatchell[2]. The present communication gives chromatographic proof of the existence of such a substance, which we propose to call 'prelupulone'. This chromatographic separation of the lupulone fraction of hops into its four components has been achieved by the technique described by us for the chromatography of the 'humulone complex'[1]. This is shown in the elution pattern of Fig. 1, which was obtained on a silica gel column, 1·3 cm. × 123 cm., buffered at *p*H 10·55 and containing 25 per cent methanol. The four bands were named in accordance with present knowledge of humulone chemistry[1,3].

When the 'lupulone complex' is recrystallized, the percentage of colupulone in the crystals thus obtained (still a mixture of several lupulones) is higher than in the starting material. This is probably due to the lower solubility of colupulone. It is therefore possible by repeated crystallizations (about five times from light petroleum and five times from methanol–water) to obtain pure colupulone with a melting point of 94°–96° [2]. Chromatography of this product on the column mentioned above yields a single band, corresponding exactly with the colupulone band of Fig. 1.

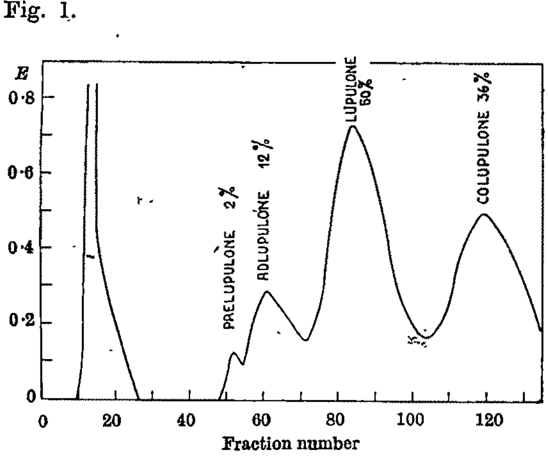

Fig. 1. Chromatography of the 'lupulone complex'. Volume of each fraction 4·5 ml. $E(1\%, 1\text{ cm.})$ lupulone in *iso*-octane = 159 ($\lambda = 275\ m\mu$)

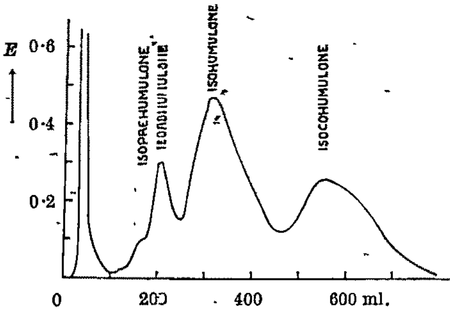

Fig. 2. Chromatography of the '*iso*humulone complex'. Volume of each fraction 6 ml. $E(1\%, 1\text{ cm})$ *iso*humulone in *iso*-octane = 276 ($\lambda = 275\ m\mu$)

The presence of an *iso*prehumulone in a beer extract can also be shown by chromatography. This separation is not as successful as for the humulone and lupulone complex, owing to extensive overlapping of the bands. An example of such a separation on a silica gel column 1·3 cm. × 85 cm., buffered at *p*H 5·22 and containing 25 per cent methanol, is shown in Fig. 2.

The beer *iso*humulone mixture for chromatographic analysis is obtained by extracting acidified (*N* sulphuric acid) beer with 2·5 times its volume of *iso*-octane. When this volume ratio is used, practically no emulsion is formed and centrifuging can be avoided. The *iso*-octane is evaporated under reduced pressure before chromatography.

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Adsorption of Trace Amounts of Cations on Anion Exchange Resins by the Formation of Insoluble Salts

It has been shown[1] that cations may be precipitated around the beads of an anion exchange resin in a column, when passed in aqueous solution through the resin, which is in a form providing a suitable anion. For example, when a cobalt solution is used with a resin in the sulphide form, cobalt sulphide is formed around the beads of resin. The nature of these precipitates suggested that fairly high concentrations of precipitating anion were present in the region of the surface of the resin particles.

It seemed likely that the anion concentration within a bead of resin might be extremely high and that a very small amount of a cation in aqueous solution, diffusing into the resin, might be precipitated in the resin itself. This hypothesis was tested by passing carrier-free radioactive isotopes down columns of anion resin in suitable forms. The behaviour of these tracers was related to the solubility of the compounds concerned and to the formation of soluble complex ions.

A column, 40 cm. long and 0·3 cm. in diameter, was packed with 'Amberlite *IRA* 400' anion resin (60–85 B.S. mesh-size). The amount of resin used was calculated to have a five-fold excess of capacity over the total amount of anion to be added with the tracer. The resin was converted to the desired form by passing large volumes of solutions of acids or alkalis through the column and then washing away the excess of reagent with water. A small volume of solution containing the tracer cation (carrier-free) was run through the column, followed by several column volumes of water. The fate of the cation was found by radioactive assay of the eluate and by the detection of radioactivity on the column. The isotopes used were cæsium-137, strontium-89 (together with a small proportion of strontium-90), zirconium–niobium-95 and cerium-praseodymium-144.

In some preliminary experiments, a column in the hydroxide form allowed strontium and cæsium to run through but collected quantitatively the zirconium–niobium mixture; an oxalate column retained most of the strontium and no cæsium; and a carbonate column collected strontium. Some systematic experiments were then carried out to relate behaviour with solubility and gave the following results:

Cation	Resin form	Solubility (gm./l.)	Behaviour of cation
Cs^+	NO_3^-	190	Unabsorbed
Cs^+	ClO_4^-	20	Unabsorbed
Sr^{++}	OH^-	17·4	Unabsorbed in most experiments
Sr^{++}	$CrO_4^{=}$	1·5	About 20 per cent unabsorbed, the rest strongly absorbed
Ce^{+++}	$C_2O_4^{=}$	0·53	Absorbed
Sr^{++}	$C_2O_4^{=}$	0·05	Most of the cation absorbed

These results suggest that compounds with solubilities of 1·5 gm./l. or less can be used for the collection of their respective cations in this way. In all cases the cations were readily washed off the resin by dilute acid.

The strontium results were particularly interesting. As hydroxide, the strontium was held on the resin in a few experiments but not in most of them. This was believed to be due to the solubility of strontium hydroxide being very near the limit for collection, so that the behaviour depended on temperature, rate of elution and possibly the presence of other ions in solution. With chromate and oxalate columns the strontium was split into two forms, one of which was quickly eluted, and the other which was retained firmly on the resin. This is believed to be due to the relatively high concentration of nitrate ions in the tracer solution (the strontium-89 was used in nitric acid solution); these ions liberated appreciable amounts of chromate and oxalate ions from the resin, which in turn gave rise to small amounts of soluble association complexes with the otherwise insoluble strontium compounds. This was confirmed when the strontium tracer was stirred with a small quantity of anion resin in the hydroxide form to reduce the total anion concentration before passing down the oxalate column, when all the strontium was retained by the resin.

Since the strontium concentration was about 1×10^7 disintegrations/min./ml., the effective concentration of, for example, chromate ions in the resin necessary to 'precipitate' the strontium would be about 1×10^4 *M*. It is more likely, therefore, that the high concentration of chromate ions in the resin promotes the formation of a radio-colloid, which is then adsorbed on the resin.

This method of collecting cations in trace concentrations has the advantages of being more efficient and more selective than the conventional co-precipitation technique. It is now being used for rapid separations of individual fission products from mixtures, and may also be used for forecasting the insoluble compounds of elements of which only trace amounts are available.

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Effect of Copper Cyanide upon the Formation *in vitro* of Melanin

As already reported, copper–xanthopterin accelerates the autoxidation of 3,4-dihydroxyphenylalanine[1]. In the course of further work, we have observed some interesting effects with cupric ions.

When potassium cyanide was added, in order to capture copper, to the solution containing the copper–xanthopterin and dihydroxyphenylalanine, the oxygen uptake was much enhanced and rapid formation of melanin was brought about. Such a result was not expected at first, for it is generally known that copper oxidases are inhibited by cyanides. We then found that the copper cyanide acted catalytically upon the autoxidation of dihydroxyphenylalanine, showing a rate of oxygen uptake as high as 70 µl. per hr., in contrast with 48 µl. consumed by the system containing copper–xanthopterin and dihydroxyphenylalanine.

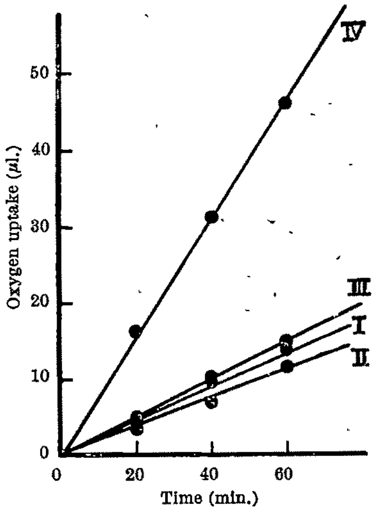

Fig. 1. Manometric determination of the accelerating effect of copper cyanide upon the autoxidation of pyrocatechol (*p*H 7·8, 37·5° C.)
Curve IV: 1·0 ml. of *M*/15 phosphate buffer, 1·0 ml. of 5×10^{-4} *M* potassium cyanide, 0·5 ml. of 5×10^{-4} *M* cupric sulphate, 0·3 ml. of distilled water and 0·5 ml. of 10^{-3} *N* sodium hydroxide in the main chamber of the flask. Curve III: 1·0 ml. of 5×10^{-4} *M* potassium cyanide in (IV) replaced by 1·0 ml. of distilled water. Curve II: 0·5 ml. of 5×10^{-4} *M* cupric sulphate in (IV) replaced by 0·5 ml. of distilled water. Curve I: 1·0 ml. of 5×10^{-4} *M* potassium cyanide and 0·5 ml. of 5×10^{-4} *M* cupric sulphate in (IV) replaced by 1·5 ml. of distilled water. Other components in the main chambers are all common to (IV).
Each of the side arms of the flasks contained 0·5 ml. of 10^{-2} *M* pyrocatechol in 10^{-3} *N* hydrochloric acid, and each of their wells, 0·2 ml. of 10 per cent potassium hydroxide. The gas space of the manometric flask was filled with air. The pyrocatechol solution was tipped from the side arm into the main chamber when the flask reached thermal equilibrium

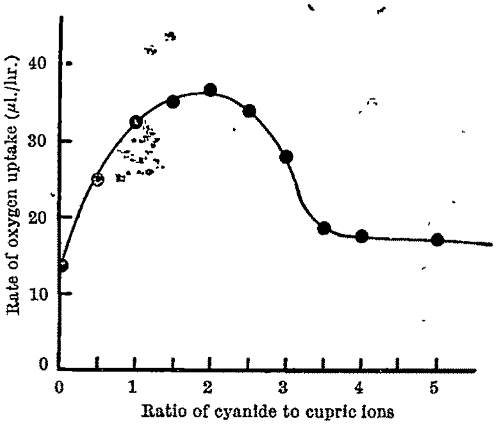

Fig. 2. Manometric determination of the effect of the mixing ratio of potassium cyanide to cupric sulphate upon the catalysis of the autoxidation of pyrocatechol (*p*H 7·8, 37 5° C.).
Each of the experimental flasks contained 0·2 ml. of 5×10^{-4} *M* cupric sulphate, 0·1 ml. of potassium cyanide of various concentrations ($0{\cdot}5 \times 10^{-3}$ *M*, 1×10^{-3} *M*, $1{\cdot}5 \times 10^{-3}$ *M*, 2×10^{-3} *M*, . . . , 5×10^{-3} *M*), 1 0 ml. of *M*/15 phosphate buffer, 0·5 ml. of 10^{-2} *N* sodium hydroxide, and 1 0 ml. of distilled water in the main chamber. In the control flask, 0·1 ml. of potassium cyanide was replaced by 0·1 ml. of distilled water, all the other components being the same as those in the experimental flasks. Each of the side arms of the flasks contained 0 5 ml of 10^{-2} *M* pyrocatechol dissolved in 10^{-2} *N* hydrochloric acid, and each of the wells, 0 2 ml. of 10 per cent potassium hydroxide. Other conditions were the same as those in the experiment shown in Fig. 1. The oxygen uptake per hour in the experimental, as well as control, flasks was plotted against the concentration ratio of potassium cyanide to cupric sulphate

In an earlier paper[2], it was shown that the accompanying xanthopterin checked the accelerating effect of cupric ions upon the autoxidation of pyrocatechol. There was, however, a remarkable production of the black pigment. Now copper cyanide, though it accelerates considerably the rate of autoxidation of pyrocatechol as well as dihydroxyphenylalanine, is not very superior to cupric ions alone as regards catalytic activity on pigment formation from pyrocatechol. In these ways at least, copper cyanide seems to differ considerably from copper–xanthopterin, probably in its mode of action toward the autoxidation processes.

As seen in Fig. 1, the cupric ion slightly accelerates, whereas the cyanide inhibits, the autoxidation of pyrocatechol. Nevertheless, the addition of both cupric ions and cyanide resulted in a definite acceleration of autoxidation. We then examined the effect of altering the ratio of copper to cyanide and found, as shown in Fig. 2, that the ratio 1 : 2 gave the maximum acceleration. It was also found that the addition of ethylenediamine, xanthopterin and certain other chelating agents to the copper cyanide–pyrocatechol system decreases the rate of oxidation.

From these results it was thought that certain complexes of copper and cyanide were produced and they acted more or less catalytically. This was also suggested by the stepwise change of the colour of the cupric sulphate solution with the increasing addition of potassium cyanide: from pale blue, through green, greenish-brown, and orange-red, to dark red. The cupric cyanide complex is known to be unstable[3].

The solution of copper and cyanide becomes more and more alkaline with the increase of the latter, but maximum activity in accelerating oxygen uptake, as mentioned above, occurs with a mixing ratio of 1 : 2. This suggests that the active species contains co-ordinated with it not more than two cyanide ions. As regards copper–xanthopterin, the optimal mixing ratio is 1 : 1 (unpublished work). From the optimal mixing ratios of these complexes, their substrate may be the bidentate donor derived from pyrocatechol and its derivatives[4].

Other substances such as thiocyanate and ammonia, when added to the cupric sulphate solution, affected the autoxidation of dihydroxyphenylalanine similarly to cyanide, although their activities were much lower. The order of the activity was $CN \gg CNS \gg NH_3$. Bivalent metallic ions other than cupric were investigated also; but if mixed with cyanide or thiocyanate or ammonia, they did not accelerate the autoxidation of either pyrocatechol or dihydroxyphenylalanine.

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Quantitative Determination of Acetylcholinesterase Activity in Individual Nerve Cells

MOST of our knowledge concerning the topical distribution of cholinesterases in the mammalian nervous system is derived from studies on tissue sections by various histochemical methods. In order to obtain more detailed information about the localization of this enzyme in the neurone, a modified thiocholine method[1] has now been applied to single cells dissected out from living tissues[2]. Quantitative data regarding the cholinesterase contents in individual nerve cells are, however, still lacking.

In 1937, Linderstrøm-Lang introduced a microgasometric method based on the principle of the Cartesian diver[3]. Later, the diver technique was applied to studies on cholinesterase and proved useful in analysing small samples of blood[4], embryonic tissue extracts and tissue sections[5]. Recently, a micro-diver technique has been developed for cholinesterase measurements in single megakaryocytes of the bone-marrow of the rat (Zajicek and Zeuthen, unpublished work), and the method was refined further for studying the increase of the specific cholinesterase or acetylcholinesterase activity during the maturation process of megakaryocytic cells (Zajicek, unpublished work). The present communication reports the application of the micro-diver technique for the determination of the acetylcholinesterase contents in a single nerve cell.

Albino rats, weighing about 200 gm., were killed by decapitation without anæsthesia. The spinal, sympathetic and parasympathetic ganglions were isolated and placed in substrate-bicarbonate Ringer's solution. Individual nerve cell bodies and a part of their neurites 100–200μ long were dissected out by micromanipulation. The divers were charged and a 7×10^{-3} *M* solution of acetylthiocholine was used as substrate (Zajicek and Zeuthen, unpublished work). The esterase activity was expressed as the amount of carbon dioxide evolved from the bicarbonate buffer by the acid formed during the enzymatic hydrolysis of acetylthiocholine. The sensitivity of the divers employed was of the order of 2×10^{-6} µl. carbon dioxide.

The esterase activity curves for a cell body, isolated from a sympathetic ganglion (filled circles) and that of its neurite (open circles) are given in Fig. 1. This graph shows that the cell body liberated about 620×10^{-6} µl. carbon dioxide, and a part of its neurite 130µ long 235×10^{-6} µl. carbon dioxide per hour, corresponding to the hydrolysis of about $7{\cdot}6 \times 10^{-3}$ µgm. and $2{\cdot}9 \times 10^{-3}$ µgm. of acetylthiocholine respectively.

Recent findings on the different types of cholinesterases indicate that acetylcholinesterase is the physiologically important enzyme in splitting acetylcholine in the animal system[6]. When measuring the enzymic activity in a single cell, the differentiation between cholinesterase and acetylcholinesterase cannot be achieved by current substrate specificity or activity-substrate concentration relationship tests for reasons discussed in detail elsewhere.

It has recently been found that 8×10^{-7} *M* mipafox (*bis*-mono*iso*propylamino-fluorophosphine oxide) completely inhibits the non-specific serum cholinesterase, whereas it affects acetylcholinesterase activity only in concentrations higher than 6×10^{-6} *M* [7].

The quantitative determination of non-specific cholinesterase and acetylcholinesterase activity in a single cell with the aid of the inhibitor involves three main steps: (i) the determination of the whole acetylthiocholine-splitting capacity of the cell; (ii) the introduction of a 6×10^{-6} *M* solution of mipafox which inhibits the non-specific cholinesterase into the diver; (iii) the subsequent measurement of the acetylcholinesterase activity (Zajicek, unpublished work).

The esterase activity curves of a cell body isolated from a spinal ganglion (crosses) and of a 100-µ long part of its neurite (filled circles), and, finally, of a sample of purified serum cholinesterase, before and after treatment with mipafox (open circles), are shown in Fig. 2. The graph shows that the cell body and its neurite, which hydrolysed 17×10^{-3} and $1{\cdot}5 \times 10^{-3}$ µgm. of acetylthiocholine per hr., respectively, exhibited the same esterase activity after treatment with mipafox as before treatment, whereas the non-specific cholinesterase was completely inactivated by the inhibitor. It is therefore concluded that the esterase estimated in the single spinal ganglion cell was an acetylcholinesterase ('specific' or 'true' cholinesterase), that is, the enzyme which is claimed to be connected with the mechanism of the transmission of nerve impulse[6].

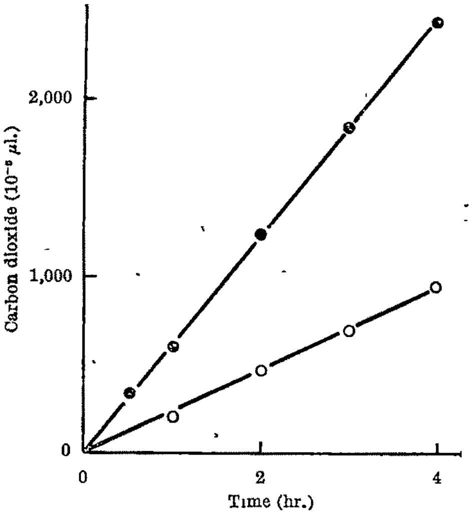

Fig 1. Esterase activity curves of a cell body (37µ) isolated from a sympathetic ganglion of rat (filled circles) and that of a 130-µ long part of its neurite (open circles)

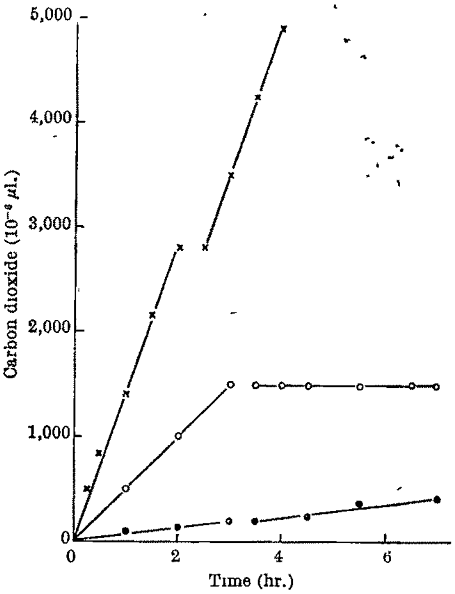

Fig. 2. Esterase activity curves of a cell body (44µ) isolated from a spinal ganglion of rat (crosses), of a 100-µ long part of its neurite (filled circles) and of a sample of purified serum cholinesterase (open circles), before and after treatment with mipafox

A detailed report of the inter- and intra-cellular distribution of acetylcholinesterase in ganglion cells will be published later.

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An Unidentified Amino-sugar present in Cell Walls and Spores of Various Bacteria

A substance reacting as a hexosamine but which is not glucosamine or galactosamine has been found in 6 *N* hydrochloric acid hydrolysates of a variety of bacterial cell walls by Cummins and Harris[1] and in peptides isolated from spores of *Bacillus megatherium*, *B. subtilis* and *B. cereus* by Strange and Powell[2]. There is evidence that in all cases the same substance is involved, and recently in this laboratory a similar compound was isolated from acid hydrolysates of cells of *Micrococcus lysodeikticus* in sufficient quantity

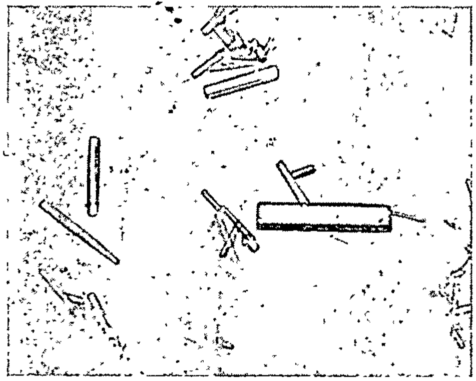

Fig. 1. An unidentified amino-sugar from *B. megatherium* spore peptide, crystallized from ethanol–water. × 100

for comparison with that from spore peptide, which showed that it was identical in a number of properties. The amino-sugar would therefore seem to be widely distributed in bacteria. The base has now been obtained in crystalline form from acid hydrolysates of spore peptide (Fig. 1) by the use of ion-exchange resins. Investigation of the crystalline compound has shown that it is not a simple hexosamine; for example, after treatment with ninhydrin according to the method of Stoffyn and Jeanloz[3], followed by paper chromatography, a spot was obtained which reacted with aniline phthalate[4] and other sugar spray reagents like a pentose but which had an R_F value considerably lower than that of arabinose, lyxose, xylose or ribose. This product reduced ammoniacal silver nitrate but did not react with naphthoresorcinol–trichloracetic acid[5].

So far, the amino-sugar has always been found in the presence of glucosamine or glucosamine and galactosamine[1,2], and since it reacts like them in three methods for their estimation, namely, those of Elson and Morgan[6], Dische and Borenfreund[7] and Tracey[8], it will be estimated with them as hexosamine. It was thought desirable to determine the quantitative effect of the substance in these three methods. The crystals were dried over phosphorus pentoxide *in vacuo* at 60°.

Using the Immers and Vasseur[9] modification of the Elson and Morgan method, the colour obtained had an absorption maximum near 520 mμ, compared with that of 530 mμ for the glucosamine or galactosamine derivatives[2]. The relationship between light absorption at 520 and 530 mμ and concentration, for the substance and glucosamine (base), is shown in Fig. 2. When the light absorption of both derivatives was measured at 530, 520 and 510 mμ, the colour produced by the amino-sugar was equivalent to 56, 69 and 77 per cent, respectively, of that produced by an equal weight of glucosamine.

Using the Dische and Borenfreund method, the light absorption of the colour produced measured at 492 mμ minus that measured at 520 mμ was 53 per cent of that produced by an equal weight of glucosamine (base).

Using the Tracey alkaline distillation method, the ammonia liberated from the substance was equivalent to 5 per cent nitrogen compared with 7·8 per cent for glucosamine (base).

From these results it is evident that the substance cannot be estimated as a hexosamine with reference to glucosamine unless the conversion factor is known for each method. A simple method of detecting it is to take readings of the absorption of the Elson and Morgan colour at 510 and 530 mμ. The ratio $\frac{-\log T\ 530\ m\mu}{-\log T\ 510\ m\mu}$ is greater than 1·1 for the glucosamine and galactosamine derivatives and less than 0·9 for the amino-sugar derivative. It is also possible, by means of this ratio, to detect it in solutions containing these hexosamines, providing its concentration with respect to them is high enough.

For the estimation of the substance in the presence of glucosamine or galactosamine, advantage may be taken of the fact that the ion-exchange resin I*R*–120 (H) (obtainable from B.D.H., Ltd.), buffered to *p*H 6·05, will remove these hexosamines but not the amino-sugar from aqueous solution. A column of I*R*–120 (H) was prepared and *M* sodium dihydrogen and disodium phosphate buffer, *p*H 6·05, passed through until the eluent was at this *p*H. The resin was washed with de-ionized water until the eluent was free from phosphate and dried at room temperature on filter paper. The solution for analysis was adjusted to *p*H 6·0; in the case of acid hydrolysates, this was achieved by the use of I*R*–4*B* (OH). The solution was diluted, if necessary, to contain not more than 100 μgm./ml. hexosamine-reacting material (as glucosamine). A sample (5 ml.) was treated with buffered resin (approximately 1 gm.) in a stoppered tube on a rotary shaker for 30 min. The solution was filtered free from resin through a Whatman No. 1 filter paper (5·5 cm.) and the Elson and Morgan reaction carried out with an aliquot of the filtrate (1–2 ml.). In the absence of the pure substance, a glucosamine standard may be used and the result multiplied by a factor, namely, 1·78, 1·45 or 1·3 for measurements taken at 530, 520 or 510 mμ, respectively, to give the approximate concentration. Recoveries with solutions containing the substance and glucosamine or galactosamine were 98–101 per cent when compared with a standard of the pure amino-sugar. Acid hydrolysates of cell walls of vegetative *B. megatherium*, *B. subtilis* and *B. cereus*

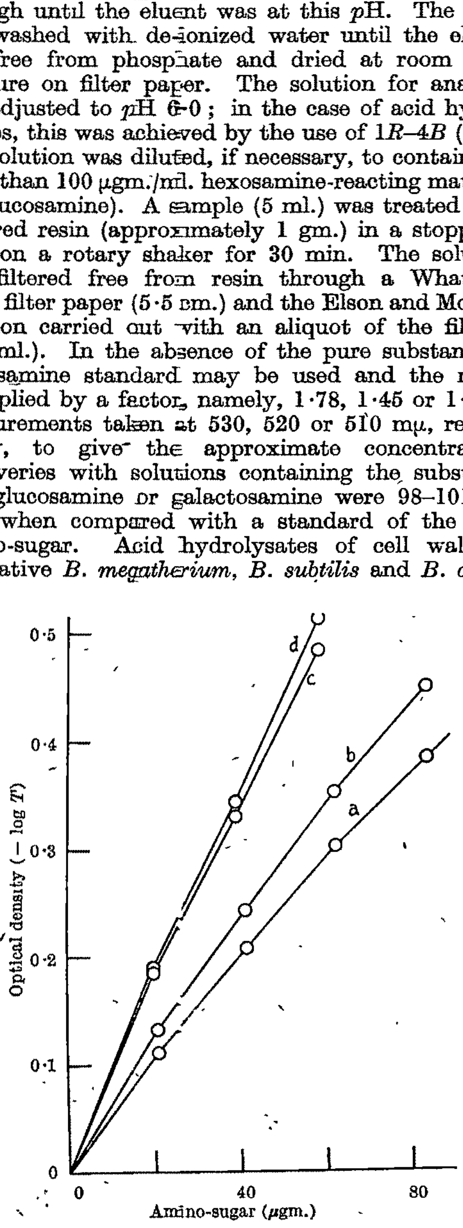

Fig. 2. Concentration/—log *T* relationships for the amino-sugar and glucosamine derivatives in the Elson and Morgan reaction: (*a*) amino-sugar at 530 mμ; (*b*) amino-sugar at 520 mμ; (*c*) glucosamine at 520 mμ; (*d*) glucosamine at 530 mμ

were found to contain 10, 11·6 and 4·3 per cent, respectively, of the amino-sugar.

Work on the identification of the substance is proceeding in this laboratory.

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Vitamin B_{12} Activity of *Chlorella vulgaris* Beij and *Anabaena cylindrica* Lemm

Microbiological tests by means of vitamin B_{12}-dependent bacteria and *Euglena gracilis* have shown that higher plants contain only traces (less than 1 µgm. per 100 gm. dry weight) of vitamin B_{12}, whereas microbiological activity corresponding to 10–50 µgm. vitamin B_{12} per 100 gm. dry weight has been reported in a number of algae.

Several substances, such as factor *A* and pseudo-vitamin B_{12}, are closely related chemically to cobalamin and capable of supporting growth of the bacteria and *Euglena* used for microbiological assay of the vitamin[1,2]; but they cannot replace cobalamin in the nutrition of higher animals[3]. Some micro-organisms are known to synthesize these substances as well as vitamin B_{12} itself[2,4]. The vitamin B_{12} activity of two algae was therefore investigated to determine whether this was due to cobalamin or to one or more of the related factors. Pure cultures of algae, which had been maintained free from bacteria during many transfers on inorganic media, were employed to ensure that any vitamin B_{12} activity detected must have originated from the synthetic activity of the organisms studied.

Vitamin B_{12} assays were carried out by a modification of the *E. coli* mutant plate-assay method[5], the solution for assay being obtained by extracting the algae with hot aqueous methanol in the presence of ammonia and cyanide. The nature of the substances present was determined by chromatography, ionophoresis and bio-autography[6]. By these tests the sample of *Chlorella vulgaris* was shown to contain 6·3 µgm. cobalamin per 100 gm. dry weight; no other compounds showing vitamin B_{12} activity could be detected. The results obtained with *Anabaena cylindrica* are shown in Table 1.

About 65–70 per cent of the activity of the *Anabaena* was due to vitamin B_{12}, the remaining effects being caused by the presence of pseudo-vitamin B_{12} and traces of factors *A* and *B*. In one experiment, cobalt (5 p.p.m.) was added to the medium to determine whether additional cobalt would allow synthesis of more vitamin B_{12}. Although the concentration of vitamin B_{12} was thereby almost doubled, scarcely any more total vitamin B_{12} activity was detected, because the dry-weight yield of alga was simultaneously depressed.

Table 1

Added cobalt	Total vit. B_{12} activity (*E coli*) per gm. dry wt.	Activity of B_{12} and related substances (in terms of B_{12}) per gm. dry weight			
		Vit B_{12}	Pseudo-vit. B_{12}	Factor *A*	Factor *B*
Nil	0·63 µgm.	0·44 µgm.	0·19 µgm.	trace	trace
5 p p m.	1·1 µgm.	0·70 µgm.	0·40 µgm	trace	trace

The cobalamin content of *Chlorella* used in these studies is of the same order as the microbiological activity reported by Combs[7] for this organism: it indicates that the algae, grown under controlled conditions, may synthesize sufficient cobalamin to contribute to the dietary needs (up to about 5 µgm./100 gm. food) of higher animals and man.

The higher animals and many Protista, for which vitamin B_{12} is an essential nutrient, have been thought to be dependent on bacterial and fungal synthesis of the vitamin. The presence of cobalamin in at least two different algae may point to an alternative source of this nutrient, particularly for B_{12}-dependent organisms living in soil or water and for the food chains of animals living on these organisms.

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Influence of the Adrenal Cortex on Wool Growth and its Relation to 'Break' and 'Tenderness' of the Fleece

We were interested to know whether the adrenal cortex exerted a depressant action on wool growth in sheep. Such a mechanism might underlie the decline in wool growth observed in winter[1] and during pregnancy[2], since cold and gestation are known to increase adrenocortical activity in other species[3]. The marked increase in the number of active follicles which begins about ten days after birth in the lamb (Ferguson, K. A., Schinckel, P. G., Carter, H. B., and Clarke, W. H., in preparation) may possibly be due to release from adrenocortical inhibition. Field-observations link the occurrence of 'break' or 'tenderness' of the fleece[4] with disease, advanced pregnancy or environmental stresses which may be expected to stimulate secretion of adrenocorticotrophic hormone.

We have observed the effects on wool growth of treating sheep with adrenocorticotrophic hormone and with cortical steroids. The sheep were main-

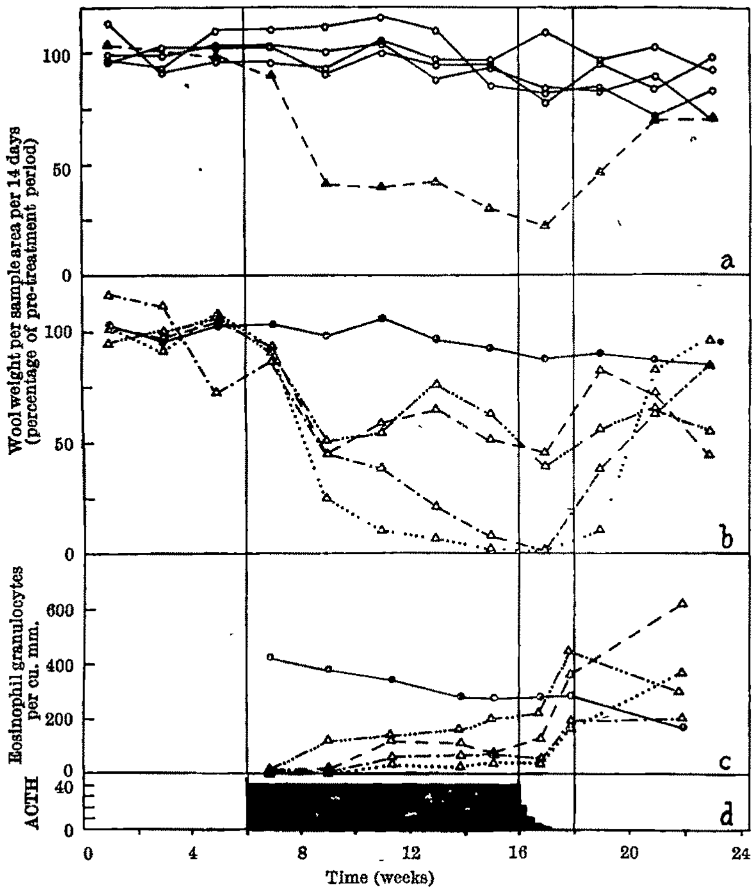

Fig. 1. Wool growth and blood eosinophil granulocyte count of sheep injected daily with adrenocorticotrophic hormone. (*a*) ○—○, untreated; ▲- - -▲, treated (mean); (*b*) and (*c*), ●—●, untreated (mean); △—···—△, *A* 91; △——△, *A* 79; △—·—△, *A* 84; △····△, *A* 89; (*d*) dose of adrenocorticotrophic hormone in I.U./sheep/24 hr.

tained in pens on a constant food intake. Wool growth was measured by the periodic clipping of a sample area defined by tattoo lines. Four ewes received daily intramuscular injections of 40 I.U. of long-acting adrenocorticotrophic hormone (Acton) for ten weeks.

The results are shown in Fig. 1. Wool growth was significantly decreased in the treated sheep ($P < 0.01$). In two sheep, wool growth diminished progressively until completely arrested, and rose sharply after cessation of treatment. In the other two animals, a degree of refractoriness developed after an initial decrease in wool growth. Fibre thickness and length growth were reduced and histological sections revealed many follicles that had shed their fibres and undergone varying degrees of involution. Primary follicles shared this effect, though to a lesser degree than secondary follicles. Coinciding with the resumption of wool growth as determined on the sample area, a 'break' appeared in the fleece above the surface of the skin in all sheep treated. Numerous shed roots and new growing tips resembling those of lambs' wool were discernible microscopically in this part of the staple, whereas other fibres, though continuous through the region of break, were reduced in diameter.

The number of circulating eosinophils was reduced by treatment with adrenocorticotrophic hormone. This reduction was less persistent in those sheep showing refractoriness to treatment, suggesting that the adrenals of these sheep were unable to respond to continued intense stimulation. No refractoriness has been noted in four sheep treated with cortisone. The serum of a sheep refractory to adrenocorticotrophic hormone failed to protect hypophysectomized rats against the effect of the hormone in restoring the weight of adrenals, indicating that antibodies to the hormone were not the cause of the refractoriness.

A response resembling that to adrenocorticotrophic hormone was produced in four ewes by the daily intramuscular injection of 1·8 mgm. cortisone acetate per kgm. body-weight for eight weeks. Again the appearance of the 'break' above the skin coincided with the resumption of wool growth four to six weeks after cessation of treatment. The local application of an ointment containing 0·1 per cent of 9-α-fluorohydrocortisone (Merck) to the sample area on three sheep suppressed wool growth and induced local skin changes resembling those produced by the systemic treatments described, while normal wool growth continued on sample areas sham-treated with the ointment base on the opposite sides of the same sheep. Treatment of other sheep with a 2·5 per cent hydrocortisone ointment (Merck) produced a much smaller response.

Experiments are in progress to determine whether the cortical secretion of the normal sheep is sufficient to limit wool growth. Comparisons are being made of the wool growth of adrenalectomized sheep maintained on different levels of cortisone and deoxycorticosterone.

The above experiments suggest that a temporary hyperactivity of the adrenal cortex may be a common physiological mechanism underlying the occurrence in the field of 'tenderness', 'break', 'rising of the fleece', and possibly the 'cotted fleece'. However, the degree of adrenocortical stimulation which occurs following natural stresses which cause 'break' remains to be determined. Further investigation is also required to test whether variations in adrenal cortical activity are of importance in determining natural variations in wool growth, such as those due to individuality, breed, nutrition, gestation and season.

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Zinc in Aspermic Human Semen

Normal human seminal plasma has been shown to contain a higher concentration of zinc than any tissue except sperm[1]. The sperm contain a very high concentration of zinc, but their removal from semen by centrifugation causes no significant reduction in the zinc concentration of the fluid because of their small relative volume. No previous opportunity had occurred for analysis of naturally aspermic semen, but recently a specimen of this nature was received. It had not been collected in specially cleaned glassware, but any contamination due to this fact could not have added more than a few μgm./ml. to the zinc content.

The centrifuged deposit from the whole specimen was examined by phase microscopy and by the staining method of Isenberg[2] and found to contain a few epithelial cells, but no sperm. The volume of the semen was 5 ml.

Zinc was estimated in 1 ml. of the plasma by the method of Vallee and Gibson[3]. The dry weight was 7·6 gm./100 gm. and the zinc concentration 234 μgm./ml. This result did not differ significantly from normal: four specimens of normal human seminal plasma contained 134 ± 59 (S.D.) μgm. zinc/ml.

It is known that dietary zinc deficiency will cause a reduction of androgenic hormone production and aspermia in rats[4]. The wide distribution of zinc in Nature makes dietary zinc deficiency in man very improbable, and the normal volume and the high zinc content of this semen suggest normal prostatic function. The donor was clinically normal, with no evidence of androgenic insufficiency.

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Reticulocyte Enzymes and Protein Synthesis

The hæmoglobin of red cells appears to be synthesized during the early stages of maturation, and its formation is more or less complete by the time the cells leave the bone marrow. Although reticulocytes have practically their full complement of hæmoglobin, evidence from amino-acid incorporation studies[1] suggests that these cells, unlike mature erythrocytes, still have protein-synthesizing capacity. In view of this, it was felt that it would be of interest to see if certain enzymes were at a high level of activity in reticulocytes; Table 1 summarizes the results of a preliminary investigation of the level of activity in the two types of cell for a number of enzymes which might be involved in some way in a protein-synthesizing mechanism.

In addition to the enzymes shown, attempts were made to detect glutamine synthetase and enzymes synthesizing glutathione. However, under the conditions of assay which were tried, such activities were not detected in either erythrocytes or reticulocytes.

Table 1

Enzymatic activity	*p*H	Activators	Approximate increase in activity in reticulocyte preparations
Cathepsin	3·2	none	6-fold
Cathepsin	7·5	0·001 *M* Zn^{++}	no increase
Glycylglycine dipeptidase	7·8	0·001 *M* Co^{++}	8-fold
Leucine amino-peptidase	7·8	0·001 *M* Mn^{++}	2-fold
Tripeptidase	7·1	none	2- to 3-fold
Liberation of inorganic phosphate from adenosine tri-, di- and mono-phosphate	7·5	0·001 *M* Mg^{++}	2- to 3-fold
Acid phosphatase	6·0	none	3- to 5-fold
Alkaline inorganic pyrophosphatase	7·5	0·025 *M* Mg^{++}	8-fold
Acid inorganic pyrophosphatase	5·2	none	12-fold

The phosphatases listed in Table 1 were investigated in view of the possibility that their *in vivo* function may be concerned with the transfer of phosphate bond energy utilized in the linking of amino-acids. The reticulocyte preparations were similar to those used in the amino-acid incorporation studies of Borsook[1], that is, preparations of rabbit blood containing 70–90 per cent reticulocytes, obtained following reticulocytosis induced by phenylhydrazine. The assays were carried out on whole hæmolysates obtained by freezing and thawing the washed cells, and activities were expressed per milligram of protein nitrogen.

During the transition from reticulocyte to erythrocyte, much of the cellular protein, other than hæmoglobin, disappears, and it might be expected that, relative to total protein nitrogen, a generally higher level of enzymatic activity might be found in the former type of cell. This may account for the fact that most of the enzymes studied showed some increase in activity in reticulocytes.

However, from Table 1 it is apparent that some enzymes are increased to a greater extent than the others: namely, cathepsin active at *p*H 3·2, one particular peptidase (glycylglycine dipeptidase), and inorganic pyrophosphatase.

The possibility that cathepsins have a synthetic function has long been considered, and there appears to be some correlation between the rate of growth, or of protein synthesis, and the level of catheptic activity in various tissues[2,3]. On the other hand, recent reports that cathepsins are mitochondrial enzymes[4] are not in accord with a protein-synthesizing function, as the latter process appears to be associated with microsomal particles. It has been suggested[3] that catheptic activity is concerned with the provision of free amino-acids for utilization in protein formation, rather than with the synthetic mechanism itself.

The observation of a specific increase in dipeptidase activity is of interest in relation to recent reports by Binkley[5], who, in the course of attempts to purify cysteinyl glycinase from swine kidney, obtained a soluble fraction which possessed a very high non-specific dipeptidase activity and which was apparently non-protein in nature. This material exhibited some of the properties of a polynucleotide, and in view of this, it was suggested that *in vivo* the activity might be related to protein biosynthesis.

Among the phosphatases studied, the largest increases were found in the case of the inorganic pyrophosphatases. This observation may have a bearing on results obtained by Hoagland and Keller[6], who have formulated the following scheme for the carboxyl activation of amino-acids (detected in their experiments by hydroxamate formation):

$$E + \mathrm{ATP} \rightleftharpoons E(\mathrm{AMP{-}PP})$$
$$E(\mathrm{AMP{-}PP}) + \mathrm{AA} \rightleftharpoons E(\mathrm{AMP{-}AA}) + \mathrm{PP}$$
$$E(\mathrm{AMP{-}AA}) + \mathrm{NH_2OH} \rightleftharpoons E + \mathrm{AMP} + \mathrm{AA{-}NH.OH}$$

If the activation of amino-acids prior to incorporation into protein takes place by a general mechanism such as the above, then a function for the intracellular pyrophosphatase is apparent: to split the inorganic pyrophosphate formed, thus providing free orthophosphate for utilization in the regeneration of adenosine triphosphate (presumably through a concomitant glycolytic process). The higher inorganic pyrophosphatase activity in reticulocytes could be related in this way to the protein-synthesizing capacity of these cells.

Detailed reports on the above investigations are in preparation for submission to the *Biochemical Journal*. This work is supported by a grant from the Secretary of State for Scotland on the recommendation of the Advisory Committee on Medical Research.

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Polyembryony in *Cassia*

DURING an investigation into a presumed hybrid swarm among *Cassias*[1], seeds with twin embryos were found. An examination of the seeds of different species of *Cassia* that were available has shown the occurrence of polyembryony to be geographically widespread and remarkably common within several species. Table 1 gives the percentage of twins and triplets (in brackets) found in different collections of fifty to a hundred seeds.

Table 1. PERCENTAGE OF TWINS AND TRIPLETS (IN BRACKETS) IN DIFFERENT COLLECTIONS OF SEED

Australian species of *Cassia*	1	2	3	4	5
C. artemisioides Gaud.	10 (1)	25	10 (1)	23 (3)	8
C. australis var. *revoluta* Benth.	0				
C. desolata var. *involucrata* J. M. Black	16 (1)				
C. eremophila A. Cunn	40 (2)	20 (2)	5	24	
C. phyllodinea R. Br.	14 (1)				
C. sturtii R. Br.	3	21	9	40 (4)	14 (2)

The exotic species *C. bicapsularis*, *C. cana*, *C. corymbosa*, *C. fistula* and *C. leptophylla* contained no twins in single samples of fifteen to fifty seeds.

Among the twins and triplets the embryos varied from equality in size to one large and one small, and one large and two small respectively, gross inequality being the general case. Fused embryos and others with extra or reduced cotyledons were also frequent. The pairs of large twins at least were viable.

These extra embryos could arise from several sources. The occurrence of cleavage polyembryony or of several embryo sacs would not be apomictic in nature, but the first case would lead to the production of identical twins as would apomictic embryos. The latter could have developed from cells of the nucellus and integuments, or in some cases from the synergids. Twins arising from several embryo sacs would not be identical. However, many genera are facultative apomicts, and both sexual and apomictic reproduction may occur simultaneously[2]. Evidence for this in *Cassia* was indicated when one plant, presumed to be a hybrid on morphological characters, failed to segregate but produced twins and other abnormal seedlings, while a second plant produced morphologically different seedlings from each of two pairs of twins.

All the Australian species listed belong to the section *Psilorhegma*, which is well developed in Australia, but the varied biotypes of which have resulted in taxonomic confusion, particularly in the species complex centred about *C. sturtii*. The preservation of the intermediates could be the result of both apomixis and of sexual reproduction.

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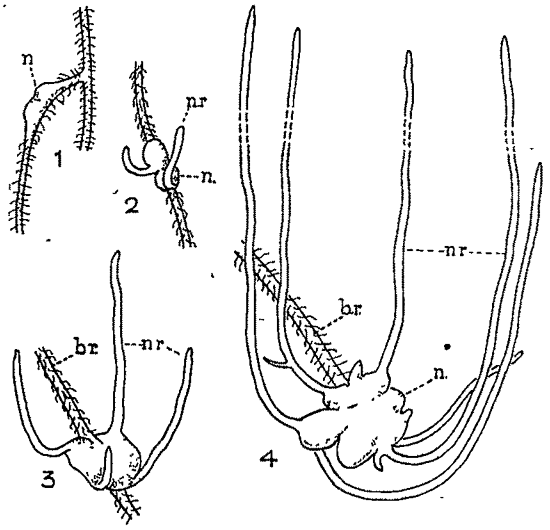
A Feature of the Root Nodules of *Casuarina*

IN the course of an investigation into the development and physiological activity of the root nodules of *Casuarina*, considerable numbers of nodulated plants of *C. cunninghamiana* and *C. equisetifolia* are being grown in water culture. Nodulation was secured by inoculating the roots of young plants with a suspension of crushed *Casuarina* nodules obtained from abroad through the assistance of Dr. H. R. Fletcher, of the Royal Botanic Garden, Edinburgh, and commenced three to four weeks after such inoculation. McLuckie[1] noted a resemblance between *Casuarina* and *Myrica* root nodules in that both show a lobed structure as the result of repeated branching (actually this is true of most non-legume and some legume nodules) and in that a root grows out from each nodule lobe.

An interesting feature which has emerged from the present study is that these nodule roots show strongly upward growth, as illustrated in Figs. 1–4. In some cases the roots (which bear few or no root hairs) have attained a length of 10 cm. and may project from the surface of the culture solution even when originating from quite deeply set nodules. Precisely similar features have been recorded previously for *Myrica gale*[2] growing under a variety of cultural and under field conditions. In that species the upward growth of the nodule roots was shown to be the result of negative geotropism (not of ageotropism, as stated in a recent review[3]), and was thought to be possibly of significance in the ventilation of the nodules, which are otherwise enclosed in a layer of cork tissue. The general position seems to be much the same in *Casuarina*.

It is somewhat surprising that this unusual pattern of root behaviour should be repeated in such unrelated plants as *Casuarina* and *Myrica*, resulting in the nodulated root systems of young plants being virtually indistinguishable from each other externally. A further resemblance is that the nodules of *Casuarina* also are frequently pink in colour. I have no oppor-



Figs. 1–4 show successive stages in the development of nodules and nodule roots in *Casuarina equisetifolia*, orientated as they had grown. *n.* = nodule; *n.r.* = nodule root; *b.r.* = root (with root hairs) bearing nodule. (× 10 approx.)

tunity for examining field material of *Casuarina* nodules *in situ* to ascertain whether the upward growth of the nodule roots is shown under natural conditions. It is probable that such would prove to be the case; but it would be necessary to examine newly formed roots, since the original orientation may no longer be shown in old, moribund roots.

Other observations on *Casuarina* nodules, which according to the work of Aldrich-Blake[4] and of Mowry[5] are nitrogen-fixing, will be presented elsewhere, along with full acknowledgments for assistance received.

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Inhibition of Salt Absorption in Red Beet Root Tissue

Rees and Skelding[1] have reported that extracts of red-beet root tissue inhibit the absorption of salts by this material. They claimed that the extracts do not affect respiration, and attributed the influence to a non-metabolic effect on permeability. It was suggested that the inhibitory principle is responsible for natural dormancy in beet roots, and for the inability of freshly cut disks of dormant tissue to absorb salts actively. In an intensive investigation of this problem during the past two years, we have confirmed the main inhibitory effect, and have suggested a probable cause. It is hoped that a full account of the work will be published elsewhere.

In this investigation, the uptake of potassium ions by disks of red beet root tissue has been examined using techniques already described[2]. Rates of respiration were determined in parallel experiments with a standard Warburg apparatus. The tissue extracts were prepared essentially as described by Skelding and Rees. In all cases the potassium content of the experimental solutions and controls was brought initially to 0·02 N, usually by the addition of an appropriate amount of potassium chloride, although occasionally, as indicated below, other salts of potassium were used. A small amount of sodium chloride was added to the control solutions to compensate for the sodium present in the tissue extracts. Competition with hydrogen ions was controlled by bringing all the solutions initially to pH 6, by addition, where necessary, of a small amount of potassium hydroxide. Uptake- and respiration-rates were generally determined over an experimental period of 6 hr. at 25° C.

It may be observed from Fig. 1 that, in the presence of tissue extract, the uptake of potassium was reduced. At the same time there was a considerable stimulation of oxygen absorption. Dilution of the extract caused reduction of the inhibition and a decreased respiratory effect. A similar stimulation of respiration by extracts of red beet has already been reported by Bennet-Clark and Bexon[3]. The absence of an effect in the experiments of Skelding and Rees seems somewhat surprising in view of these observations.

During the present work, the respiratory and salt inhibitory effects of the extract have been separated to some extent by ether fractionation. It has become evident that a large part of the stimulation of oxygen uptake is attributable to sugars, and perhaps other respiratory substrates which do not inhibit salt uptake. On the other hand, fractions of the extract which cause inhibition invariably retain a significant stimulatory effect on respiration. These fractions contain large amounts of organic acids, chiefly malic and citric, which have been separated and identified chromatographically. It is claimed that these are chiefly responsible for the inhibition of ion uptake, and the residual respiratory effect.

The slower uptake of cations from solutions of single salts containing a relatively immobile anion is a well-known phenomenon. Uptake of potassium from a solution containing chloride may be compared with that from a solution of malate from the results in Table 1. Table 1 also shows that potassium uptake in the presence of a tissue extract is inhibited when compared with the uptake from potassium chloride, but not inhibited when compared with the uptake from potassium malate. This is true whether the potassium content of the extract is made up initially by the addition of either potassium chloride or potassium malate. A similar effect has been observed with other organic acids, including citric and succinic acids.

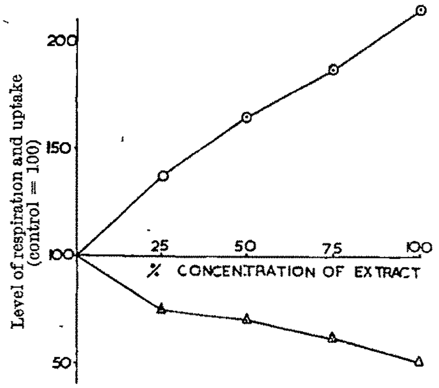

Fig. 1. Effect on disks of red beet root of extracts of the same tissue. Respiration, ○; uptake of potassium, △. 6 hr. at 25° C.

Table 1. Uptake of potassium ions (μequiv. per gm. fresh weight) from solutions of different salts, and in the presence of tissue extracts, in 6 hr., at 25° C.

Solution	Uptake	S.E
Potassium chloride	44·4	± 0·57
Potassium malate	30·9	± 0·07
Tissue extract+chloride	34·4	± 0·26
Tissue extract+malate	29·7	± 0·18

It is concluded that the apparent inhibitory effect of tissue extracts of red beet is mainly attributable to association of a proportion of the cations present with organic anions, which are absorbed more slowly than chloride and cause a retardation in the rate of uptake of cations.

In later experiments we have observed that extracts prepared from actively growing roots of the beet, and also from disks with a strong accumulatory ability, show inhibitory effects on cation uptake which are not significantly different from those exhibited by extracts from dormant roots. These observations indicate that the inhibition is without significance either in relation to the life-cycle of the beet plant, or to the development of an absorptive capacity in tissue disks.

One of us (J. E. D.) wishes to thank the Agricultural Research Council for permission to publish this communication.

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Virulent Attacks of Eyespot on Oats

OATS, although known to be occasionally attacked by eyespot caused by *Cercosporella herpotrichoides*, are generally regarded as very resistant to this disease, and hence are usually considered the safest crop to follow wheat or barley where intensive cereal cultivation is being carried on. In view of this statement, the following observations on disastrous attacks of *Cercosporella herpotrichoides* on oats may be of interest.

During a survey of cereal crops in 1955 and the incidence of eyespot in Ireland, numerous crops of oats were reported as badly affected by lodging. A microscopical examination of specimens from eighteen crops confirmed the presence of *Cercosporella herpotrichoides* as the causative agent, the take-all fungus *Ophiobolus graminis* being present in one sample. The lodged crops were widely distributed over twelve counties: in nine cases the number of affected plants was more than 80 per cent, and in some of these the entire crop had gone down; the remaining nine crops had lodged patches of varying extent.

All crops were spring sown, that is, in March or April, and the varieties were Victory, Sun II and Glasnevin Triumph, the rotation being:

1 crop oats, following three successive barley crops;
4 crops, each following three successive wheat crops;
3 crops, each following two successive wheat crops;
4 crops, each following one year wheat after ley;
2 crops, each following one year wheat after roots;
1 crop, the third successive crop of oats;
2 crops, each following wheat, no other particulars;
1 crop, no particulars.

Although typical eyespot lesions occurred to some extent on the oat plants, they were rather scanty; but frequently an indented line was present on one or both sides of the culm. This indentation presented the appearance as if the culm had been pressed in with the thumb-nail, the dent extending up the plant from the base to a height of one to three inches, and sometimes causing a split in the culm. When such stems were cut longitudinally, the fungus was often visible to the naked eye in the central cavity, and, as a rule, more profusely developed than occurred in either affected wheat or barley.

This attack on oats was no doubt closely connected with the prevailing climatic factors. Weather conditions in the autumn of 1954 and the following winter were such as to preclude ploughing. March and April in 1955 were favourable for cultivation, but both May and June were wet. In fact, the last mentioned was the wettest June since 1928 and the nights were unusually cold. Rain fell early in July, but then the weather suddenly changed and came in exceptionally warm, and it continued so throughout August. Lodging of diseased crops commenced towards the end of the third week in July, and as the very warm weather continued, more and more cases were reported. The collapse of the plants was sudden and spectacular on many farms, lodging of most of the crop occurring within two or three days. As no rain had fallen during the previous three weeks in many districts, the occurrence naturally aroused the growers' interest. The various county instructors in agriculture were then consulted, and due acknowledgment is made to them for assisting in this investigation.

In a previous communication[1], Miss Glynne reported a severe attack of sharp eyespot on oats due to *Corticium solani*. We, however, are not aware of any record in plant pathological literature of widespread attacks of ordinary eyespot on oats such as described, and it would seem as if our views on the resistance and liability of oats to *Cercosporella herpotrichoides* will have to be considerably modified.

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Spawning of the Sardine at a Definite Time of Day

THE sardine is the principal food-fish of the lands bordering the Adriatic Sea. It is fished only from April to September, since it disappears from the fishing grounds from October to March. This period is the spawning time, when it migrates to regions hitherto unknown. The eggs float in the upper layers of the sea and are therefore found in the plankton. We have now been able to determine the spawning areas by means of systematic plankton studies throughout the Adriatic[1]. In the course of this work, it was found that the sardine (*Sardina pilchardus*) spawns at a certain time of day, namely, in the evening. This is an extension of the finding of Ahlstrom[2] for the Californian sardine (*Sardinops caerulea*). Since the phenomenon seems to be unknown in other marine fishes, we think it worth while to describe our method and results.

Plankton samples were taken hourly for a period of 48 hr. at one spawning place on two occasions.

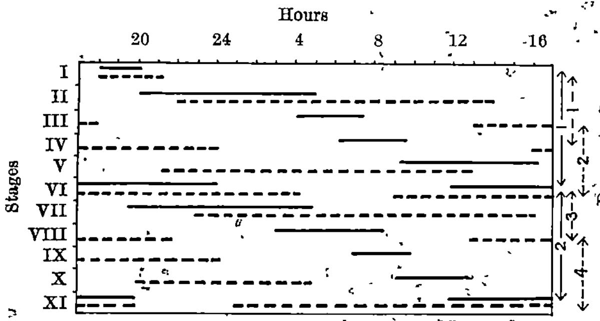

Fig. 1. Duration of embryonic development in the sardine: ———, in December at 18° C.; - - - -, in March at 13° C.

The first occasion was in December and the second in March. These dates were selected because at the place chosen the water temperature is then uniform from surface to bottom: in December it was 18° and in March 13° C. Thus the temperature conditions were as constant as in a laboratory experiment. We made use of the eleven embryonic stages of Ahlstrom, since the development of the two species is similar. Our results are shown diagrammatically in Fig. 1. Hatching takes place after stage XI. It will be seen from Fig. 1 that at 18° C. the duration of embryonic development is nearly two days, and at 13° C. about three and a half days. It is also clear that spawning takes place in the evening.

We have some evidence, deduced from studies of planktonic ova, of the occurrence of spawning at a definite time of day in yet other species of fish, especially pelagic ones, but the data are as yet incomplete. A full account of the work on the sardine will be published in *Acta Adriatica*, volume 7.

T. GAMULIN
J. HURE

Oceanographic Station,
Dubrovnik, Yugoslavia.
Sept. 30.

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[1] Gamulin, T., *Rep. Inst. Oceanog., Split*, No. 4 C (1954).

[2] Ahlstrom, E. H., Spec. Sci. Rep. No. 23, Fish and Wildlife Service, U.S.A. (1943).

Swimming of Fishes

THE 'load carried' by a nursehound *Scyllium catulus* is approximately 5 per cent in this fish, and fishes closely related to it; only 95 per cent of the weight of the fish (in air) is supported by the water. In most teleosts (with swim-bladders), such as the conger, the load carried is about 0·01, or practically the whole of the weight is supported by the water[1].

A large nursehound lends itself to the simple experiment of hanging additional weights on to it and ascertaining how much additional weight it can carry. This was done recently in one of the large outside tanks at the Marine Biological Association at Plymouth, when it was found that a large nursehound could carry an additional weight amounting to practically 25 per cent of its weight in air, while a teleost was practically incapable of carrying anything.

Thus a nursehound has an enormous reserve of carrying power, while most teleosts (with swim-bladders) have practically none.

A. G. LOWNDES

Probus School,
Probus, Truro.
Sept. 13.

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[1] Lowndes, A. G., *Ann. and Mag. Nat. Hist.*, **8**, 241 (1955).

Nomenclature in Microscopy

SOME confusing terms are used nowadays in microscopy. One repeatedly sees and hears the expression 'light-microscopy' used with the intention of excluding phase-contrast and dark-ground, as though these methods did not involve the use of light. One also notices the expression 'phase-contrast illumination', which is used despite the fact that the essential part of the method occurs at or near the upper focal plane of the objective.

We need a universally recognized word for what is sometimes called 'ordinary' microscopy. The word 'ordinary' is not very suitable, because other methods are coming into wide favour. It might be convenient to speak of 'direct' microscopy in all cases in which (1) there is only one illuminating cone, arranged symmetrically about the optical axis, and (2) the direct and diffracted light are not treated differently. Direct microscopy would be in contrast with 'oblique', 'dark-ground' and 'interference' microscopy.

In 'oblique' microscopy the direct rays are sent through the optical system in such a way that their course is not symmetrical about the optical axis.

In 'dark ground' microscopy the direct rays are either so directed as to miss the lenses of the objective by passing externally to them (external dark-ground), or else they are stopped within or just above the objective (internal dark-ground). What is here called internal dark-ground is commonly called 'central dark-ground'; but the term is not fortunate, for an annular stop is preferable to a central one. ('Dark-ground' seems preferable to 'dark-field', because it is only the background, not the whole field of view, that is dark.)

'Interference' microscopy is also of two main kinds. In one, which may be called 'double-beam interference', two coherent sets of rays are used for illumination. In the other, a single (hollow) illuminating cone is used, and the second set of rays, with which the direct rays will be caused to interfere, originates at the object. This is 'single-beam interference', but the name 'phase-contrast' is (unfortunately) firmly established.

It would be a convenience to limit the expression 'light-microscopy' to cases in which visible light is the illuminant. If one did not state or suggest the contrary, it could be assumed that the illuminant was light. Thus, the unqualified expression 'dark-ground microscopy' would mean dark-ground microscopy with visible light. The various terms suggested in the preceding paragraphs would be (potentially) as applicable to infra-red, ultra-violet and electron-microscopy as to light-microscopy.

It would be consistent to restrict the term 'photomicrograph' to micrographs made with visible light, and thus to speak always of infra-red, ultra-violet and electron 'micrographs'. The expression 'electron photomicrograph', which one sometimes sees in scientific papers, is objectionable.

I thank Mr. W. Galbraith for criticism of the first draft of this communication.

JOHN R. BAKER

Department of Zoology and
Comparative Anatomy,
University Museum,
Oxford.
Sept. 28.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 30

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "Hypothermia".

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. A. Nizet (Liège): "Hæmopoiesis and General Protein Metabolism".*

Royal Institution, Library Circle (at 21 Albemarle Street, London, W.1); at 5.30 p.m.—Mr. Geoffrey Parr: "What Constitutes a Technical Best-Seller?"

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8 30 p.m —Prof. Sir Mortimer Wheeler: "East Africa's Ancient Past" (Mrs. Will Gordon Lecture for 1956).

Tuesday, January 31

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. McKie: "Science in Eighteenth-Century Paris".*

Fauna Preservation Society (in the Mappin Terrace Pavilion, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—General Meeting. Mr. J. A. Hislop: "Some Animals of Malaya".

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5 15 p.m.—Sir Gilbert Rennie: "Recent Developments in the Federation of Rhodesia and Nyasaland".

Society of Chemical Industry, London Section (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—M. Jean Gerard "La Co-opération Technique Européenne" (Jubilee Memorial Lecture).

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p.m.—Mr. A. M. Godridge, Dr. R. Jackson and Mr. G. G. Thurlow: "Industrial Measurement of Gas Temperature".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7.30 p.m —Mr. Edwards: "Laminar Flow Aircraft Design".

Wednesday, February 1

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C.2), at 5 p m.—Mr. L. L. Hall and Mr. S. G. Young: "Civil Engineering Aspects of Radio Stations' Work".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. L. Gillams: "The Harnessing of Nuclear Power for Industry".*

Royal Institute of Chemistry, London Section (joint meeting with the South-West Essex Technical College Chemical Society, at the South-West Essex Technical College, Forest Road, London, E.17), at 7 p.m.—Mr J. S. Hughes and Mr. R. L. Bass. "Silicones—their Manufacture, Application and Analysis".

Thursday, February 2

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p m.—Dr. Mary Whitear· "On Being a Fish".*

Chemical Society (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m. and 7.30 p m.—Symposium on "Recent Advances in the Chemistry of Colouring Matters".

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Mr. K. H. L. Erhard and Prof. R. G. W. Norrish, F.R.S.: "Studies of Knock and Antiknock by Kinetic Spectroscopy"; Mr. F. J. L. Lipscombe, Prof. R. G. W. Norrish, F.R.S, and Mr. B. A. Thrush: "The Study of Energy Transfer by Kinetic Spectroscopy. I. The Production of Vibrationally Excited Oxygen".

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p m.—Mr. E. L. E. Wheatcroft and Mr. H. H C. Barton: "The Potentialities of Railway Electrification at the Standard Frequency".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. E. Gordon: "New Ideas in Plastics for Aircraft Structures".

Friday, February 3

British Psychological Society, Industrial Section (in Room 408, Birkbeck College, Malet Street, London, W C.1), at 7.30 p.m.—Informal discussion on Mr. Alec Rodger's British Association paper—"The Effective Use of Manpower". Opening Speaker· Mrs. H. S. Anthony.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m —Prof. H. Munro Fox, F.R.S.: "The Moon and Life".

Saturday, February 4

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Gwynne Vevers: "Life in the Sea".*

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. T. D. Bourdillon: "Portable Breathing Apparatus".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with a good honours degree and teaching experience, and preferably with industrial or research experience) in Physical or Organic Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (February 4).

Lecturer (with an honours degree in metallurgy of a British university or equivalent, together with some teaching experience, and experience of metallurgical research or industry) to specialize in the teaching of general and industrial metallurgy—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (February 4).

Superintending Scientist (with a university degree of high standing in physical science engineering or mathematics, and extensive experience in research and development work and in the direction of such work) at the Weapons Research Establishment, Department of Supply, Salisbury, South Australia, to supervise groups engaged in research and development in the fields of electronics, optics and electro-mechanical devices—Senior Representative (AP43) Department of Supply, Australia House, Strand, London, W.C.2 (February 6).

Assistant (preferably with an honours degree in science or agriculture) in the Chemistry Department at Auchincruive, for work mainly relating to the analysis of soil and other agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (February 8)

Lecturer in Genetics—The Secretary of University Court, The University, Glasgow (February 11)

Physicist (with a first- or second-class honours degree or equivalent in physics), at the Ministry of Supply Chemical Defence Experimental Establishment, near Salisbury, Wilts, for research on problems involving optics, heat transfer or radiation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting A.4/6A/AA (February 11).

Senior Scientific Officer (with a first- or second-class honours degree in biochemistry or in a biological subject with subsidiary chemistry, or with evidence of outstanding ability) at the Ministry of Agriculture, Fisheries and Food in London—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4549/56 (February 16).

Lecturer in Education—The Registrar, The University, Reading (February 18).

Lecturers (2) in Statistics—The Secretary, The University, Aberdeen (February 18)

Professor of Psychology—The Registrar, University Registry, Oxford (February 23)

Associate Professor in Soil Science at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 25)

Lecturer (with an honours degree in physical chemistry or equivalent qualification) in Physical Chemistry, at the School of Mines and Industries, Adelaide—The Agent General and Trade Commissioner, South Australia House, Marble Arch, London, W 1 (February 27)

Assistant Lecturer or Lecturer in Pure Mathematics—The Secretary and Registrar, The University, Southampton (February 28).

Associate Professor of Soil Science in the Faculty of Agriculture, University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (Australia February 28).

Lecturer (preferably with experience in the field of plant physiology with special reference to agriculture, and some training in agriculture as well as botany) in Plant Physiology at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (Australia, February 29).

Lecturer (with at least an honours degree in mathematics, and specialized in either pure or applied mathematics) in Mathematics at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia February 29).

Research Fellow in the Department of Zoology and Comparative Physiology—The Registrar, The University, Birmingham (February 29).

Senior Lecturer in Clinical Biochemistry at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

Imperial Chemical Industries Research Fellows in Physics, Chemistry, Engineering, Metallurgy and Pharmacology, or any related subject; three Leverhulme Postgraduate Fellows (two in the Faculty of Science and one in the Faculty of Engineering); and Research Fellows in Nuclear Physics—The Registrar, The University, Liverpool (March 1)

Research Fellow in Botany or in Zoology—The Registrar, The University, Nottingham (March 1).

John Rankin Chair of Geography—The Registrar, The University, Liverpool (March 3).

Assistant Lecturers (2) (one in pure and the other in applied mathematics) in Mathematics—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 30).

Imperial Chemical Industries Research Fellows in Bacteriology, Biochemistry, Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology or Textile Industries Chemistry of High Polymers (keratin and man-made fibres), Textile Technology and Wool Textile Engineering—The Registrar, The University, Leeds 2 (April 14).

Imperial Chemical Industries Fellows in Physics, Chemistry, Colloid Science, Biochemistry, Engineering, Metallurgy, PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary General of the Faculties, The Old Schools, Cambridge (April 30).

ASSISTANT (Grade B) IN PHARMACEUTICS, and an ASSISTANT (Grade B) IN THE DEPARTMENT OF MATHEMATICS at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

CHEMIST/ASSAYER IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Gold Coast Local Civil Service, to take charge of the Geological Survey Chemical Laboratory; to assay ore; to carry out silicate analyses of rocks and minerals; to participate in research in the inter-relation of Gold Coast rocks and in geochemistry—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/13/06.

CHEMIST (with a first- or second-class honours degree or equivalent, and at least three years general industrial experience) at the Central Laboratory, Chiswick—Recruitment and Training Officer (F/EV 550), London Transport, 55 Broadway, London, S W.1.

GENETICIST, Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree in botany or other natural science and some years experience in plant breeding and genetics, and preferably experience with tropical perennial crops or maize breeding), at the West African Institute of Oil Palm Research, Nigeria, to carry out research under a senior geneticist in charge of his division, directed towards improving the oil palm by selection and breeding—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD 197/199/012.

LECTURER IN PHYSICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN REFRIGERATION at the National College for Heating, Ventilating, Refrigeration and Fan Engineering—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

PHYSICAL CHEMIST OR PHYSICIST (with a first- or second-class honours degree or equivalent qualification in physical chemistry or physics), at a Ministry of Supply Armament Research and Development Establishment near Sevenoaks, Kent, for research on initiation of explosive systems and in application to Service stores—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.963/5A/AA.

SCIENTIFIC ASSISTANT (with a good science degree, a reading knowledge of two European languages (of which one should preferably be other than French or German) and ability to write good English), for work in scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SENIOR RUBBER TECHNOLOGIST (with a good degree, substantial experience in the rubber industry, evidence of research ability, and eagerness to co-operate with colleagues engaged on basic chemical and physical research), for research and applicational studies in the dry rubber field—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

SENIOR TECHNICIAN IN ZOOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Gas Council. Research Communication GC 22: A Comparison of Fuels for Cooking. By E. W. B. Dunning. Pp. 55. Research Communication GC 23: An Investigation of Explosion Reliefs for Industrial Drying Ovens. 1: Top Reliefs in Box Ovens. By P. A. Cubbage and Dr. W. A. Simmonds. Pp. 46. Research Communication GC 24: An Investigation into the Composition of Ammoniacal Liquor 1 (continued): Continuous Vertical Retort Liquor. By Dr. W. H. Blackburn, Dr. L. Barker, J. R. Catchpole and N. W. Hollingworth. Pp. 101. Research Communication GC 25: The Treatment of Gas Works Liquor in Admixture with Sewage in Percolating Filters (continued). By Dr. W. H. Blackburn and T. G. Tomlinson. Pp. 21. Research Communication GC 26: The Bacterial Oxidation of Gas Liquor. By E. H. M. Badger. Pp. 39. Research Communication GC 27: 46th Report of the Joint Refractories Committee, 1954–55. Pp. 80. Research Communication GC 28: An Examination of the Measurement of Radiant Energy. By P. W. R. Morpurgo. Pp. 39. Research Communication GC 29: The Internal Structure of Flame Reaction Zones. By Dr. G. Dixon-Lewis. Pp. 30. (London: The Gas Council, 1955.) [2111

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain (England and Wales). Geology of the Country between Burton upon Trent, Rugeley and Uttoxeter. By I. P. Stevenson and Dr. G. H. Mitchell, with contributions by Dr. C. J. Stubblefield, M. A. Calver, Dr. K. C. Dunham and Dr. W. Bullerwell. (One-Inch Geological Sheet 140 (New Series).) Pp. vii+178+9 plates. (London: H.M. Stationery Office, 1955.) 21*s*. net. [2111

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1954–55 (Volume 96). Pp. 153+xxxviii. (Manchester: Manchester Literary and Philosophical Society, 1955.) 31*s*. 6*d*. [2111

Association of Universities of the British Commonwealth. United Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants, etc.). List of Awards tenable at Universities in the United Kingdom; Short List of Awards tenable Overseas. Pp. 123. (London: Association of Universities of the British Commonwealth, 1955.) [2111

Planning. Vol. 21, No. 389 (21 November 1955): The European Coal and Steel Community. Pp. 225–244. (London: Political and Economic Planning, 1955.) 2*s*. 6*d*. [2111

Anti-Locust Research Centre. Anti-Locust Bulletin No. 21: Habitats of the Desert Locust (*Schistocerca gregaria* Forskål) in Western Libya and Tibesti. By K. M. Guichard. Pp. iii+33+10 plates. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1955.) [2111

Ministry of Education. Report of the Committee on Maladjusted Children. Pp. vi+180. (London: H.M. Stationery Office, 1955.) 6*s*. net. [2111

British Industries Fair Bulletin. Vol. 1, No. 1 (November, 1955). Pp. 24. (London: British Industries Fair, Ltd., 1955.) [2111

Admiralty Bulletin No. 72: Underwater Hydrodynamic Research—New Laboratories at A.R.L. Teddington. Pp. 1+12. (London: Admiralty and Ministry of Works, 1955.) [2111

Ministry of Pensions and National Insurance. Digest of Statistics Analysing Certificates of Incapacity, 1953/54. Pp. 25+60 tables. (London: Ministry of Pensions and National Insurance, 1955.) [2111

Sondes Place Research Institute. Pp. 16. (Dorking: Sondes Place Research Laboratories, Ltd., 1955.) [2311

Bedfordshire Naturalist, No. 9. (Being the Journal of the Bedfordshire Natural History Society and Field Club for the year 1954.) Pp. 50+4 plates. (Bedford: Bedfordshire Natural History Society and Field Club, 1955.) 5*s*. [2411

Other Countries

Republic of Egypt. Ministry of Commerce and Industry: Mines and Quarries Department. Geological Survey of Egypt. Rocks of Aswan Area. By Dr. E. M. El-Shazly. Pp. v+22+7 plates. P.T. 100. Geology of Gebel "El-Ineigi" District. By G. A. Moustafa, M. L. A. Kabesh and A. M. Abdalla. Pp. x+40+18 plates. P.T. 110. (Cairo: Ministry of Commerce and Industry, 1954 and 1955.) [2111

Symposium on Artificial Rain held in February 1953, under the joint auspices of the Atmospheric Research Committee, C.S.I.R., and the India Meteorological Department. Pp. vii+148. (New Delhi: Council of Scientific and Industrial Research, 1955.) [2111

New Zealand. Department of Scientific and Industrial Research (Geophysics Division). Seismological Observatory. Bulletin No. E-131: January, February, March 1953—Wellington, other New Zealand Stations, and Fiji. Pp. ii+13. (Wellington: Government Printer, 1955.) [2111

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 114, No. 1: The Size of Parietal Foramen and Organ in Reptiles—a Rectification. By Tilly Edinger. Pp. 34. Breviora. No. 48 (October 10, 1955): Notes on American Earthworms of the Family Lumbricidae, 1–2. By G. E. Gates. Pp. 12. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [2111

Variation and Genetic Relationships in the Whitlavia and Gymnobythus Phacelias. By George Willson Gillett. (University of California Publications on Botany, Vol. 28, No. 2. Pp. 19–78+plates 3–5.) (Berkeley and Los Angeles: University of California Press, 1955.) 1 dollar. [2111

Indian Forest Records (New Series). Botany. Vol. 4, No. 5: Grasses of the Upper Gengetic Plain and some Aspects of Their Ecology. By M. B. Raizada. Pp. iv+83+104. (Delhi: Manager of Publications, 1955.) Rs. 1/8/–; 2*s*. 3*d*. [2111

Bulletin of the Illinois Natural History Survey. Vol. 26, Article 5 (August, 1955): Hill Prairies of Illinois. By Robert A. Evers. Pp. iv+367–446. Vol. 26, Article 6 (September, 1955): Fusarium Disease of Gladiolus—Its Causal Agent. By J. L. Forsbery. Pp. iv+447–504. (Urbana, Ill.: Department of Registration and Education, State of Illinois, 1955.) [2111

University of Illinois Engineering Experiment Station Bulletin. No. 431: The Removal of Entamoeba Histolytica Cysts from Water by Porous Filter Septums either with or without Filter Aid. By E. Robert Baumann and Harold E. Babbitt. Pp. 40. 60 cents. No. 432: Performance of Three Types of Indirect Water Heaters. By Warren S. Harris and Lyman L. Hill. Pp. 46. 75 cents. (Urbana, Ill.: University of Illinois, 1955.) [2111

Transactions of the American Philosophical Society (New Series). Vol. 45, Part 4: a Documentary History of the Problem of Fall from Kepler to Newton: De Motu Gravium Naturaliter Cadentium in Hypothesi Terrae Motae. By Prof. Alexandre Koyré. Pp. ii+329–396. 1.50 dollars. (Philadelphia: American Philosophical Society, 1955.) [2111

New York University: College of Engineering. Meteorological Papers. Vol. 2, No. 4 (August, 1955): On the Dynamics of Wind-driven Ocean Currents. By Gerhard Neumann. (University Series.) Pp. 33. (New York: New York University Press, 1955.) [2111

Royal Geographical Society of Australasia: South Australia Branch. Lake Eyre, South Australia—The Great Flooding of 1949–50. (The Report of the Lake Eyre Committee.) Pp. xi+75+9 plates. (Adelaide: Royal Geographical Society of Australasia (South Australian Branch), 1955.) [2111

Catalogues

Shell Films, 1955. Pp. xviii+156. (London: The Shell Petroleum Co., Ltd., 1955.)

Cambridge Instrument Co., Ltd. Cambridge Humidity Instruments. (Folder No. 70B.) Pp. 6. (London: Cambridge Instrument Co., Ltd., 1955.)

Lancashire Dynamo Switchgear, Ltd. "Heavy Industrial" Distribution Switchgear. Pp. 24. (List LS 30.) (Bridgwater: Lancashire Dynamo Switchgear, Ltd., 1955.)

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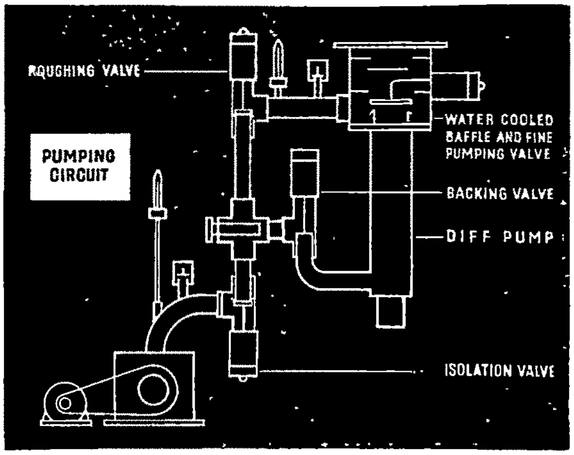

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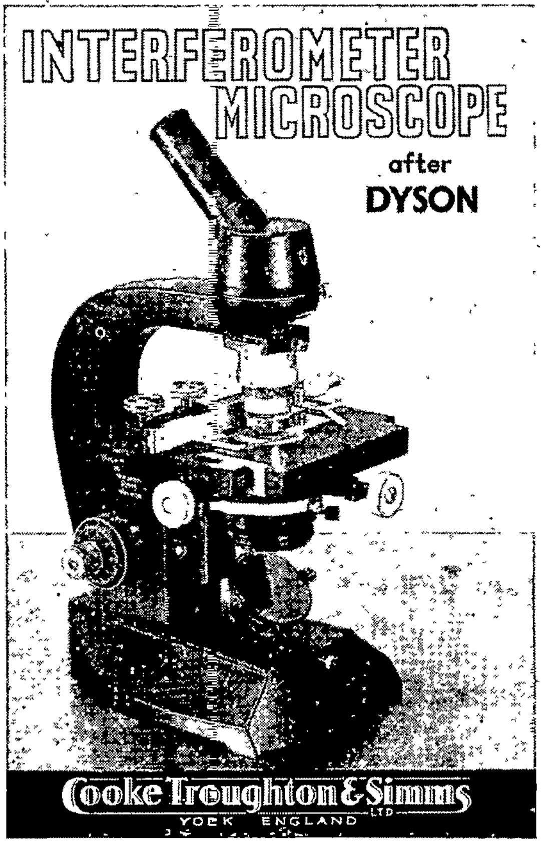

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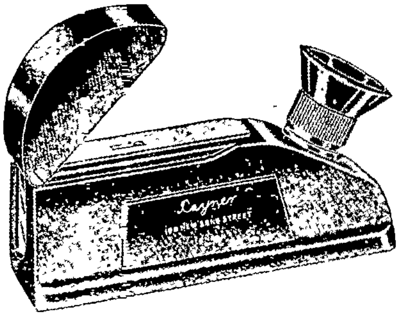

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GRESHAM LECTURES

Dr. W. H Steavenson, F R A.S. (Gresham Professor in Astronomy) will deliver a course of Four Lectures entitled "Means and Ends in Astronomy" on Mon to Thurs., Jan. 30 to Feb 2, at Gresham College, Basinghall Street, E C.2 Tel. MONarch 2433

The Lectures are free and begin at 5 30 p m

UNIVERSITY OF LONDON

A lecture on "Some Recent Aspects of Diene Synthesis" will be given by Professor K Alder (Cologne) at 5 30 p m, on February 6 at University College (Chemistry Theatre), Gower Street, W C.1.

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar.

OFFICIAL APPOINTMENTS

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W. IVES,
Chief Scientific Liaison Officer.

Australian Scientific Liaison Office,
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G L BARNES,
Secretary

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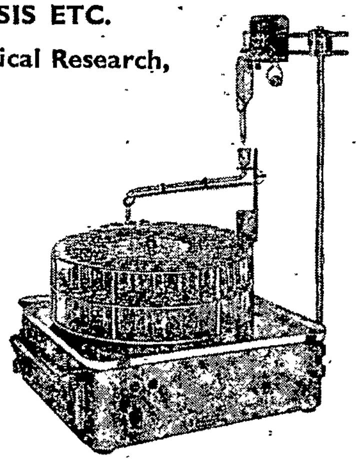

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TECHNICAL ASSISTANCE PROGRAMMES AND THEIR SUPPORT

THE fourth annual report of the Consultative Committee for Co-operative Economic Development in South and South-East Asia was published* in Britain about a month after the meeting of the Committee in Singapore. A major issue at that meeting was the decision whether, after the conclusion in 1957 of the first six-year period, the Colombo Plan should continue for a further six years or on an annual basis. On that question the report gives plenty of evidence as to the value of some period greater than one year to enable effective technical and economic plans to be made, without exactly conveying the concern of the delegates over the difficulties resulting from an annual increment of population of 1·6 per cent and the failure of food production to keep pace with this increase in an area already containing one-quarter of the population of the world. The report also provides further background to the report on technical co-operation in the area, issued in August by the Council for Technical Co-operation in South and South-East Asia (see *Nature*, 175, 267; 1955).

On technical assistance the report itself adds but little to the latter report. Progress in this field has matched the progress in economic development in the area, and during 1954–55 more trainees were sent abroad under such schemes and more experts and special equipment supplied to the area than in any previous year, while the amount of technical assistance provided within the area is also increasing. Since the various schemes of technical assistance started, 7,189 training awards have been made and 3,715 experts have been supplied to countries of the area; of these the United Kingdom has made 853 awards and supplied 157 experts. The United States has made 3,025 training awards and supplied 949 experts, and besides utilizing the services of consultant firms in management and engineering, these United States programmes make much use of inter-university contracts, usually for a three-year period, involving interchange of staff between educational institutions in the United States and in the host countries, and also providing training institutions in the United States universities for candidates nominated by these institutions. At the end of August 1955, twenty-three such contracts were in operation in eight member countries, and like other programmes, those of the United States seek to foster activities which can be continued by the recipient country itself. It should be noted also that the United States is now attempting to relieve the chronic shortage of technicians for the Technical Assistance Programme by direct recruitment from the universities.

A feature of the technical assistance programmes of the past two years is the increasing emphasis on the development of training facilities within the Asian countries themselves, and particularly for the middle and lower technical grades. While, moreover, the co-operating governments now have a better idea of what forms of assistance and what type of experts or training facilities the respective agencies can best provide, it is a major and continuing task to ensure co-operation between governments and agencies responsible for technical assistance schemes. Nevertheless, progress is clearly being made, and a sound basis has already been provided on which technical assistance may become of even more significance in the economic development and welfare of the countries of the area in future.

One such direction is nuclear power. It was announced at the Singapore meeting that the United States had offered to establish in south or south-east Asia a centre for nuclear research and training, which will include a research reactor and a small power reactor, and that Canada and India are now working out details of an agreed plan for a research reactor in India. Both establishments will be available also for the use of scientists from other centres. The Canadian delegate announced that Canada would provide Burma with a cobalt beam therapy unit, and that she wished to receive as many Asian scientists as her facilities allowed for research and training in nuclear physics. Afterwards, the United Kingdom and India, as a result of discussions between the Atomic Energy Authority and the Indian Department of Atomic Energy, announced an agreement providing for close co-operation and mutual assistance in developing the peaceful uses of nuclear energy. Members of the staff of the two bodies are to consult and work together on mutually agreed topics, and under the agreement Britain will provide India with enriched uranium fuel for the reactor, offered to India by Canada under the Colombo Plan and now under construction at Bombay.

It is desirable that the magnitude of the assistance which Britain is able to offer in this field should be fully appreciated both in Britain itself and overseas. The reactor under construction at Bombay is intended primarily for research purposes; and in this field Britain is particularly well placed to offer assistance, though in the present man-power situation it is a matter of nice judgment how far that assistance can be given by supplying experts to India or other Colombo Plan countries, as against offering training facilities at Harwell and elsewhere, or exporting nuclear plant. Such developments are as important for Britain's own industrial future as they are for the development of those areas of the world where nuclear energy may well play an essential part if natural resources are to be opened up in step with expanding population.

Nuclear energy is one of the more spectacular aspects of the developments which technical assistance makes possible; but it should be seen in proper perspective, not only in relation to our available resources of materials and man-power, but also to technical assistance generally and Colombo Plan developments as a whole. Perhaps even more than the reports coming from the Consultative Committee for the Colombo Plan, that of the Technical Assistance Board of the United Nations brings out the extent to which technical assistance consists mainly in the multiplication of little schemes rather than in fostering large international projects. From one point of view, the United Nations organization and the Council for Technical Co-operation under the Colombo Plan can be regarded as essentially recruiting organizations for drawing on the experts of the specialized agencies or supporting countries and selecting students from the backward countries to be sent to Western universities and colleges.

---

* Colombo Plan Technical Co-operation Scheme. Report 1954–55. Pp. 30. (London: H.M. Stationery Office, 1955.) 1s. 3d. net.

In 1954, for example, the Technical Assistance Board had 1,584 of its specialists at work in seventy-one countries and made awards to 1,524 Fellows from eighty-six countries. On all this work less than £7 million was spent in 1954, to which Britain contributed £650,000. This share is to be increased to £800,000 in 1956, and at the Singapore meeting Lord Reading emphasized the value which the British Government attached to the technical assistance part of the Plan and indicated that the purpose of the new grant is to increase the British aid to non-Commonwealth countries which have not been members of the Colombo Plan from the beginning and which would not benefit from Colonial Development and Welfare Funds. Moreover, it seems but common sense, where the exchange of experts and provision of training places is so important, to make some reasonable provision for continuity from year to year, so that planning ahead and continuous training are possible. That, and the elimination of as many obstacles as possible to the movement of experts, seem to be the great needs. It is therefore satisfactory to find a disposition on the part of the British Government to lend its support to the idea of continuity, and also to note in the United States some decrease in the difficulty which foreign scholars have experienced in the past in securing entrance visas. Whether or not it is due to the determined efforts of the Federation of American Scientists, which presented a report on the subject last May, no real difficulties were experienced by the participants at the international meeting on arid lands, research and utilization arranged by the American Association for the Advancement of Science last April. Participants were selected entirely for their scientific competence, and, according to *Science*, the State Department co-operated efficiently.

It is at such points as these that the vigilance and help of professional associations can make a valuable contribution to the effectiveness of technical co-operation. Thus it may be recalled that the Federation of British Industries, in a report issued in 1954, emphasized the importance of continuity of budgeting and of giving the fullest possible support that the man-power situation in Britain would permit. Technical assistance is indeed one element for which any expansion in technical and technological education in Britain should provide. Similarly, the improvement of means of communication in scientific and technical matters, whether in the means by which such information is disseminated or in the extent of co-operation between appropriate government departments, is another way in which the provision of technical assistance could be made more effective and the attraction of the indispensable foreign capital made easier. The fourth annual report of the Consultative Committee referred to earlier notes; for example, the establishment of the Ceylon Institute of Scientific and Industrial Research to improve technical processes in industry, to advise on matters affecting the utilization of Ceylon's internal resources, to foster training and the dissemination of technical information, and to co-operate with government departments and the university and other technical organizations in promoting scientific and industrial research.

Where, as in India and Ceylon, such bodies exist and are well staffed and efficiently administered, technical assistance is greatly facilitated. There are, however, wide differences in the technical and administrative standards of the different under-developed countries, as well as in their economic situations. The report emphasizes that, while all the countries in South and South-East Asia depend largely and at crucial points on imports for their development projects, there are wide differences from country to country in such factors as the diversity and stability of exports, the dependence on imports for current consumption, capital inflow or outflow, and the size of reserves in relation to turnover. Again, the countries of the area differ widely in the degree to which they have been able to organize their development. Considerable progress has been made, but all of them face formidable difficulties in collecting the complex technical, economic and financial details on which plans must be based, and creating or expanding the necessary administrative and executive organization.

Largely these are problems of personnel, in which the Technical Co-operation Scheme and other arrangements for technical assistance are invaluable; but in spite of the progress that has been made, this review indicates that the tasks that still remain may well prove even harder, and call for a proportionately greater effort if pace is to be kept with a population increase in the area as a whole estimated at about 10 million persons a year. The review does not encourage facile optimism; it sets the difficulties and problems in the forefront, challenging the sharing of experience in the search for solutions. None the less, it demonstrates that the idea of co-operative effort, both within each country and between countries, is spreading ever more widely and deeply. The British contribution to the Colombo Plan is only a part of a contribution to the development of the more backward areas of which Britain has a right to be proud.

An article on some problems in under-developed areas which Mr. E. W. Golding contributed to the June 1955 issue of *Impact* shows very clearly how closely related are the factors contributing to the effectiveness of technical assistance to those on which scientific and technical advance in general depend. Besides the educational, administrative and like problems which hinder development in the backward areas, there is the exchange of information;

Mr. Golding stresses the vital importance in this connexion of fellowships and studentships which permit free movement of scholars, students, scientists and all kinds of experts from universities and colleges, research institutions and government research stations or laboratories in one country to those in another. It is not simply that the exchange of technique and information is thereby facilitated: international understanding and good-fellowship are likewise promoted; and this can further the better hospitality now afforded the essential foreign capital by most of the Asian countries which are members of the Colombo Plan. The possibilities of agreement on development schemes for international sponsorship are also increased, as Mr. Golding points out, by international meetings such as the symposia organized by the Unesco Advisory Committee on Arid Zone Research in a different area each year. Forums such as these can also assist arrangements for regular exchanges of information on the progress of the schemes and for demonstration visits. What needs to be realized is that scientific, technical and economic data are the indispensable basis for any sound development plan, and that informal as well as official contacts can greatly assist the acquisition of the information needed by the Colombo Plan countries and the backward areas—and even many advanced countries. By pressing resolutely but imaginatively for the removal, as far as possible, of all barriers to the exchange of information, the dissemination of knowledge and the movement of the scholar and scientist and student, the scientist could do something tangible to promote the great purposes for which the Colombo Plan and similar schemes were conceived.

GENETICS AND BRITISH MOTHS

Moths

By Dr. E. B. Ford. (New Naturalist Series: a Survey of British Natural History.) Pp. xix+266+56 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 35*s*. net.

GENERALIZING, this is an excellent book. Its approach is the same as in Dr. E. B. Ford's well-known "Butterflies" in the New Naturalist series, and it is really a sequential volume, there being constant page-references back to "Butterflies". The book is primarily concerned with biological phenomena occurring in the British moth fauna that can be studied and are likely to contribute to the general stream of biological knowledge; it is not a collector's identification book. This is intentional; for, as Dr. Ford states on p. 19, the "entomologist or ornithologist thinks in terms of insects or birds. That was the right way to think when biology was being developed in the past: it is becoming wrong today". This is a curious statement coming from Dr. Ford. So many of the problems that are his concern in the text could only have come to light by means of old-fashioned field-work and the amassing of cabinet collections. Furthermore, the text seethes with evidence that Dr. Ford is himself an extremely active field collector. To bring further problems to light, more collecting will have to be done; surely the ordinary systematic collector might get the status of co-operator and not merely handmaiden. One fears that the latter status is indicated by Dr. Ford's words (p. 19) when he states that he directs "attention to these aspects of the subject which have been neglected in the Lepidoptera, in the hope that entomologists and collectors may be able to supply the data on them which are so badly needed".

A brief chapter on structure and physiology is followed by four chapters on genetics, genetical phenomena and theory, and especially those phenomena seen in wild populations of British moths when these are taken into the laboratory for study or worked on in the field. This is a topic that Dr. Ford has made his own, and these chapters on moth genetics are authoritative. Then follow chapters on polymorphism, on dispersal, and on protective devices. The wealth of illustrative material that Dr. Ford has found in the British moth fauna almost surprises one.

Chapter 8 is a brief intrusion on injurious moths, after which the reader is taken back, through geographical distribution (Chapter 9) and types of habitat (Chapter 10), to relict faunas (Chapter 11), geographical races (Chapter 12) and a most useful chapter on melanism, industrial and otherwise. This last chapter suggests that entomologists should make a serious effort to conduct long-term studies of the moth faunas in the neighbourhood of some of the new industrial centres springing up in Great Britain. Entomologists overseas in the Dominions and elsewhere might do likewise.

The final chapter, on evolution, is again remarkable for the way in which Dr. Ford is able, in discussing this topic, to illustrate it with numerous examples from the British moth fauna. There is an appendix on the classification of moths dealt with in the book. This classification follows, in the main, that of Kloet and Hincks[1], and it is possibly unfortunate that, though more modern, it differs from those of Meyrick[2] and South[3], which are the identification books that readers are most likely to use. There are a glossary of six pages, two pages of references, some distribution maps, and an index that seems to be adequate.

Such criticism as one might level at the book seems, on second thoughts, to be criticism of the editors and, possibly, of an undisclosed lepidopterist whom they may have employed as a sub-editor. On Pl. 20, Fig. 1 is a light-coloured specimen of the great brocade, *Eurois occulta*; Fig. 2 is a dark specimen of the same species. The legend states that the first comes from Rannoch and the second from Essex. In the text, on p. 80, it is correctly stated that the dark form is found in Scotland and the light in the south of Britain. On Pl. 17, Fig. 7, one feels almost certain that the specimen figured is not the silky wainscot, *Chilodes maritima*, as stated.

The colour of inks used in printing the coloured plates should be more carefully controlled by the editors. On Pl. 31 the purple hue on the moths would certainly prevent some of the species from being recognized from the figures. There is an unnaturalness in the green coloration in some places, and the coloration of some of the caterpillars seems a little untrue. An example is the elephant hawk caterpillar (Pl. 21, Fig. 4); but possibly this is in fact a specimen of the greenish form sometimes encountered, though there is no statement in the text or legend that this is so. In the copy before the reviewer, four colour plates (Pls. 6, 7, 18, 19) are off-register: 6 and 18 slightly, 7 and 19 to an extent that makes the subjects very fuzzy. The goat moth caterpillar shown in Pl. 6, Fig. 1, looks moribund, but perhaps it is just getting ready to pupate. The black-and-white photographs are of uniform excellence and make one feel that there is a need to discriminate a little bit in the choice of subjects best suited to colour or to black-and-white photography and reproduction when information is to be conveyed by eye to the reader. Some of the colour figures of small caterpillars tell one very little indeed.

There is no point in combing the text for trivial errata; but one cannot help wondering how the author, or the editors, at least two of whom are well versed in general taxonomic theory, allowed the family Lasiocampidae (the eggars) to stray out of the super-family Lasiocampoidea into the next super-family Bombycoidea, though they might be forgiven for not realizing that the Endromididae (*sic pro* Endromidae) of the super-family Bombycoidea were out of place in the super-family Lasiocampoidea (p. 237).

JOHN SMART

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[1] Kloet. G. S., and Hincks, W. D., "A Check-list of British Insects" (Stockport, 1945).

[2] Meyrick, E., "A Revised Handbook of British Lepidoptera" (Watkins and Doncaster, London, 1927).

[3] South, R., "The Moths of the British Isles", 2 vols., revised by H. M. Edelston (Warne, London, 1939).

AN INTRODUCTION TO PRECAST CONCRETE

Precast Concrete

By Dr. Kurt Billig. Pp. xvi+341. (London: Macmillan and Co., Ltd., 1955.) 32*s*. net.

THE art of precasting concrete has given rise to an established industry producing staple things like blocks, tiles, floor beams and parts for small structures, where problems are in the nature of factory production-engineering, and a more nebulous practice involving the more sophisticated extension of the art to large structures, bridge girders, and so on, which demand the designer's closest attention if the choice of the medium is to be economically justifiable. The whole industry has been profoundly affected within the past decade by the technique of prestressing, which has developed into a competitor with structural steel.

To deal with the whole subject in a comprehensive manner would demand a writing of considerable dimensions. Dr. Kurt Billig has mentioned most aspects of precast concrete: those forming the basis of organized industry are treated summarily, and attention is given chiefly to the structural uses of reinforced and prestressed precast concrete. In attempting to cover so large a field in a book of about three hundred pages, it is not surprising to find that frequently the treatment is hurried. The aim appears to be the stimulation of interest in the potentialities of structural precast concrete, rather than to present a text-book for the factory engineer or designer. Some 40 per cent of the material has appeared elsewhere; almost the whole of Dr. Billig's earlier work, "Structural Precast Reinforced Concrete", published by the Cement and Concrete Association in 1947, has been reproduced with scarcely any alteration, except that the sections have been re-shuffled to suit the larger work. Dr. Billig has also drawn on his book, "Prestressed Concrete".

The book is divided into four parts: Part 1 deals with design and production; Part 2 with the precast units themselves; Part 3 with joints; and Part 4 with structures in which precast concrete has been used. One might expect difficulties in avoiding overlapping with this breakdown of the subject, but on the whole Dr. Billig handles his matter satisfactorily. There are some cases of repetition, however, and occasionally the meaning becomes elusive, as, for example, "The work done during prestressing levels the discrepancy between the absolute values of the compressive and tensile resistances of the concrete and between the ultimate strains in tension of the steel and the concrete". One or two points seem to receive disproportionate attention: a discussion on 'æsthetics' labours the old problem whether concrete, which looks like stone, can rightly be placed in a position of tension, and six systems are described which use concrete spread on hessian or jute fabric.

References are quoted at the ends of a number of chapters, but Dr. Billig has chosen not to annotate the text in any way to indicate what he may have drawn from these works. This is unfortunate since, for many readers, it defeats the object of such references.

Dr. Billig is at his best when writing about industrial structures, and one wishes that he had gone into greater detail and given more examples. Many of the examples invite the comparison of precast reinforced concrete with *in situ* concrete. In his chapter on "Efficiency", Dr. Billig has attempted to indicate that the assessment of prestressed concrete should be by comparison with structural steel. That there is a place for both normally reinforced and prestressed precast concrete in the scheme of things seems to have been demonstrated, but what is best done by one or the other does not emerge at all clearly.

T. WHITAKER

ZOOLOGICAL LITERATURE OF 1952

The Zoological Record

Vol. 89 (Being the Records of Zoological Literature relating chiefly to the year 1952). Edited by G. Burder Stratton. Pp. vi+1450. (London: Zoological Society of London, 1955.) 120*s*.

ZOOLOGISTS throughout the world owe a special debt of gratitude to the Zoological Society of London for continuing to produce each year the "Zoological Record". Its compilation is a very heavy task and the general editor, Mr. G. Burder Stratton, and the sectional editors and recorders, in preparing the lists of titles of all zoological publications appearing during the particular year under consideration, have to search through hundreds of scientific periodicals in all languages. In addition, the material is classified so as to be of use not only to taxonomists, but also to those engaged in any of the many specialist branches of the subject, such as structure (including histology and cytology), physiology, evolution and genetics, development, reproduction and sex, ecology and habits, geographical distribution, and palæontology and geological distribution. The amount of time saved by having this information thus summarized by specialists in the subjects can only be fully realized by those who have tried to search through the literature on any particular group of animals, or species, previous to 1864 when the "Zoological Record" was founded.

The present volume relates chiefly to the literature of the year 1952, but unfortunately does not include the sections dealing with Vermes and Trilobita, which did not arrive in time. It is hoped, however, that the literature for both 1952 and 1953 of these two groups will be included in Vol. 90.

The other sixteen sections give a rough indication of the work going on in different groups of the animal kingdom, and, as would be expected, Insecta heads the list with a total of 3,332 titles. The next largest section is Aves with 1,696 titles, and other large groups include Mammalia, 1,282; Protozoa, 1,194; Pisces, 1,115; Amphibia and Reptilia, 1,090; and Mollusca, 968. Finally, there is a section giving a list of 1,883 new generic and subgeneric names recorded during 1952, which is made up as follows: Protozoa, 94; Porifera, 12; Coelenterata, 86; Echinoderma, 26; Brachiopoda, 22; Bryozoa, 51; Mollusca, 140; Crustacea, 50; Arachnida, 139; Insecta, 1,107; Protochordata, 1; Pisces, 75; Amphibia, 7; Reptilia, 29; Aves, 2; Mammalia, 42.

It may be recalled that in 1954 the Zoological Society of London authorized a reprinting of Vols. 1–20 of the "Zoological Record", which had been out of print for many years. The success of this venture has been such that the reprinting of further volumes which have become out of print is now under consideration, and any such issues would be welcomed by all zoological libraries and departments with incomplete sets of this invaluable publication.

EDWARD HINDLE

COLORIMETRIC METHODS IN CHEMICAL ANALYSIS

Colorimetric Methods of Analysis, including Some Turbidimetric and Nephelometric Methods

By Dr. Foster Dee Snell and Dr. Cornelia T. Snell. Vol. 3, Organic—1; pp. viii+606; Vol. 4, Organic—2; pp. vii+676. Third edition. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953–54.) 93*s.* 6*d.* net each vol.

THE authors of this well-known treatise on colorimetry have set themselves an almost herculean task in producing a third edition. The organic and biological material covers such a wide field that it has necessitated two volumes instead of the single volume originally contemplated. Vol. 3 comprises nineteen chapters commencing with a very brief but important introductory one, which explains that "every possible method of condensation has been applied" in order to include such a large number of individual substances. The division of this wide variety into logical sequence and chapters has been difficult. Whereas all the hormones are dealt with in a single chapter, it has been found necessary to spread the vitamins between the two volumes in six chapters. This difficulty also applies to pigments, weed-killers, insecticides and plant growth-regulating substances. In order to make easy reference to a given compound, each substance in the subject index is listed as far as possible both under its systematic name and also its trade or recognized trivial name.

Several methods are sometimes described for one substance, depending on the need to determine milligram or microgram quantities. The authors have described, as far as possible, the substances known to interfere with a particular determination and have included methods for their removal. The nineteen chapters include hydrocarbons, alcohols, esters, phenols, the sugar and glucoside family, aldehydes and ketones, the acid family (except amino-acids), sulphur and halogen compounds. Where such a wide field has been covered it seems unjust to want more; but I, and no doubt others too, regret that a little space could not be found for some important subjects. In the chapter on alcohols and their esters, it is disappointing that more space has not been found for the determination of alcohol in blood and urine, as this subject has assumed much medico-legal significance in recent years.

Glycerol, in view of its commercial importance, seems worthy of fuller treatment. On the other hand, sixteen pages have been devoted to thiamine (vitamin B_1), since the vitamin may occur in so many materials, including pharmaceutical products, foods and biological specimens. There are no less than fifty-eight references to the literature for this one substance. Similarly, sulphonamides, which have assumed such prominence in medicine, have been allocated thirteen pages and seventy-three references. For the sake of completeness, methods which are scarcely colorimetric have been included; for example, in the section on fats and oils, the conjugated and non-conjugated constituents of fats and oils are determined by an isomerization method, and readings taken by spectrophotometer in the ultra-violet region. Included in the chapter on halogen compounds are some of the more important insecticides and their determination in foods, milk, biological tissue and spray residues. While the specialist in this subject will need more information than can be given in such a general treatment, the authors are to be congratulated in collecting such a wide range of references.

Vol. 4 deals almost entirely with naturally occurring substances in its sixteen chapters. These range from amines and amino-acids to sterols, hormones, alkaloids, enzymes, antibiotics and pigments. Methods for the determination of quaternary ammonium compounds and domestic and textile detergents in effluents and sewage would have been welcomed by water consultants, since the presence of these substances constitutes an increasing difficulty in water purification. The final chapter describes methods for the measurement of the colour of liquids. The authors have confined themselves almost entirely to methods adopted by the Association of Official Agricultural Chemists, the American Public Health Association, and the American Oil Chemists Society. This is logical for American readers, but others may require more general methods. As stated in Vol. 1, the authors considered the use of the C.I.E. system of colour measurement outside the scope of their treatise, but it is hoped that a wider use of the system will merit its inclusion in a future edition.

In the four volumes of the complete work a surprising variety of materials and methods has been dealt with, and very few which reach the consultant omitted. This greatly enlarged edition should find a place in all laboratories using colorimetric methods of estimation. Although the specialist in each subject is unlikely to find methods which are new to him, the four volumes contain the most complete collection of colorimetric determinations I have yet encountered. The volumes are well printed and illustrated and are reasonably free from misprints, and the index to each volume is full and carefully prepared.

J. KING

Primates

Comparative Anatomy and Taxonomy, 2: Haplorhini: Tarsioidea. A Monograph by W. C. Osman Hill. (Edinburgh University Publications—Science and Mathematics, No. 3.) Pp. xx + 347 + 14 plates. (Edinburgh: At the University Press, 1955. Agents: Thomas Nelson and Sons, Ltd.) 63*s.*

DR. W. C. OSMAN HILL has lost little time in bringing out the second part of his monumental review of the Primates, of which the first, on the Strepsirhini, was published in 1953 (see *Nature*, 172, 880; 1953). The present volume deals with the Tarsioidea, which Osman Hill, following Pocock (but contrary to Gaylord Simpson), accepts as a sub-order of the Haplorhini. This division of the Primates also includes the sub-order Pithecoidea, comprising the monkeys, apes and man. Osman Hill appreciates that the Tarsioidea differ considerably in many parts of their anatomy from the Pithecoidea, but justifies his acceptance of the earlier classification by appealing to the difficulty of classifying *Tarsius* with the lemurs.

The volume is essentially a monograph on *Tarsius spectrum*, but begins with a general review of the literature on the systematic anatomy of the Haplorhini, which includes some observations on reproductive physiology and behaviour. The middle section of the book, some hundred and thirty pages long, deals specifically with the anatomy of *Tarsius spectrum*. This part of the work incorporates a number of original observations. The final sixty pages or so summarize what has been published about the palæontology of the sub-order. The book is well illustrated.

In a review dealing with a field as wide as that which Dr. Osman Hill is trying to cover, it is inevitable that some literature should be overlooked and that reference to certain authoritative views should be lacking; such omissions are especially evident in the section dealing with the general biology of the Haplorhini. In view of the limited amount of our knowledge, it is also not surprising that the section dealing with the embryology, psychology and reproductive physiology of *Tarsius spectrum* occupies only fifteen pages as compared with the hundred or so devoted to its anatomy. Disproportions of this kind are a challenge to future workers. Dr. Osman Hill's work is sufficiently encyclopædic to serve, like the volume which preceded it, as a reference book and summary for all future students who are likely to concern themselves with the phylogenetically important group of Primates which *Tarsius* represents.

S. ZUCKERMAN

A Textbook of Radar

Edited by Dr. E. G. Bowen. (A Collective Work by the Staff of The Radiophysics Laboratory, C.S.I.R.O., Australia.) Second edition. Pp. xiii + 617 + 41 plates. (Cambridge: At the University Press, 1954.) 45*s.* net.

THIS second edition of a collection of articles on various aspects of radar by the staff of the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization, Australia, is now published by the Cambridge University Press, under the editorship of Dr. E. G. Bowen. The book deals with the fundamental principles of radar, and its application to war, to navigation and to various problems of physical science. In the first two of these, the present edition does not differ greatly from the first, though the section on military applications has been curtailed. The section on application of radar to physical science has been expanded and now deals with such topics as ionospheric research, moon echoes, meteor trails, meteorology and radio astronomy. This is a welcome addition which helps to bring the subject up to date as regards non-military applications.

The book succeeds in compressing into a single volume a large amount of material, but is still quite readable by the beginner. As editor, Dr. E. G. Bowen has brought a certain amount of unity into what might have been just a collection of papers. Clearly, it cannot replace the specialist volumes on war-time radar research issued by the Radiation Laboratory in the United States or the Modern Radio Techniques Series published by the Cambridge University Press, but will serve as an excellent introduction to these. The practice of the first edition of quoting unpublished reports has fortunately been discontinued to a large extent, and many more references to published work are given. The index of authors is, however, very inadequate for a work of this sort, which should prove valuable for reference as well as for initial instruction.

R. A. SMITH

Frontier to Space

By Eric Burgess. Pp. xvi + 174 + 26 plates. (London: Chapman and Hall, Ltd., 1955.) 21*s.* net.

IN "Frontier to Space" Mr. Eric Burgess gives a survey of recent research on the terrestrial upper atmosphere, paying special attention to the results obtained with the aid of rockets. Most of these results were reported at the conference held in Oxford in the summer of 1953 under the auspices of the Gassiot Committee of the Royal Society. Though they have been published in full in "Rocket Exploration of the Upper Atmosphere" (Pergamon Press, Ltd., London) the summary presented by Mr. Burgess is to be welcomed. Sufficient detailed references to the original literature are given to make the book a useful introduction to the subject. Many interesting and instructive diagrams and plates are included.

The student must not accept all that is said uncritically, for the author sometimes quotes out-of-date views. For example, it is misleading to state (p. 79) that "The growth and decay of the ionized atoms and molecules [in the ionosphere] causes a glow to be emitted which appears as the day and night airglows"; or to state (p. 82) that "It is nowadays thought, therefore, that the ionization of oxygen is the most likely mechanism [for the production of *D*-region ionization]". In spite of occasional defects of this nature, the book can be recommended. The educated scientific public should be able to read most of it without difficulty and should find it stimulating. The production is excellent.

D. R. BATES

The Theory of Stereoscopic Transmission and its Application to the Motion Picture

By Raymond and Nigel Spottiswoode. Pp. xii + 179. (Berkeley and Los Angeles: University of California Press; London: Faber and Faber, Ltd., 1953.) 42*s.* net.

AMONG the most popular items at the 1951 Festival of Britain were the three-dimensional films shown at the Telekinema. A year or two later, 3D had taken the film industry by storm, and we became familiar with 'Polaroid' viewers, eye-strain, some curious space distortions and, from time to time, some quite remarkable and beautiful stereo-cinematic effects. All this has now vanished, and we are left with wide-screen techniques instead.

During these years the Spottiswoode brothers were the leading enthusiasts in Great Britain, and they give in this book an account of the theory of stereoscopic cinematography in a form which they have found by experience to be most helpful. Perhaps some people may be surprised to learn that anything serious in the way of a theory is required—Hollywood was probably taken by surprise too—but the presentation of a set of mutually consistent three-dimensional clues is no easy task.

In addition to elaborating the geometry of the binocular parallax, the book deals with the characteristics, mechanisms and methods of practical stereoscopic systems. Neither the algebra nor the terminology which the authors have used makes the book easy reading—terms like hyper-infinite and hypo-infinite systems seem designed to confuse rather than clarify the problem—yet if only the film industry could have spared the time to master the subject instead of impetuously rushing ahead, something really exciting might have emerged. The possibilities are still there.

W. D. WRIGHT

Practical Physical Chemistry

By Prof. Alexander Findlay. Revised and Edited by J. A. Kitchener. Eighth edition. Pp. xiii+364. (London: Longmans, Green and Co., Ltd., 1954.) 18*s*. net.

PROF. A. FINDLAY'S book has been a friend to teachers and students of physical chemistry for many years. It was first published in 1906 and has now reached an eighth edition. With the passage of time new interests and techniques have arisen, and books must take account of these. Dr. J. A. Kitchener has undertaken a revision which is intended to preserve the original character and at the same time bring the book up to date. Many new experiments and apparatus for performing them are described. References to literature are given at the ends of the sections.

The error of some books of this kind of giving large digressions on theory, and sketchy mentions of experiments which cannot be performed in the average student laboratory, is avoided, and the text is studiously devoted to practical work, the equations necessary for the calculation of the results being provided. In this way it has been possible to include a large amount of material—more than can be attempted in the usual practical course but giving a choice of work.

The book is an excellent guide to practical physical chemistry for the honours student, and research students should find it of great service. The revision has been very well done; and with its type reset and new figures provided, the volume is very handsome and worth double the price at which it is sold.

Birds of Eastern and North-Eastern Africa

By C. W. Mackworth-Praed and C. H. B. Grant. (African Handbook of Birds—Series 1, Vol. 2.) Pp. viii+1099+plates 54–96+photographs 7–19. (London: Longmans, Green and Co., Ltd., 1955.) 45*s*. net.

AFTER an interval of three years, this useful and excellent work has been completed by the issue of the second volume, on the same lines as its predecessor (see *Nature*, 172, 92; 1953). Among other things, one notes again with pleasure the marginal drawings and distribution maps; and the standard of reproduction of the colour plates has been much improved. The lithographed text, as before, gives the essential facts about identification, range and habits for each species and race; and there are keys to the different groups. The volume covers the passerine birds, and the number of represented forms makes it even larger than the first; the weavers occupy more than a fifth of it.

In an introductory note to this volume, the authors make a point which needs to be stressed on every suitable occasion. They refer to the many missing facts about habits, habitat and breeding which field observers have the opportunity of filling in: "It is, however, essential that they should be published. We know of many cases where such biological data are known to local residents but to no one else". This work should be a great stimulus, throughout East Africa, to the making of such observations and to recording them as contributions to available knowledge.

LANDSBOROUGH THOMSON

The Genus Nicotiana

Origins, Relationships and Evolution of its Species in the Light of their Distribution, Morphology and Cytogenetics. By Prof. Thomas Harper Goodspeed. (Chronica Botanica, Vol. 16.) Pp. xxii+536+118 plates and illustrations. (Waltham, Mass.: The Chronica Botanica Company; London: Wm. Dawson and Sons, Ltd., 1954.) 12.50 dollars.

A FEATURE of agricultural botany to-day, in both warm and temperate climates, is the intensive study that is often given to all the members of any genus that happens to contain crop plants or economic plants of some kind. How valuable this kind of work can be has been well demonstrated with the potato.

The appearance now of a most comprehensive monograph of the genus *Nicotiana*, to which tobacco belongs, is therefore very much to be welcomed. These investigations on the genus *Nicotiana* have been carried out by Prof. T. H. Goodspeed at the University of California Botanic Garden during the past thirty years and were actually initiated even earlier (in 1904). Of the sixty species known to belong to the genus *Nicotiana*, no less than fifty-six were cultivated in the Botanic Garden—a fine achievement. Five different expeditions were made to South America, and these accounted for a good deal of the living material. Actually, only two species, *N. tabacum* and *N. rustica*, are of direct economic value or yield commercial smoking tobacco at the present time. In its original distribution, before being spread by man, the genus was more or less restricted to the Americas, with a few species in Australia and some islands of the Pacific.

The author divides his monograph into six parts, the first part dealing with distribution, while successive parts deal with morphology, cytology of species, cytology of F_1 interspecific hybrids, phylesis (or evolution) and taxonomy of *Nicotiana*. Full descriptions, accompanied by line-drawings, are given for each of the sixty species. In the sections on cytology, karyotypes of all but four species and complete meiotic sequences in representative species and hybrids are illustrated. The work is a good example of modern treatment in speciation and probable evolution in plants. It should be of special interest to botanists and geneticists and to many others engaged on scientific work with tobacco or the related species.

BRITISH NUCLEAR ENERGY CONFERENCE

INAUGURAL MEETING

ON November 30, Sir Christopher Hinton, managing director of the Industrial Group, United Kingdom Atomic Energy Authority, opened the inaugural meeting of the British Nuclear Energy Conference by recalling that, although the first six years of the British atomic energy project were devoted to military requirements, a nuclear industry is now emerging. Success in this field depends upon the ability to develop and adapt existing techniques, and it was thought better that the Institutions of Civil, Mechanical, Electrical and Chemical Engineers and the Institute of Physics should jointly organize the British Nuclear Energy Conference as a permanent body for providing a forum where nuclear developments can be discussed rather than set up a new and independent society for this purpose.

Sir John Cockcroft, director of the Atomic Energy Research Establishment, gave the opening lecture, which was on "The U.K. Atomic Energy Authority and its Functions", and said that during the past three years it has been possible to turn an increasing part of the efforts of the Authority's Research and Industrial Groups to the development of nuclear power. He recalled that the Government White Paper, "A Programme of Nuclear Power", anticipated that by 1965 it might be possible to commission on a commercial basis more advanced (Stage II) reactors than the gas-cooled ones with which the programme is being started. Studies have been made of the pressurized light-water reactor and of the sodium–graphite reactor. Within the limits of the present uncertainties, there is little to choose between them on economic grounds. A choice will therefore have to be made on other grounds, since the present feeling is that the Authority's resources are adequate for the development of only one Stage II reactor in addition to the work already in hand on the fast reactor for Stage III of the programme. Development of the fast reactor will take a long time and is unlikely to make any significant contribution to electricity supply until the 1970's.

Development of a new type of reactor commences with a feasibility study by a team of physicists and engineers working with chemists and metallurgists. If the reactor is feasible, it is followed by a design study at which stage sub-critical or just-critical assemblies are built to ascertain nuclear data, and testing loops are arranged in research reactors to obtain technological data. Such a study may easily cost £300,000 a year. The annual value of isotopes produced by the Authority is now about £400,000, and this activity will be extended by the preparation of mega-curie sources from fission-fragment cæsium and strontium. These have a potentially wide field of industrial use, and their application to the polymerization of ethylene to polyethylene is already well known. A Technological Irradiation Group has been formed at Harwell to assist industry in studying these possibilities.

V. A. Pask, the chief engineer, and J. C. Duckworth, the nuclear power engineer of the Central Electricity Authority, followed Sir John with a lecture on "The Place of Nuclear Energy in United Kingdom Power Development". They pointed out that of all the countries interested in nuclear power, none has quite the same need for its quick commercial development as has Great Britain, since it is now clear that a rapidly increasing proportion of the nation's energy requirements must be supplied either from imported coal or oil or from nuclear fission. Future plant requirements were surveyed in the paper on the basis that home-produced coal for electricity might reach a maximum of 60 million tons a year by 1970 and thereafter remain at that level, and arrived at the conclusion that the nuclear capacity required to avoid import of fossil fuel would rise from 3,900 MW. in 1965 to 23,000 MW., or rather more than the present total plant capacity, by about 1980. It was noted that 3,900 MW. by 1965 is about twice the capacity proposed in the White Paper for that year, and arrangements have already been made to burn oil equivalent to about 8 million tons of coal as a stop-gap measure. The capacity of coal-fired plant must be expected to continue to rise, and by 1980 might still be nearly two and a half times the nuclear capacity. By 1980 the nuclear plant might well be carrying the whole of the base load or continuous demand.

The costs of electricity from nuclear power plants are subject to many uncertainties, not least of which is the length of time a fuel element may be left in the reactor before it must be withdrawn for re-processing. Nevertheless, Mr. Pask and Mr. Duckworth, after a detailed consideration, have come to the conclusion that it is a reasonable expectation that net generation costs per kilowatt-hour from the earlier nuclear plants should be comparable with those from the most advanced coal-fired plants.

The prospect of competitive nuclear power with low operating costs means that this plant will carry the base load and that eventually the whole of the conventional plant will be required to operate on one- and two-shift cycles. Thus the Central Electricity Authority and the manufacturers of the conventional plants are faced with the problems of providing full operational flexibility in the large sets with advanced steam conditions which are essential if maximum economy in both capital and operating costs is to be achieved. The alternative approach is to improve the load factor. If, in the long run, nuclear power provides cheaper electricity, it should permit more attractive night tariffs than are possible at present, but a radical change is unlikely unless solutions can be found to the social problems involved in the wide adoption by industry of shift working. The fact that there would be an enhanced case for pumped-storage schemes was explained.

Nuclear plant will tend to be sited in areas where insufficient coal is mined to meet local requirements and as near as possible to major load centres. The electrical system in Britain as planned before nuclear energy became a serious proposition involves the transmission of some electricity from the coal-producing Midlands to the load centres in the south. It follows from the base-load operation of nuclear plant that transmission of electricity generated from coal will be impossible at a high load factor and therefore uneconomic. The transmission capacity now being provided for this purpose will, as time goes by, be absorbed as inter-connexion capacity for the pooling of spare plant.

A. S. McLean, medical officer of the Industrial Group of the Atomic Energy Authority, and W. G. Marley, head of the Health Physics Division at Harwell, in their lecture on "Health and Safety in a Nuclear Power Industry", set out to put this aspect in its proper perspective. The early approaches to this subject may now seem timid and full of unrealistic apprehensions, but at the time they were perfectly justified in view of the unfortunate history of radiation in occupational disease.

Radiation injuries are often grave and are seldom reversible by treatment, but the doses causing injury are now quite well known. The workers in the Atomic Energy Authority show no abnormalities, there has been no case of radiation injury, and no new disease has made its appearance among them. In fact, no disease is peculiar to radiation. Causes cannot be determined clinically, and statistical methods are clearly necessary should questions of liability arise. The direct experience of the atomic energy project in Great Britain now extends over nearly a decade, and there has come with it a feeling of reasonable confidence that, given proper attention to adequate safeguards, work in the nuclear power industry is as safe as work anywhere else.

H. J. Grout, head of the Reactor Engineering Division at Harwell, emphasized in his lecture on "The Use of Research Reactors in Nuclear Power Development" that there is no broad background of experience yet available to guide engineers in the specification and design of nuclear power reactors. They must rely on the results of theoretical calculations and laboratory experiments, and the opportunities for subsequent inspection, repair or modification are strictly limited once the reactor has been at power and the internal structure has been intensely radioactive. It is therefore of paramount importance to ensure that the industry is backed by adequate research facilities. The purpose of research reactors is to provide both the radiation field and test-bed facilities to enable the behaviour of reactor materials and components to be studied and tested under simulated operating conditions and to obtain fundamental information in the fields of reactor physics, chemistry and metallurgy. On the fundamental side, he instanced the determination of neutron cross-sections of the various fissile materials, the metallurgical investigation of radiation damage, and the study of the effect of radiation on the rate and the equilibrium conditions of chemical reactions.

The direct application of some of the foregoing to practical designs is not easy, because many problems are so complex that the behaviour of specific systems and complete components must be studied under operating conditions. An 'active hot loop', which is an experiment on an engineering scale, would consist of a number of prototype fuel elements in a coolant system, built into an experimental hole in a reactor such that the neutron flux-level in the region would cause the elements to operate at their designed rating. A serious technical limitation of research reactors is that it is impossible to carry out accelerated tests on fuel elements without radically altering many factors which contribute to their failure.

For certain neutron cross-section measurements, a low-power reactor of stable characteristics is needed, and the pile at Harwell known as GLEEP satisfies this need. The pile BEPO at Harwell provides facilities for matters not directly connected with the power programme, such as isotope production and studies of biological systems as well as much fundamental and technological data. Its low flux ($1{\cdot}5 \times 10^{12}$ neutrons/cm.^{2}/sec.), however, limits its field of application to technological investigations. To provide the necessary facilities at a flux of 10^{14} neutrons/cm.^{2}/sec. three enriched-uranium heavy-water-moderated and cooled reactors are under construction. The piles DIDO and PLUTO will be at Harwell, and another PLUTO will be constructed at Dounreay. Each will be equipped with associated 'hot' laboratories for the examination of irradiated specimens. The rent of experimental facilities in DIDO may vary from £100 a day down to £10 a day for those in less-attractive low-flux positions.

In the discussion, emphasis was laid upon the magnitude of the task ahead both by Mr. J. Eccles, deputy chairman (operations) of the Central Electricity Authority, and by Mr. A. L. G. Lindley, of the General Electric Co., Ltd., who stressed the problem of finding sufficient men with suitable qualifications for work in this field without making undue sacrifice of effort on other work in the electrical industry. There was no suggestion from any quarter at the meeting that the problems can be regarded in any light other than that of difficulties which must be faced and overcome and it is fitting to conclude this article with the sentiments expressed by Sir Claude Gibb, chairman of the Nuclear Power Plant Company, that it is quite certain that we can, and must, meet the nuclear power programme if Britain as we know it to-day is to survive.

THE MORPHOLOGY OF LARGE-CHAIN MOLECULES*

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SINCE the work of Staudinger some thirty years ago, followed by that of a few pioneers such as H. Mark, K. H. Meyer, W. Kuhn, and others, it has been established that the concept of a molecule can be applied to assemblies of atoms of ever-increasing complexity, ranging from the single atom of the rare gas molecule to hundreds of thousands of them. In fact, it is now known that there is no upper limit to the mass and dimensions of molecules: a crystal of diamond, or a piece of vulcanized rubber, can consist of one single enormous molecule.

Yet, although the notion of the molecule remains constant throughout this vast range, as the assemblies of atoms become more complex so they assume progressively new properties. For example, the substances which they make up do not have such well-defined properties: they cannot exist in the gaseous state; they are not thoroughly crystallizable; and their physical and mechanical properties in the solid state are new, complex and delicately balanced. All the same, new problems arise and new methods of investigation are required for the description of giant molecules. In the case of a molecule containing a very few number of atoms, it is possible to describe exactly the relative mean positions of their nuclei, their vibrations and even sometimes the probability distribution of the electrons which bind the atoms together.

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* Substance of a lecture given in the University of London on November 7.

The use of quantum mechanics and of such techniques as spectrometry with radiation ranging from X-rays to microwaves, and even the use of proper chemical methods, generally suffice. As the number of atoms included in the molecule becomes larger, it appears that we have to describe the relative positions of atoms at larger distances, and we have to consider two steps in our investigation. First, using the classical methods just quoted, we try to find out the characteristic atomic groups included in the macromolecule. Secondly, we investigate how these groups are arranged, and we describe their whole assembly with different parameters, according to the type of the macromolecule. If the latter is a quite rigid particle (as a small crystal would be, for example), we use the simple concepts of shape and size. If it is not (as would be the case for a linear and flexible chain of a high-polymer molecule), we use some means of statistical description, as we shall see later on. But the important fact is that for this type of macromolecule it is necessary to add to the ordinary structural data a set of new morphological parameters available to new techniques of investigation.

We could perhaps compare a macromolecule to a large building. The short-range methods enable one to know the kind of stones it is composed of, and even to recognize pieces of walls, windows or staircases, but they cannot give us any idea as to the arrangement of all the parts together. They have to be completed by methods giving the general outline of the building the morphology of which is under investigation. From this point of view, we can give a rough estimate of the limits of the macromolecular domain. It begins when the molecule contains a sufficiently large number of atoms, or atomic groups, to require the use of morphological parameters for its complete description. Despite the fact that each case has to be considered in particular, this number in practice lies around one hundred. At the other end of the scale, particles which can be seen under an optical microscope—that is to say, of a size of about 0·2μ—are no longer considered as being macromolecules, since, above that limit, the determination of size and shape implies the use of very straightforward macroscopic methods.

We can conclude, therefore, that when a molecule lies in this range of dimensions (10–10,000 A.), or of molecular weights (about a thousand to several million), it is said to be a macromolecule and its complete description requires: the investigation of its chemical composition, which is a problem of chemistry; the investigation of the detailed structure of the clusters or groups of atoms it is composed of, which is a problem of chemistry or of classical physical chemistry; and thirdly, the determination of morphological parameters connected with its size, shape or statistics of configuration, which is the problem of morphology.

Before starting on this last point, which is my principal aim here, let us consider as an example a macromolecule resulting from the polymerization of a monomer such as $CH_2{=}CH{-}X$ (X not being a hydrogen atom). From mere chemical considerations it can be readily determined that the macromolecule is made up of the assembly of divalent atom groups $-CH_2-\underset{\underset{X}{|}}{CH}-$. Next one wants to know how these atom groups are connected together. Of course, they follow one another, but different types of sequence can be contemplated: first, there is the so-called head-to-head or head-to-tail arrangements; secondly, even in the case of a regular head-to-tail sequence (that is, following Natta, the so-called isotactic polymers) it may happen that all the X atoms can be on the same side of the stretched zigzag chain, or distributed at random on one or the other side; thirdly, it may happen that the law of succession is broken during the process of polymerization and that a branching occurs. These three possibilities—which all correspond to the short-range structure domain—can be investigated by pure chemical means (especially the first and third) or by physical means like infra-red or X-ray spectroscopy.

Finally, if one gives numbers from 1 to N to the N carbon atoms of the backbone of the chain, there remains the problem of the position of atom number i relatively to any other, or to the centre of mass of the whole chain. This is the problem of morphology that we shall now examine.

Let us consider the succession of four atoms C_{i-1}, C_i, C_{i+1}, C_{i+2} (Fig. 1) and choose, as a plane of figure, the plane defined by the two vectors $C_{i-1}C_i$ and C_iC_{i+1}. The position of C_{i+2} is not fixed and can be anywhere on the circle Γ_{i+2}, except a possible effect of steric hindrances, which will be taken into account later on. Thus the backbone of the chain can have an infinite number of possible configurations—from the stretched zigzag line to a more or less inextricable coil—and we shall have to determine the statistics of these configurations. They will depend upon the state of the matter which the chains make up: thus they will be different in the liquid state and in the solid state, and in the latter case they will be different if the piece of matter is, for example, stretched or not. In fact, this correlation is responsible for the special physical properties of high-polymer substances. For the sake of clarity, we shall assume that each

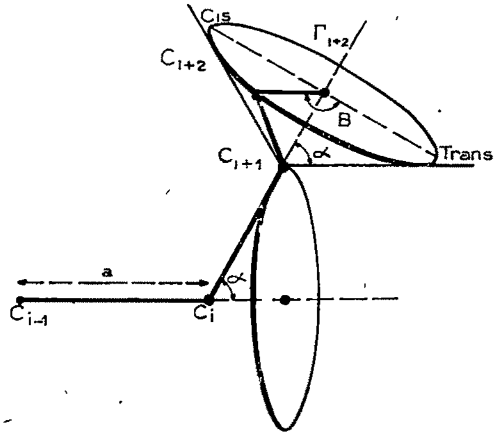

Fig. 1. $a = 1{\cdot}54$ A.; $\alpha = 70°\ 32'$; $\mu = \cos\alpha = \frac{1}{3}$

chain molecule is individualized, or in other words—since the substance cannot be vaporized—that it is placed in a solvent at an infinite dilution. In that case, we shall have to describe for each macromolecule the configurations of an assembly of N points, linked together as already explained.

Up to now, the general approach has been to give the law of probability of position $W_{i,p}(\mathbf{r})d\mathbf{r}$ of any point C_{i+p} in the element of volume $d\mathbf{r}$, $\mathbf{r}$ being the vector $C_i C_{i+p}$. We may consider also the value of $<r_p^2>$, the average of the square of all the possible distances $C_i C_{i+p}$. The interesting point is that often this value can be calculated directly even when it is not possible to know the expression of the function W_{ip}. Then, we can consider $<\rho_p^2>$, the average value for all the configurations, where ρ_p is the distance of C_p to the centre of mass of the molecule. The mean value $\rho^2 = \frac{1}{N} \sum_{p=1}^{N} <\rho_p^2>$ of all the $<\rho_p^2>$ for all the points C_p is another interesting quantity, which is called the radius of gyration of the chain.

In principle, all these parameters can be computed as a function of N, a, and $\mu = \cos\alpha$ (Fig. 1), as soon as we know the elementary law of probability of position of each point C_{i+2} on circle Γ_{i+2}. Unfortunately, this calculation is rather difficult, and it can be completely carried out only under the restriction of assumptions the physical meaning of which is sometimes uncertain. The most simple case is when all the atoms of the assembly are supposed to have no volume and no interactions (such as in an ideal gas). In that case, it can be treated as a Markov process. $<r_p^2>$ can be calculated for all values of p (from 1 to N) as soon as the probability of positions of C_{i+2} on Γ_{i+2} is symmetrical on both sides of the *cis–trans* line (Fig. 1). For very large values of p, it can be calculated in all cases, and one obtains the relationship:

$$<r_p^2> = b^2 p, \qquad (1)$$

where

$$b^2 = a^2 \cdot \frac{1+\mu}{1-\mu} \frac{(1+c)^2+s^2}{1-c^2-s^2} \qquad (2)$$

c and s being respectively the average values of $\cos B$ and $\sin B$.

When equation (1) can be used, then the function $W(\mathbf{r})$ has a Gaussian form:

$$W(\mathbf{r}_p) = \left(\frac{3}{2\pi b^2 p}\right)^{3/2} \exp\left(\frac{-3r^2}{2pb^2}\right)$$

where b^2 is given by equation (2).

When it is assumed that the excluded volume is no longer negligible and that, due to the energy of dilution, there are repulsions or attractions between the elements of the chain, the situation is much more complicated and no probability theory is available. However, with certain assumptions which seem to be supported by experience, an expression can be given for $<r_p^2>$, for $p = N$ only—that is, for the two ends of the chain. It is found that $<r_N^2>$ is proportional to $N^{1+\varepsilon}$, where ε is an increasing function of the second virial coefficient B of the solution. $\varepsilon = 0$ when $B = 0$ (ideal solution).

Finally, in the case of large values of N and for real as well as for ideal solutions, the radius of gyration is given by the equation:

$$\rho^2 = <r_N^2>/(2+\varepsilon)(3+\varepsilon)$$

No matter what the basis of these theoretical or semi-theoretical results may be, the important fact is that the morphological parameters $W(\mathbf{r}_p)$, $<r_p^2>$, ρ_p^2 and ρ^2, which replace the very simple notions of size or shape available for rigid molecules, can be more or less derived from proper measurements performed on solutions.

The general principle upon which these methods are based is to measure the value Φ of a physical character of the solution or its excess compared with the same character of the solvent (that is, viscosity, turbidity, etc. . . .). Generally, Φ is proportional to the number ν of the solute molecules per cubic centimetre, and we may write:

$$\Phi = \nu\varphi = N_0 \frac{c}{M}$$

where N_0 is the Avogadro number, M the molecular weight of the solute, and φ the physical contribution of each single molecule. In general, the magnitude of φ depends on the other molecules in the neighbourhood, so that we may write:

$$\varphi = \frac{N_0}{M}\varphi_0 + c\varphi'_1 + \ldots\ldots$$

where φ_0 is the contribution of a molecule of the solute when it is alone in the whole solution. We have then:

$$\Phi/c = \frac{N_0}{M}(\varphi_0 + \varphi'_1 + \ldots\ldots\ldots)$$

and we can see that the value of φ_0 will be obtained in extrapolating to $c = 0$ the values of Φ/c measured at different concentrations. This is very important, because until now the theories linking φ to the macromolecular data can be set up at their maximum degree of accuracy, when the interactions between solute molecules are negligible. Generally, the interpretation of coefficients φ_1' and so on is more or less unsound—hence the necessity of the extrapolation process just quoted.

We can perhaps try a classification of the main methods into three groups.

(1) Methods which give independently M, or M plus morphological parameters: measurement of the osmotic pressure gives M and also B, the latter being more or less connected with the morphology of the macromolecule; measurement of light scattering also gives M and B, and, moreover, the radius of gyration ρ can be obtained so long as it is larger than a twentieth part—or about—of the wave-length of the incident light.

(2) Methods giving only morphological parameters: measurement of the Brownian translatory diffusion constant.

(3) Methods giving a result dependent simultaneously on the molecular weight and morphology: measurement on intrinsic viscosity; measurement of sedimentation velocity; and measurement of double refraction of flow.

The mass is obtained from osmotic pressure or light-scattering measurements using the general laws of thermodynamics, and this procedure is not open to criticism. The same reliability can be vouchsafed for the theory whereby ρ is derived from light scattering, and it is still fairly sound to derive the value of M from a combination of sedimentation velocity and Brownian diffusion. But all the 'hydrodynamical' methods such as measurement of viscosity, or sedimentation velocity (when used for morphology), have until now had no completely solid theoretical basis. However, they can be used as semi-empirical methods, and viscosity, from this point of view, is quite useful because of its very simple experimental device. In the present state of affairs, there can be little doubt that the light-scattering method is the most reliable, both from the theoretical and experimental points of view. Its generalization to the use of small wave-lengths (for example, X-rays) makes it useful even to the lower limit of the macromolecular domain.

Though it may be felt that the work leading to a complete description of a chain macromolecule—including its morphology—does not need any further justification, it is nevertheless useful to indicate a few aspects of its consequences. Nobody, in fact, doubts the necessity of inquiring about the molecular weight and the short-range structure of a chain, since these factors are of first-rate importance with regard to the properties of matter in bulk—as in rubber or plastic materials—or to the biological specificity of the macromolecule itself in the living organisms, as is the case for proteins or nucleic acids. But it may be reasonable to ask whether it is of any interest to spend so much time and effort in order to describe more accurately the complicated wriggling of a worm-like molecule in its solution.

This question may be answered in a number of ways. First, methods which are widely used for determining molecular weights give—as is the case in the scattering of light—morphological parameters, and the very straightforward curiosity inherent in a scientist's mind would have to be arbitrarily restrained if he were not to try to understand their meaning. Secondly, and more important, the morphological results may lead to significant improvement in the knowledge of the structure itself. Since ρ, for example, depends on steric hindrances, its value depends in principle on the sequence of the atomic groups in a chain. Though it could be slightly changed when head-to-head arrangements are changed to head-to-tail, the effect is much larger when branching occurs. In fact, the determination of morphological parameters is a quite useful way of investigating branching in high polymers.

The third reason appears to me to be the most important one. I have implicitly assumed, in the foregoing discussion, that all the molecules in a solution were identical. Actually, this is not so. A sample of high polymer coming from an autoclave, as well as a sample of nucleic acid extracted from a chromosome, contains a mixture of different molecules. It is then of the utmost importance—for the improvement of our fundamental knowledge in chemistry as well as in biology—to analyse this heterogeneous or poly-disperse medium. The different species have to be characterized and, if needed, separated. This is very often done by using their difference in solubility ; but it can also be achieved by using their difference in morphological parameters (after all, this is the principle of Svedberg's experiments on proteins), and this method is sometimes more direct and can lead to much clearer results. There is little doubt that it will be one of the most efficient means of resolving this problem, which is one of the most irritating in the present state of our knowledge.

As a conclusion, the morphology of large molecules, which is a new and well-defined chapter of physical chemistry, is essential for increasing our knowledge on macromolecules. Of course, this part of science has not the relish of, for example, nuclear physical chemistry. If the first half of this century be thought of as the era of the dawn of nuclear bombs and reactors, perhaps the argument could be advanced, without daring too much, that during the second half the synthesis of materials replacing the traditional natural products and our increased knowledge of fundamental biological processes may in their turn, though in a less spectacular way, weigh very heavily on our future. In this field the morphology of large molecules plays a modest but unquestionable part ; it would be an error to misunderstand it.

CHEMISTRY AND CROP NUTRITION

THE problem of providing adequate food for an increasing world population, and the disastrous and far-reaching consequences of inadequate nutrition, are perhaps more widely realized now than ever before. But it is improbable that it is clearly and universally realized that the ultimate source of our food is the soil and that, were it not for the application of science to agriculture, famine would have overtaken us in Great Britain as a result of an increase in population from ten and a half to forty-nine million during the past hundred and fifty years. This was clearly brought out by Sir William Ogg, director of the Rothamsted Experimental Station, in the ninth Dalton Memorial Lecture, given in Manchester on October 28 under the auspices of the Royal Institute of Chemistry. In the Lecture, which was entitled "Chemistry and Crop Nutrition" and has since been published*, Sir William discussed the contribution of science in general, and of chemistry in particular, to the maintenance of soil fertility.

Early manurial practice, with little or no understanding of its theory, relied in the main upon animal manures, and it was not until early in the nineteenth century that scientific ideas about manuring began to develop as the result of the work of de Saussure, Boussingault, Liebig and others on the Continent of Europe and of Lawes and Gilbert in Britain. The discovery by Lawes in 1842 that treatment of mineral phosphate with sulphuric acid resulted in the production of the phosphatic fertilizer superphosphate, and the setting up of a factory by him for its manufacture, were the beginnings of the modern fertilizer industry.

Lawes and Gilbert during fifty-seven years of active collaboration at Rothamsted carried out investigations into the principles of crop nutrition, the results of which laid the foundations of our present knowledge of manuring. They succeeded in showing the long-term effects of nitrogen, phosphate and potash, both singly and in combination, and some of their field experiments, the classical plots, have been continued at Rothamsted to the present day. Their pioneer work was followed by the use of increasing quantities of nitrogenous, phosphatic and potassic fertilizers in addition to the traditional organic manures. Supplies of phosphatic fertilizers presented no problem since there were known deposits of naturally occurring rock phosphate, and in 1861 the commencement of the working of potash salt deposits ensured a supply of potassic fertilizers. Not until forty to fifty years ago, however, when fixation of atmospheric nitrogen on an industrial scale became possible, could adequate supplies of nitrogenous fertilizers be assured.

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* Royal Institute of Chemistry. No. 5 Lectures, Reports and Monographs Series of the Royal Institute of Chemistry. Pp 13 (London: Royal Institute of Chemistry, 1955.) 3s.

Sir William directed attention to the recent rapid rise in fertilizer consumption in Britain, the need for fertilizers being accentuated by intensification of cropping and reduction in imports of animal feeding stuffs. A wide range of fertilizers is now provided by modern chemical industry. In addition to ammonium sulphate, superphosphate and basic slag, such nitrogenous and phosphatic fertilizers as liquid ammonia, ammonium nitrate, calcium nitrate, urea, nitrophosphate, triple superphosphate and silicophosphate are available. Supplies of potassic fertilizers are still directly dependent upon deposits of potash salts in various parts of the world. Other major plant nutrients, apart from nitrogen, phosphorus and potassium, include calcium, magnesium and sulphur, and the significance of these was referred to by Sir William; there are also the trace elements (iron, manganese, copper, zinc, boron, molybdenum and chlorine) which, when deficient in the soil, and in some cases when present in excess, are responsible for reduction in crop yield or for disease in both crops and stock.

The precise determination of the manurial requirements of crops is a matter of no little difficulty. Different soils of varying fertility vary in their response to fertilizer application, and that section of the lecture which Sir William devoted to soil testing makes it quite clear that soil fertility cannot be completely explained in chemical terms, since biological, physical and climatic factors are involved also. Total chemical analysis of soil reveals only the quantities of potentially available plant nutrients.

Arbitrary chemical methods for determining the amounts of phosphorus and potassium in the soil that are available to the plant, and the amount of lime necessary to correct soil acidity (the lime requirement), have been developed, and the results, correlated with those of field experiments, can be interpreted in terms of fertilizer application to crops. Nitrogenous manuring, however, still lacks a reliable method of soil analysis upon the results of which guidance can be given, and although field experimentation has provided many useful data, more precision is desirable.

The phenomenon of base exchange in soils and the nature of the clay and humus of soils are of first importance in crop nutrition. Sir William dealt briefly with the researches which have increased our knowledge in this connexion and directed attention to the practical application of the results of these researches. Sound manurial practice involves the maintenance of a suitable balance between the amounts of the various exchangeable cations, and a further application of the principle of base exchange is the use of gypsum in the reclamation of saline and alkali soils in various parts of the world, and of soils flooded by sea water. By the release of exchangeable sodium ions from the soil colloids and their replacement with calcium ions, the deflocculation of the soil colloids is prevented and a favourable soil structure for plant growth ensured. New techniques applied to the study of clay and humus have revealed properties intimately concerned with the physical conditions of soils and with their capacity to take up and retain plant nutrients.

Lastly, Sir William discussed the relationship between organic manures and fertilizers, pointing out that in Britain half the food for crops still comes from farmyard manure, which also improves soil texture and enhances the capacity of the soil to retain water and plant nutrients. Fertilizers, however, are essential since farmyard manure may be deficient in necessary plant nutrients, and moreover, the amounts of organic manures available are not sufficient to meet the needs of present-day intensive farming. The contentions of those who are opposed to the use of fertilizers and who condemn all chemical aids to agriculture on the grounds that there is some vital principle present in organic manures which must be transmitted to the soil if crops, livestock and the human population are to remain healthy, are without scientific foundation. The alleged harmful effects of fertilizers existed before they were discovered and are rife where they have never been used.

This Dalton Lecture was a reminder that, besides his world-famed work in chemistry and atomic theory, John Dalton made notable scientific contributions to meteorology; all agricultural scientists concerned with the water requirements of crops owe to him the first clear ideas of the nature of the evaporation processes, and Dalton may be said to have laid the foundation for modern work in this field.

J. S. Willcox

OBITUARIES

Prof. W. M. H. Greaves, F.R.S.

W. M. H. Greaves, Astronomer Royal for Scotland and professor of astronomy in the University of Edinburgh, who died suddenly on Christmas Eve at the age of fifty-eight, was one of that distinguished series of Cambridge men who have held the Isaac Newton Studentship. His published papers cover a wide range of astronomical subjects, from perturbation-theory to geomagnetism; but his principal interest was the use of photography for the study of the spectra, and especially the continuous spectra, of stars. His appointment as chief assistant at Greenwich, in 1924, gave him his initial opportunity in this field, and he seized and developed it with characteristic enthusiasm. The 30-in. reflector, mounted on the same assembly as the 26-in. refractor (to the great inconvenience of both), was all that was available for such work at the Royal Observatory of that day, but Greaves took such obstacles in his stride. The rather less obvious (but much more formidable) challenge presented by the Greenwich sky was met by rigorous adherence to well-considered rules for observing, and the small probable errors of the results which were obtained testify to the judgment, as well as the courage, which lay behind the whole programme. Six years after his arrival at Greenwich, "gradients" were published for twenty-four stars "suitable for use as spectrophotometric standards", and these intercomparisons were of such quality that they scarcely had to be modified at all as a result of the main programme which followed. This comprised 250 stars, most of them fainter than the standard ones; but the foundations had now been laid, and the advent of the new 36-in. Yapp reflector in 1934 also speeded the work. By 1938, when Greaves was appointed to Edinburgh, there was little still to do except publish the extensive results.

An essential part of photographic spectrophotometry is the calibration of the plates, and since it would have been very time-consuming to use, in this, the long exposures which had to be used on stars, the question of 'reciprocity failure' had had to be faced. Greaves reduced this somewhat venerable bogey to very manageable proportions, and definitely established the value of photography as a precise quantitative tool, at a time when photocells were still too insensitive to compete in this field.

The Second World War came soon after his move to Edinburgh, and for a while his principal concern was with the time service, where he co-operated closely with the Greenwich station that had been evacuated to Abinger; a substantial share of the advance in accuracy which occurred about this time, in spite of difficult conditions, was due to him. After the War, he obtained for his Observatory a badly needed increase in staff, and spectrophotometric data both on the Sun and on early-type stars have come increasingly from Edinburgh in recent years. Extensive work is in progress that would undoubtedly have benefited further from his leadership if he had lived.

Greaves definitely enjoyed taking charge of things, and could keep a committee firmly to the point. He served for six years as secretary of the Royal Astronomical Society, and was president during 1947–49. He was an active member of several commissions of the International Astronomical Union, serving for seven years as president of the one for photometry. His influence in the British National Committee for Astronomy was considerable, and he was one of the keenest sponsors of the plan for a large paraboloid at Jodrell Bank.

He will be warmly remembered by those who have worked under him, and with him. His complete integrity, and his devotion to astronomy, were unquestionable; but his numerous generosities may often have been less commonly known. The proportion of his papers which bear also the names of one or more subordinates is high, and this reflects not only his scrupulous fairness but also his power of stimulating the best efforts of his staff in the first place. He was capable of brusqueness, and even more, on occasion; but those who could see past this will remember the very real tact and skill with which he would guide and help all, whether old subordinates or new colleagues, who were associated with him.

R. d'E. Atkinson

Dr. F. H. Burstall

Dr. F. H. Burstall, who died on December 2 at the untimely age of fifty-two, had spent the whole of his working life at Teddington. He was one of a small band who were recruited by the late Sir Gilbert Morgan to staff the Chemical Research Laboratory (of the Department of Scientific and Industrial Research) when it was founded in 1925; and it can be said with truth that no one has done more to establish the prestige and repute that the Laboratory has, in the meantime, achieved.

The second son of the late Prof. F. W. Burstall (who held the chair of mechanical engineering and was dean of the Faculty of Science in the University of Birmingham), Francis Burstall did not follow the profession in which other members of his family have achieved distinction. After graduating at Birmingham with first-class honours in chemistry, he became research assistant to Morgan, who had been his professor and was about to take up a new appointment as superintendent of the Teddington Laboratory.

As a young man Burstall was entirely unsparing of the time and effort he applied to chemical research. He made substantial contributions to the organic chemistry of selenium and tellurium, undeterred by the frequently obnoxious nature of the materials he had to handle. It was, however, by his work on metallic co-ordination compounds that he won recognition as an authority in a field then little cultivated. In a book published in 1933, of which he was co-author with Morgan, he provided an admirable survey of the more recent developments in this branch of inorganic chemistry.

When war came in 1939, Burstall was obliged to take on a succession of problems which, important though they were at the time, offered little of continuing interest, and it was only with the ending of hostilities that his Department was able to make the best use of his very versatile ability. In 1947 he was placed in charge of a small section set up to study the analysis of uranium and thorium ores on behalf of the Department of Atomic Energy. The extraordinary value of the contribution that he and the staff he led (and inspired with some of his own enthusiasm) were able to make to the national effort in this new field was quickly recognized. Greater responsibilities were laid upon Burstall, and his unit ultimately became so large that an extensive new building was constructed and equipped to accommodate what now became the Radiochemical Group of the Chemical Research Laboratory. Those who knew what Burstall put into his task will always see in this fine laboratory a memorial to his success in what, unfortunately, was to be the last phase of his scientific career. Much must remain untold; nevertheless, the series of papers in which he and his colleagues revealed their application of chromatography to the separation of metals indicate the power and generality of a technique they were among the first to use. The formal seal was set on Burstall's accomplishments in chemical research when in 1952 he attained the academic distinction of D.Sc. of the University of London.

Modest and self-effacing, Burstall was nevertheless a man whose judgments were shrewd, being based on wide (if unparaded) knowledge and deep self-communion. He had an extraordinary charm for his friends and colleagues. This was due to the utter impossibility for him to do or say anything in the slightest degree unkind or inconsiderate. His main preoccupation throughout his life was with chemistry, which to him was far more than the means to a livelihood. To purely personal advancement he never gave a thought; nevertheless, he found a high degree of self-fulfilment as a scientist in the service to which he gave his loyalty and whose traditions he upheld.

In the course of his last illness he underwent two major operations and it almost seemed after the first that hope could be entertained of a recovery. Unfortunately this was not to be. Dr. Burstall bore his grievous afflictions with stoicism for more than twelve months. He is survived by his wife, whom he married in 1929, and two sons.

E. A. COULSON

Prof. G. T. R. Hill

PROF. G. T. R. HILL, who died recently at his home in Ireland, was a member of a very distinguished family. His father, the late Dr. M. J. M. Hill, was professor of mathematics and a vice-chancellor of the University of London. His elder brother, the late Air Chief Marshal Sir Roderic Hill, became rector of the Imperial College of Science and Technology and also vice-chancellor of the University of London, and his sister, Dr. Gwen Hilton, is now director of the Radiotherapy Department of University College Hospital.

The two brothers both had close interests in aeronautical engineering, and though their careers were quite different, one was very much complementary to the other in its contribution in this sphere to progress during the past thirty years.

Even as a boy, Geoffrey Hill's future career was unmistakably marked out. He spent much of his spare time making aircraft models, and at the age of seventeen secured a place for one of them at the Children's Exhibition at Olympia. He was educated at University College School and afterwards at University College, London, where as an engineering student he graduated in 1914. After a period of active service in the Royal Flying Corps at the beginning of the First World War, when he rose to the rank of captain and was awarded the Military Cross, he undertook responsibilities in aeronautical research for the Air Ministry. After demobilization in 1919 he pursued his absorbing interest in aeronautics as an experimental engineer and chief test pilot to Messrs. Handley Page, Ltd. By this time he had acquired a background of knowledge and experience which, coupled with his inventive ability, enabled him, in collaboration with his brother, to conceive the idea of the tail-less aircraft or Pterodactyl as it was afterwards called.

In 1922 Hill was awarded an 1851 Exhibition Senior Studentship and after two years of research to test the validity of the principles that the two brothers had enunciated, he began the design and construction of a Pterodactyl. The work was supported in its early stages by the Aeronautical Research Committee and eventually the machine was further developed in association with the Westland Aircraft Co. when he joined that firm in 1926. It was shown to the public for the first time at the R.A.F. pageant at Hendon and is now in the Science Museum at South Kensington, where it bears witness to the great contribution which the two brothers made to aeronautical science by establishing the important principles demonstrated in this machine. The industry to-day owes them a deep debt of gratitude.

In 1934 Geoffrey Hill returned to his old College as Kennedy professor of engineering, and he held that post with great distinction until 1947, when he resigned to re-enter the aircraft industry as consultant to Short Brothers and Harland, Ltd., of Belfast. During the Second World War he was seconded to the Air Ministry and later the Ministry of Aircraft Production for research work, and as a pioneer in the invention of the isoclinic wing he made valuable contributions in helping to maintain the superiority of the Allies in the air. He was elected to fellowship of the Royal Aeronautical Society, and was awarded the D.Sc. in engineering of the University of London.

His most delightful personality and his charm of manner will always be treasured by the wide circle of his friends and acquaintances. His death at the early age of sixty is a great loss, not only as a personal one, but also to the science of aeronautical engineering.

H. M. BARLOW

NEWS and VIEWS

Wellcome Museum of Medical Science : Lieut.-Colonel C. A. Bozman, O.B.E.

LIEUT.-COLONEL C. A. BOZMAN has been appointed director of the Wellcome Museum of Medical Science, and will take up his duties on February 1. Colonel Bozman, who received his medical training at the University of Edinburgh, joined the Indian Medical Service in 1924. He held various public health and laboratory appointments, including that of director of public health, Burma, and became a public health commissioner to the Government of India. After his retirement in 1947 he was successively lecturer in public health in the University of St. Andrews, health counsellor at the British Middle East Office, Cairo, and professor of preventive medicine at the University College of East Africa (Makerere College). His new post with the Wellcome Foundation will enable Colonel Bozman to apply his wide knowledge of tropical medicine and pathology in the service of a Museum which has specialized in this field.

Glasshouse Crops Research Institute : Dr. W. F. Bewley, C.B.E.

DR. WILLIAM F. BEWLEY retires from the post of director of the Glasshouse Crops Research Institute next summer. Bewley was educated at the University of Durham and first joined the staff of Rothamsted Experimental Station, being seconded for service in the Royal Field Artillery during the First World War. While at Rothamsted he collaborated with the late Dr. H. B. Hutchinson on the classic researches on partial sterilization of soil which were later to prove the salvation of the tomato industry. In 1919 he went to the research station in the Lea Valley founded in 1914 by the glasshouse growers of the district and later to become world-famous under his leadership as the Cheshunt Experimental and Research Station. He became director in 1921, and instituted the long series of experiments on glasshouse crops which laid the foundations of modern techniques. His many years of experience, first as a mycologist and later as an authority on all aspects of glasshouse cultivation, were summed up in his two standard books, "The Diseases of Glasshouse Crops" and "Commercial Glasshouse Crops". In 1954, the old Cheshunt Station became the new Glasshouse Crops Research Institute, with Bewley as director, and in 1955 its staff moved to the new site at Toddington near Littlehampton. Bewley's warm, friendly nature, together with his exceptional powers of lucid exposition, have long endeared him to the industry, and to-day there is no man who stands higher in the respect and affection of the glasshouse growers of Great Britain. Not least among his admirers are the growers of the Channel Islands, to whom he pays regular visits.

Mr. F. W. Toovey, O.B.E.

MR. F. W. TOOVEY, who has been appointed to succeed Dr. Bewley, graduated from the Imperial College of Science and Technology, London, where he was awarded the Forbes Medal and Prize. He was then selected for the Colonial Agricultural Service. and after postgraduate work at Cambridge and in Trinidad, was appointed to the Nigerian Agricultural Department in 1935. In Nigeria his work was concerned almost exclusively with the oil palm, a crop of the greatest importance in the economy of the country. Twenty years ago, very little study had been devoted to the crop, but a lead had been given by the fine work that was being done by the Belgians at the I.N.E.A.C. In 1938 Mr. Toovey was sent to the Belgian Congo to report on the progress made in oil palm-research there, and returned to take part in the development of the Oil Palm Research Station of the Agricultural Department of Nigeria. Largely under his direction, this station, which covered, initially, 4,000 acres of undeveloped tropical forest, was built up as the main centre for oil palm research in Nigeria, with many supporting out-stations. In 1952 the station assumed responsibility for research in all the British West African territories, becoming an autonomous institute known as the West African Institute for Oil Palm Research (W.A.I.F.O.R.). Mr. Toovey was appointed its first director, and for his services was made O.B.E. in the New Year's Honours list of 1955.

Chair of Marine Engineering at Newcastle upon Tyne

THE Council of King's College, Newcastle upon Tyne (University of Durham), has announced the receipt of £35,500 from local industrial firms towards the endowment of a new chair of marine engineering at the College. This sum is additional to some £22,000 which was contributed to the College two years ago and earmarked for the development of marine engineering studies. The two sums together provide sufficient funds to proceed immediately to the appointment of the first professor. A separate undergraduate course in marine engineering has been provided at the College—then Armstrong College—since 1913, in the Department of Mechanical and Marine Engineering, of which the present head is Dr. Aubrey Burstall, professor of mechanical engineering. In August 1954 he suggested to the Council that the Department had grown so large that a second professor should be appointed to work in his Department and that he should be designated professor of marine engineering. This proposal was accepted and afterwards widely approved by industrialists and others concerned in marine engineering in Britain. It is hoped to attract more university men into the marine engineering industry and to develop a centre for marine engineering studies at King's College, where there already exists one of the largest university departments of naval architecture (under Prof. L. C. Burrill) in Britain.

Protection against Ionizing Radiations

THE International Labour Office made history in the field of protection against ionizing radiation when, in 1949, it introduced its Model Code of Safety Regulations. The relevant sections of the code are included in a report submitted to the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955 (The Protection of Workers against Ionising Radiations (International Labour Office, Geneva, 1955). 50 cents ; 3*s*.). In 1955 it seems, as the report states, "out of date in some respects . . . and is now due for revision". Nevertheless, this code of practice has been in print and outdated, while no British National Code has yet appeared since the demise of the British X-ray and Radium Commission. A report, therefore, by the International Labour Office, progressive as it is in this field, is worthy of study. It recommends the adoption of the general principles of protection laid down periodically by the International Commission on Radiation Protection. If it accepts its own recommendation, it will have to revise its Model Code drastically in a number of important respects—including incidentally Regulation 208.7, which states that photographic dark rooms should have some natural lighting. It reviews the effect of ionizing radiations on human beings (in parts this is a little naive, indicating that the author was not a medical man) ; the uses of ionizing radiations ; protective measures ; problems arising in uranium mining and processing ; and safety in transport of radioactive materials. It is at its best when it deals with the problems met with to-day in industry. It therefore behoves the industrialist about to use the newly available tools of radioactivity and ionizing radiation to study it. The industrial medical officer and the Ministry of Labour will note, no doubt, the recommendation of the International Labour Office that diseases due to ionizing radiations be included in the international list of occupational diseases to be notified to the labour inspectorate.

Veterinary Research in Britain

IN the committee stage of the Agricultural Research Bill, which received its third reading in the House of Commons on January 26, Mr. A. J. Champion, Captain J. A. L. Duncan and Mr. Leslie Hale pressed for more attention to veterinary research and to livestock farming as contrasted with crop husbandry. For the Government, the Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, Mr. C. R. H. Nugent, while maintaining the view previously expressed that a separate veterinary research council is undesirable and that veterinary research as well as general agricultural research appropriately come under the Agricultural Research Council, promised to take note of the comments made and particularly of the importance of developing preventive veterinary work in agriculture to-day. He pointed out that the Lord President's Committee would consist of the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland.

The Houghton Poultry Research Station

THE Animal Health Trust founded its Poultry Research Station at Houghton, Huntingdonshire, some seven years ago, and under the leadership of Dr. R. F. Gordon the staff has done much useful work on behalf of the poultry industry. The Trust and the Agricultural Research Council have now agreed on financial co-operation on lines which should satisfy the aims of both the Trust and the Council for the expansion of research facilities and meet the conditions essential to the provision of government financial support. Under these arrangements the Trust will contribute one-third of the net annual maintenance expenditure up to £10,000 a year and the Agricultural Research Council will contribute the other two-thirds, with freedom to each party to give more if they wish and if it is in the interests of the Station. The Station is to have an independent status and will be known as Houghton Poultry Research Station. It will be governed by a board of nine members who have been appointed by the Lord President of the Council, the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland, three of them having been nominated by the Animal Health Trust. They are as follow: Mr. T. H. Turney (chairman), Prof. E. C. Amoroso, Mr. H. Finn, Mr. G. Guttridge, Mr. F. Grove, Prof. K. Mather, Lord Stamp, Prof. E. G. White and Dr. W. R. Wooldridge.

New Zealand Heavy-Water Scheme

THE United Kingdom Atomic Energy Authority, after consultation with the New Zealand Government, has decided to withdraw from participation in the Wairakei Scheme. This scheme provided for utilizing geothermal steam for the generation of electric power and for the manufacture of heavy water, the New Zealand Government being interested in the former product and the Atomic Energy Authority in the latter. It has now been found that the cost of constructing the heavy-water plant would be much higher than was originally estimated. A company, Geothermal Development, Ltd., was formed for this purpose, and this will be wound up in due course. The New Zealand Government is to continue with the power station project.

Combustion Institute

THE great interest in research in the field of combustion in the post-war period has been made evident by the support accorded the three symposia held in 1948, 1952 and 1954. To undertake the responsibility of organizing such symposia, a sub-committee was formed in the United States, with representatives from industry, government and universities, and this sub-committee, in conjunction with the honorary members of the Standing Committee in Belgium, France, Great Britain and Netherlands, recommended that a "Combustion Institute" should be founded. The Institute was incorporated in the State of Delaware on July 1, 1954, and at the first meeting of its members, held in Pittsburgh on September 1, 1954, during the fifth symposium, a board of directors of fifteen members was elected, and two working committees were established—the Executive Committee and the Combustion Institute Committee. The latter comprises representatives from a number of different countries, and it is intended that the symposia should continue to be international in character. It is in no way the intention of the Combustion Institute to compete with other societies either in its meetings or publications, but its main object is to encourage activity in this important field crossing the boundaries of so many scientific and engineering disciplines. The first symposium under the auspices of the newly formed Institute will be held at Yale University during August 19–24. The British members of the Combustion Institute Committee (Sir Alfred Egerton, Dr. J. S. Clarke and Mr. P. Lloyd), with Dr. J. W. Linnett, form the British Committee. Further information can be obtained from the assistant secretary, Miss H. Smith, c/o Joseph Lucas, Ltd., Great King Street, Birmingham 19.

Geochemical Society

AT a meeting of the Geological Society of America, held in New Orleans on November 7, the organization of a new society, the Geochemical Society, was completed, and a constitution was adopted which specifies that "The object of the Society shall be to encourage the application of chemistry to the solution of geological and cosmological problems" and that "any person who is qualified to advance the objects of the Society shall be eligible for membership". Thus membership is open to physicists, biologists, mathematicians, oceanographers, meteorologists, etc., as well as chemists and geologists. Those wishing to become charter members should send their names, addresses, fields of interest, and a year's subscription (2 dollars) to the treasurer, Dr. George T. Faust, U.S. Geological Survey, Washington 25, D.C. Names of those who might be interested, but who are not on the "List of Persons doing Research of Interest to Geochemists" (*Geochimica et Cosmochimica Acta*, 6, 132; 1954) would also be appreciated. The following have been elected officers of the Society: *President*, Earl Ingerson (U.S. Geological Survey, Washington); *Vice-President*, Julian R. Goldsmith (University of Chicago); *Secretary*, John C. Maxwell (Princeton University); *Treasurer*, George T. Faust; *Councillors-at-Large*, J. W. Greig, W. F. Libby, W. T. Pecora, W. W. Rubey, G. R. Tilton and H. S. Yoder.

The Hakluyt Society

THE Hakluyt Society exists to publish original narratives of important voyages and travels and other geographical records. The volumes, two of which are generally issued for each year, are made up of the original documents together with introductory material of great value to the geographer, historian, ethnologist and, not infrequently, to other students of the natural sciences. Since its beginning in 1846, the Society has issued one hundred volumes in its first series and one hundred and seven in its second (current) series. Throughout the greater part of its history, its annual subscription remained unchanged at one guinea, and only in 1955 was it increased to two guineas, a modest sum to pay for two volumes of its publications. At irregular intervals the Society produces an 'extra' series. The great collections of Richard Hakluyt and Samuel Purchas have already appeared in this series, these being little more than reprints of the original works. Perhaps the most ambitious and the most important work in this series is the definitive publication of the "Journals" of Captain James Cook, edited by Dr. J. C. Beaglehole. Here the Society is not merely following its normal practice in printing journals and other documents that have not previously been published from the original manuscripts, but is adding a volume dealing particularly with the scientific results of these great voyages. Vol. 1, covering the first voyage, and a portfolio of original charts and views drawn on all three voyages, have recently been published; the whole project will be completed in four volumes. Last year Mr. J. N. L. Baker succeeded Mr. Malcolm Letts as president

Mr. Letts has occupied the office for five years and has made valuable contributions to the publications of the Society. The honorary secretary of the Society is Mr. R. A. Skelton, superintendent of the Map Room of the British Museum (London, W.C.1), who has done much in helping with the publication of the Cook volumes.

Physics and Philosophy

THE first Robert Grosseteste Memorial Lecture, given by Lord Cherwell on May 21 last, was delivered most appropriately in the Chapter House of Lincoln Cathedral; it has now been published (pp. 21. London: Oxford University Press, 1955; 2*s*. 6*d*. net). In it Lord Cherwell performs a valuable service in pleading for a closer understanding between physics and philosophy such as, in broad outline, existed in the lifetime of the great bishop and scholar in whose honour he was speaking. An exceptionally clear picture is presented of the æsthetic choice before the investigator in modern physics, coupled with the recognition that an axiological element is not excluded, thus revealing a measure of personal preference. It is one of the major tragedies of modern thought that the natural philosopher of to-day is expected to know all the answers, whereas, in fact, he is taking a quite limited sector of awareness as his plane of discourse—and likewise for workers in other fields of knowledge. The well-known antipathy of metaphysicians towards mathematics, and the reluctance of physicists to meditate upon fundamentals, are symptoms of a somewhat arid intellectual climate in which the triumphs of science have been won, but which is not necessarily conducive to "helping bewildered humanity to confront the mysteries of existence".

Green Earthworms

THE eastern United States has been invaded by a plague of green earthworms (Smithsonian Institution News Release, Dec. 9, 1955). In a few areas these immigrants from China and Manchuria have become a serious problem for keepers of golf courses because of their borings in putting greens. In a night they may cover a best-kept green with little piles of earth. This particular earthworm, *Pheretima hupeiensis*, was first described more than fifty years ago from the Hupei Province of China, and its first appearance in the United States, near Philadelphia, was noted in 1933. Since then there have been numerous reports from golf clubs which almost unquestionably deal with the same species. Presumably it was introduced into America on some kind of nursery stock from China and has been spread by transportation of turfs from one golf course to another. It is such a serious problem in Westchester County, N.Y., and southern Connecticut that the Connecticut Agricultural Experiment Station has instituted a control programme. It is a slender worm, 1–3 in. long. Its colour varies from pale green to deep olive. A distinct purple or black line is apparent on the back.

The Cross-Bill

ONE of the excellent leaflets issued by the Forestry Commission deals with the cross-bill, *Loxia curvirostra* (Leaflet No. 36; pp. 11. London: H.M.S.O., 1955; 9*d*. net). Besides an illustrated description of the bird, accounts are given of its habitat, song, behaviour, feeding habits and distribution in Great Britain. For the forester the important section is one describing its economic significance. Although the cross-bill does not breed anywhere in Great Britain in numbers large enough to cause the slightest alarm to foresters, it cannot be described as a 'beneficial' bird; it takes some insects and some of them may be harmful to sylviculture, though the amount involved is too small to be of economic account. The leaflet recommends that, for the present, it is best to regard the cross-bill as a highly specialized inhabitant of mature coniferous woodland the ordinary life-history and feeding habits of which are by no means well known, and which—in respect of the periodic invasions—poses a problem of great biological interest still awaiting solution.

Gold Coast Pteridophyta

A COMPREHENSIVE list of the Pteridophyta in the Gold Coast has recently been prepared by C. D. Adams and A. H. G. Alston (*Bull. Brit. Mus.* (*Nat. Hist.*) *Bot.*, 1, 6, 143; 1955). This is an up-to-date statement of the taxonomy, nomenclature and broad distribution of most of the indigenous species, and includes habitat notes based on extensive field observations in the Gold Coast and neighbouring territories and on collectors' annotations. The classification used for the ferns is that of R. E. Holttum (1947). The Pteridophyta are poorly represented in the savannah country and include only such plants as show a geophytic habit or are aquatic annuals. Endemic species are stated as being almost totally absent. Pteridophytes other than the ferns are represented by a relatively small number of species.

Films in Human Relations

THE industrial committee of the Scientific Film Association organized a conference at Ashorne Hill during May 24–26, 1955, on the use of the film in the improvement of human relations in industry, and the report of the proceedings (pp. 24; from the Association; 2*s*. 6*d*.) shows the need for more readily accessible information about available films that are suitable for education and training in industry. A new and comprehensive catalogue of all industrial films available in Great Britain is both desirable and necessary. Such a publication would not be an end in itself. To be of lasting use it would have to be supplemented by an information service which could keep catalogued information up to date and answer specific inquiries about industrial films. The Scientific Film Association is anxious to provide such a service, which can, however, only be established when sufficient funds are available. To gather information in this way is an important step which must be taken before further serious investigation can be made into the use and efficacy of films in industry.

Indian Society of Genetics and Plant Breeding

THE sixteenth annual general meeting of the Indian Society of Genetics and Plant Breeding was held at New Delhi on December 12 under the presidentship of Dr. T. R. Mehta, joint director of research, Madhya Bharat College of Agriculture and Research Institute, Gwalior, who delivered an address on "The Genotype in Agriculture". At the meeting it was decided to organize a symposium, to be held later in the year, on the role of genetics in the improvement of tropical crop plants. The following were elected officers of the Society for 1956: *President*, Prof. V. M. Chavan (Poona); *Vice-Presidents*, Dr. P. N. Bhaduri (New Delhi) and Dr. G. S. Murty (New

Delhi); *Secretary*, Dr. M. S. Swâminathan (New Delhi); *Treasurer*, Dr. N. L. Dhawan (c/o Division of Botany, Indian Agricultural Research Institute, New Delhi-12); *Editor*, Dr. B. P. Pal (New Delhi); *Councillors*, Shri P. D. Gadkari (Indore), Dr. B. S. Kadam (Rajkot), Dr. N. Parthasarathy (Cuttack), Dr. Pushkarnath (Simla), Dr. R. H. Richharia (Sabour) and Dr. T. S. Venkataraman (Madras).

University of Birmingham

The Huxley Lecture for 1956 of the University of Birmingham will be delivered by Dr. Harry Godwin (reader in Quaternary research, University of Cambridge) on February 23, at 5 p.m., his subject being "The Quaternary History of the British Flora". The Sir Josiah Mason Lectures of the University, which have already started, will be continued by Prof. Max Gluckman (professor of social anthropology in the University of Manchester) on successive Thursdays at 5.15 p.m. until March 8, his subject being "Conflict and Cohesion in Zululand". The following have been appointed Research Fellows in chemistry: J. A. Gascoigne and Miss M. Ramsay (British Rayon Research Association Fellows), Dr. H. Weiss, of the Technische Hochschule, Vienna (British Council Research Fellow), and Nadim A. Ghanem, of Alexandria.

Admiralty Student-Apprenticeship Scheme

The Admiralty has decided to supplement its craft-apprentice scheme by the recruitment of student apprentices who will be selected and trained specifically to meet the Admiralty's requirements of draughtsmen and subordinate technical officers. Student apprentices will be given five years of training in one of the four main dockyards (Chatham, Devonport, Portsmouth and Rosyth), at which basic knowledge of the building and repair of ships will be imparted, and this will be followed by detailed training in the work of one particular branch—naval construction, marine engineering or electrical engineering. Two days a week theoretical instruction will be given in the technical colleges in the Royal Dockyards. A few of the students will be selected for advanced training with the view of their entry into the Royal Corps of Naval Constructors or training as electrical engineers. The Admiralty will continue its long-established craft-apprentice scheme for boys of 15–17 years, and on the basis of their progress during the first year such craft apprentices will be eligible for transfer to the direct-entry student scheme. Student apprentices will be recruited by an open competition conducted annually by the Civil Service Commission; candidates must be 16–18 years of age and will take a written examination in mathematics, physics and chemistry, and English, followed by an interview. The first examination will be held in April, and further information can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1.

Announcements

Dr. John Lamb and Dr. J. H. Westcott, lecturers in the Imperial College of Science and Technology, London, have been appointed to University readerships in electrical engineering tenable at that College. The title of reader in anatomy in the University of London has been conferred on D. H. L. Evans and D. A. Sholl in respect of their posts at University College, London.

The following appointments have been made in the Development and Research Department of the Mond Nickel Co., Ltd.: G. L. Harrison, to succeed A. D. Busby as a development metallurgist in London, where he will work in the field of cast iron; P. D. Wilmot, to be a development chemist in London, where he will be concerned with the chemical and chemico-physical aspects; and J. H. Gittus, to be section leader of the Cast Iron Section at Birmingham.

The Council of the Royal Society has awarded a Mackinnon Research Studentship to Dr. C. J. Waddington, of the H. H. Wills Physical Laboratory, University of Bristol, for his work on the nature and properties of the primary cosmic radiation.

The British Museum (Natural History) has received from the Malacca Museums Board a skull of a beaked whale, *Mesoplodon stejnegeri*. This specimen is the first of its kind to be acquired by the Museum, and the species is represented in only one other museum in the world (the United States National Museum, Washington).

The journal *Vox Sanguinis* is no longer being published by the Central Laboratory of the Netherlands Red Cross Blood Transfusion Service. Publication is now in the hands of the company S. Karger, at Arnold Bocklin-Strasse 25, Basle, to which all inquiries should be sent.

A symposium on vegetable tannins, organized by the Society of Leather Trades' Chemists, will be held in the Chemistry School, Cambridge, during April 12–13 under the chairmanship of Prof. R. D. Haworth and Dr. F. E. King, respectively. Thirteen papers have so far been arranged, including three from workers in Heidelberg; but other papers will be considered if sent in without delay. Registration forms for the symposium and further information can be obtained from the honorary secretary, G. H. W. Humphreys, c/o Forestal Central Laboratories, Harpenden, Herts.

The third Easter symposium in agricultural science of the University of Nottingham will be held at the School of Agriculture, Sutton Bonington, during April 23–25. The main theme will be the growth of leaves, and the four sessions will deal, respectively, with general aspects of growth and development, initiation and growth of leaf primordia, the expansion of leaves, and the influence of external factors on leaf growth. Further information can be obtained from Prof. F. L. Milthorpe, School of Agriculture, University of Nottingham, Sutton Bonington, Loughborough.

The Medical Research Council is offering a number of fellowships for the academic year 1956–57, as follows: Rockefeller, Eli Lilly and Lederle travelling fellowships in medicine (2,700 dollars a year or 3,900 dollars for married men), for graduates resident in Great Britain with previous research experience in clinical medicine or surgery, or in some other branch of medical science, to work at a centre in the United States or elsewhere abroad, before taking up positions for higher teaching or research in Britain; Dorothy Temple Cross research fellowships in tuberculosis (£650 a year or £900 for married men), for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Great Britain. Application forms (to be returned by March 15) and further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

CENTENARY OF THE GEOLOGICAL SURVEY IN SCOTLAND

On January 16 Dr. W. J. Pugh, director of the Geological Survey of Great Britain, and Dr. A. G. MacGregor, assistant director in Scotland, welcomed a distinguished company at a ceremony and exhibition of work, in the Edinburgh office of the Geological Survey, marking the completion of an extension of that office and of a hundred years of Geological Survey work in Scotland. Among the guests were Mr. D. L. Macintyre and Mr. J. MacMinn, of the Ministry of Works, who were responsible for the building operations; Sir Walter Drummond, chairman of the Geological Survey Board, Sir Edward Bailey and Dr. W. F. P. McLintock, former directors of the Survey; Dr. Murray Macgregor and Mr. T. H. Whitehead, former assistant directors in Scotland; professors of geology from the Scottish universities and representatives of Scottish learned societies, professional institutions and government departments, etc., with special geological connexions. The older generations of Scottish Survey geologists were represented by descendants of Dr. B. N. Peach, Prof. James Geikie, Dr. John Horne, Dr. C. T. Clough and Sir John Flett.

Geological Survey work in Scotland commenced in a small way in 1854, at the time when Scottish six-inch-to-mile Ordnance Survey topographical maps began to appear. The first worker, Sir Andrew Ramsay, mapped in Scotland for only a few months. In 1855 his work was continued in the Lothians area, Berwickshire and Fife by H. H. Howell (coalfield areas) and by Sir Archibald Geikie.

Work in Scotland has been successively under the direction of Sir Andrew Ramsay (1854–67), Sir Archibald Geikie (1867–82), H. H. Howell (1882–99), Dr. John Horne (1899–1911), Sir John Flett (1911–20), Dr. Walcot Gibson (1920–25), Dr. Murray Macgregor (1925–45) and T. H. Whitehead (1945–52).

The economic importance of six-inch-to-mile regional geological mapping was early in evidence, for in 1858 Geikie was able to indicate to James Young, founder of the Scottish oil industry, the general distribution of West Lothian oil-shales. The first one-inch-to-mile geological map (Edinburgh Sheet) was published (hand-coloured) in 1859 and the first memoir (Edinburgh District) in 1861. The first six-inch coalfield maps were also published in that year. One-inch maps were coloured by hand up to 1910, when the Edinburgh sheet was one of the first to be colour-printed. The Scottish coalfields were largely covered by 1880. By 1890 the whole of Lowland Scotland, East Highland coastal districts as far north as Dornoch, and part of the North-west Highlands had been published on the one-inch scale.

It was in 1883 that Geikie, in his second year as director general, brought the North-west Highlands under survey. His object was to test conflicting current hypotheses regarding the sequence and structure of the older Highland rocks by carrying out detailed regional mapping in the only area where fossils were known to occur in some of the rocks concerned. The brilliant work of B. N. Peach, J. Horne and their colleagues at once made the region internationally famous for its complex, but clearly demonstrable, tectonic structure. A summary of results was given to the Geological Society of London in 1888, and a monumental official memoir on the region was published in 1907.

Scottish work during 1882–1901 was almost entirely in the Highlands. From that time until to-day, except during the two World Wars, primary Highland survey and revision of coalfield areas have gone on concurrently. The wide knowledge, enthusiastic leadership and literary ability of Dr. John Horne, assistant director during 1901–11, led to a good output of Highland and Lowland maps and memoirs during that period. Sir John Flett's remarkable Scottish petrographic output while petrographer during 1901–11, and his delegation of some petrographic research to others, were of great assistance to Horne. Flett's initiative and drive while assistant director in Scotland (1911–20) and director in London (1920–35) ensured that good progress with the publication of Highland and Lowland maps and memoirs was maintained. The first revision of the main Scottish coalfields and of the West Lothian oil-shale area was complete before 1939; recent economic work has included a second revision of the Lothians coalfield.

During the first three decades of the twentieth century scientific discoveries of fundamental importance to volcanology were among the results of the Survey's Highland work. A. Harker in Skye and Rhum, C. T. Clough, H. B. Maufe and E. B. Bailey in Appin and Lochaber, Clough, Bailey, E. M. Anderson and others in Mull, and J. E. Richey in Ardnamurchan vastly supplemented previous knowledge of Scottish Tertiary and Devonian volcanoes and of volcanic mechanisms in general. Bailey and Maufe also revolutionized ideas on the tectonic structure of the schists of the South-west Highlands.

Pioneer British geophysical work with the Eötvös gravity balance was organized by Sir John Flett and carried out in Scotland by W. F. P. McLintock and J. Phemister between the years 1927 and 1931.

During the First and Second World Wars all available staff were employed on work of economic importance. One result of this activity was the gathering together, for the first time, of a great amount of information on Scottish mineral resources, additional to coal and oil-shale. Much of this geological and mining information has been made generally available by publication. The Survey's geological advice led to the exploitation of virgin deposits of bauxitic clay in Ayrshire, of iron-ore in Raasay, of silica sand in Morvern, of mica in Knoydart and elsewhere, and of potash feldspar in South Harris. These raw materials made notable contributions to the war-time economies of Britain, and in two instances still command a market.

The First World War saw the initiation of a long series of memoirs on the economic geology of the Scottish coalfields. Dr. Murray Macgregor, who was prominent in this undertaking, has done more than anyone else to convince Scottish coalmasters and National Coal Board officials of the practical importance of Geological Survey methods and work. For some thirty years, during twenty of which he was assistant director (1925–45), he encouraged and influenced the constantly expanding economic work of the Scottish Survey.

During the hundred years of Survey work in Scotland, seventy-two memoirs on general and scientific geology, thirty-eight economic memoirs and thirty-six pamphlets on mineral resources, and nine pamphlets on underground water supply have been published. In the thirty years between 1910 and the outbreak of the last War, sixty-nine one-inch maps and ten quarter-inch maps were colour-printed. Sales stocks were destroyed during the Second World War; but since 1945, in collaboration with the Ordnance Survey, every effort has been made to replace the lost maps, while continuing to publish new maps on the one-inch scale and many second revision coalfield maps on the six-inch scale.

As a result of growing recognition of the scope and national importance of the Geological Survey's work, increases of staff followed both World Wars. The most recent expansion is not yet complete enough to balance increased commitments. In Scotland, for example, extensive collaboration with the Scottish Division of the National Coal Board and with the North of Scotland Hydro-Electric Board, the annual incidence of some hundreds of inquiries from other government departments and the general public, and the work involved in republishing colour-printed maps destroyed by enemy action, have prevented the Survey from making rapid progress over the whole field of its activities. A. G. MacGregor

THE TRAINING OF UNIVERSITY TEACHERS

The question of the advisability and possibility of providing new recruits to university teaching with some initial guidance in the technique of their calling has been examined by S. Radcliffe, lecturer in German at the University of Bristol (*Univ. Rev.*, 28, No. 1; October 1955).

Unlike France, little attention has been paid to the technique of lecturing in Great Britain. In general, lecturers are conscientious about the matter of their lectures, but give little thought to their form or their delivery.

That this can have a detrimental effect on students' work was borne out recently in the Vice-Chancellor's report for 1954–55 to the Convocation of the University of Liverpool. In examining the causes of failure among students taking university examinations, he includes, among "matters about which our consciences ought to be troubled", the following point: "the presentation of a subject in the lecture room, though impeccable as regards content, does on occasion leave much to be desired in the matter of elementary teaching techniques".

This is the most vital point of all. The cause of so much dissatisfaction quite often proves to be some fault in the technique of presentation, or even a mere mechanical shortcoming, which could in most cases so easily have been circumvented by some initial instruction and guidance of the lecturer concerned.

Radcliffe does not claim that teaching is a mechanical craft to be learned in a workshop, but suggests that an artist requires some basic instruction, at least in the rudiments of his craft.

The following are a few of the purely mechanical skills which might be considered desirable in a good teacher or lecturer. First, the adoption of a fitting speed and clarity of diction. Secondly, the clear formulation and appropriate stressing of the main points of the subject under review. Thirdly, the ability to use a blackboard successfully. Fourthly, the 'staging' of material to make it come 'alive'. The correct lighting and ventilation of the lecture room are of importance. A few weeks teaching in any school will bring these and many allied points home.

What is a fitting speed and clarity of diction? How many lecturers ask their students whether they can hear clearly, or whether they are speaking too quickly for them? A teacher can soon learn the correct measure in these instances with the aid of a little guidance. The undue dropping of the voice at the end of each sentence, for example, can produce both monotony and inaudibility. A person with a weak voice can be shown how to make the most of it by someone trained in these matters. This is a problem faced by teacher-training departments.

The clear formulation and appropriate stressing of the main points of the subject cover a large number of factors. Just as the potential teacher must learn how to arrange and present the various points he is intending to convey in a lesson, so must the lecturer have a clear and systematically arranged plan of what he intends to talk about. He must know which points are important or difficult enough to require particular stressing either in the form of repetition or slower and more deliberate speaking, or even by the dictation of vitally relevant matter.

The extent to which the blackboard is used will obviously vary with the nature of the lecture; a statistical, technical or linguistic theme will call for more blackboard writing than, say, a literature or philosophy lecture. Titles of works, proper-names, unusual or foreign terms, dates—all these should be written up to ensure that students get the correct form. The writing must be clear and legible, and not scattered about in disorder on the board.

Lastly, Radcliffe elucidates his reference to the proper 'staging' of material. There is an element of the histrionic in all personal teaching; the teacher is to some extent an actor, who must make his material come to life. There are some generally recognized devices into the application of which the tyro could with advantage be initiated. A slight break before passing on to a new theme in a lecture can be most refreshing for all concerned. An occasional pause to receive questions from students will in certain cases add to the effectiveness of the lecture; it "draws the students in" more and gives the lecturer a chance to gauge their grasp of what he is saying. Learning the students' names is an essential requirement in establishing such closer contact with them. The prompt return of written work not only helps to keep up students' interest in their subject, but also gives the right to demand written work from the students within the time-limit specified.

MORPHOGENETIC STUDIES OF *DRYOPTERIS*

In two studies, the growth, organization and morphogenetic activity of the shoot apex of *Dryopteris aristata* have been further investigated by experimental means. C. W. Wardlaw and E. G. Cutter (*Ann. Bot.*, 19, 76, 515; 1955) have observed that when the apical cell-group is damaged, leaf primordia, which may be orientated abnormally, continue to be formed on the meristem; but one or more buds may also arise. The observations reported here indicate that a zone at the periphery of the apical meristem is particularly reactive when the apical cell group is damaged, the majority of buds being induced in this region. The extent of damage to the apex may affect the sequence of organogenesis: when damage is extensive buds tend to be formed immediately, subsequent primordia developing as leaves; when the damage is confined to the apical cell, or extends to only a few of its segments, bud formation tends to be delayed. It is concluded that the effect of the apical cell on organ formation is exercised through the growth and organization of the apex as a whole.

E. G. Cutter (*ibid.*, 485) has also observed that in the shoot apex in *Dryopteris aristata*, maintained under conditions of progressive starvation for periods up to a year, the apex decreases very markedly in size; the size of leaf primordia at their inception decreases, but their size relative to the shoot apex increases; the rate of inception of leaf primordia decreases; the rate of morphological development of leaf primordia increases; there is a reduction in the system of phyllotaxis towards that characteristic of sporelings; the vascular system of the attenuated axes is dictyostelic, but there is a reduction in the number of meristeles in the axis and in the leaves.

THE SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

SPECIAL posts have been created in the Scientific Civil Service, as in previous years, under provisions included in the White Paper (Cmd. 6679: 1945), designed to provide for the promotion of individual research workers of exceptional merit. The promotions are effective from July 1, 1955.

Chief Scientific Officer

Dr. P. B. Walker spent five years as a designer in the aircraft industry after postgraduate research in the University of Cambridge on fluid motion. Then in 1935 he joined the Royal Aircraft Establishment, Farnborough, and was a pioneer of the rational scientific approach to aircraft structural design in place of the old empirical formulæ. During the Second World War he was responsible at the Ministry of Aircraft Production for the supervision of the design of gliders and paratroop aircraft. Dr. Walker returned to the Establishment in 1945 as head of the Structures Department, where he concentrated on building up first the Flutter Division, and secondly the Aircraft Structural Fatigue Division, into flourishing teams with widespread reputations. In particular, his work on aircraft fatigue was of great importance in connexion with the investigation of the Comet aircraft, for which he was made C.B.E. In 1951 he delivered the Wright Brothers Lecture in Washington, D.C.

Deputy Chief Scientific Officers

Mr. E. H. Cooke-Yarborough entered government service in 1940 and worked on the development of airborne radar. Later he concentrated on radio counter-measures and also on guided weapons. In 1946 he became interested in atomic energy, and eventually joined the Atomic Energy Research Establishment, Harwell, where he is at present deputy head of the Electronics Division. Mr. Cooke-Yarborough is well known as a specialist in the design of electronic circuits, and during recent years he has been associated with the design of digital computers and the use of transistors; a new computer employing transistors as circuit components is now in use at Harwell.

Mr. B. Sykes joined the Royal Aircraft Establishment, Farnborough, in 1925 from the Imperial College of Science and Technology, London, and his early work was in the field of aircraft electrical engineering, covering such problems as electrically heated flying clothing and the design of a self-regulating generator for aircraft. During the Second World War he played a considerable part in the design and setting up for production of predictor gunsights, and since the War he has been increasingly concerned with general problems of air fighting.

Dr. P. C. Thonemann graduated from the University of Melbourne in 1940 and worked first at the Munition Supply Laboratories, Victoria, and then at the Research Laboratories of Amalgamated Wireless of Australasia, where he was concerned with propagation problems. Later he gained a Commonwealth research fellowship at the University of Sydney, studying physical phenomena in ionized gases, and assisted in the development of gas-discharge modulator switches. At the Clarendon Laboratory, Oxford, he continued to study gas-discharge phenomena and their applications in nuclear science, and this led to the production of the radio-frequency type of proton source which is now used almost universally in laboratories equipped with high-voltage sets for the acceleration of ion beams. Since 1949 he has directed the work of a group investigating the properties of highly ionized gases.

Dr. D. Williams entered the Royal Aircraft Establishment, Farnborough, in 1924 from industry, where he had served as a pupil apprentice after graduating in mechanical engineering from University College, Cardiff, in 1922. Following a few years on stress calculations and the supervision of experimental aircraft contracts, he began work in 1930 on aeronautical structural research. During recent years his research has covered a wide field, including the first complete mathematical theory of 'sandwich' construction, the response of aeroplane structures to dynamic loading, aero-elastic calculations, pressure-cabin problems, and the dynamic instability of systems incorporating pneumatic-tyred wheels.

Senior Principal Scientific Officers

Mr. G. K. Adams graduated in chemistry from the University of Bristol in 1942 and then joined the Armament Research Department of the Ministry of Supply, where until the end of the Second World War he worked on the thermal decomposition of explosives and the evaluation and combustion of pyrotechnic compositions. In 1946 he joined the Explosives Research and Development Establishment, where he has carried out theoretical and experimental researches on combustion processes, especially on rates of flame propagation and of chemical reactions in flames.

Mr. R. Benjamin graduated in 1944 from the Imperial College of Science and Technology, London, and immediately joined the Admiralty Signal and Radar Establishment, where he is still serving. He has been mainly concerned with research in the fields of radar and electronics, and is the author or co-author of some ninety scientific reports and memoranda ranging from circuit design to the evolution of complete new radar systems. For security reasons the more important of his researches have not yet become available for open publication; but his theoretical ability and his exceptional skill in the practical solution of complex electronic problems are well known among workers in this field.

Mr. G. F. Clarke entered the electronics industry on graduating from the University of Birmingham in 1928, and after holding several posts he joined the Bawdsey Research Station in 1938, whence he went to the Radar Research and Development Establishment. Eight years later he transferred to the Royal Aircraft Establishment, where much of his work has been concerned with radar and guided weapons, but has not been published. As an investigator and adviser on widely varied problems, his knowledge combines both theory and practice.

Mr. D. R. Davies graduated in chemistry from University College, Cardiff, in 1924 and held a number of appointments in biochemical and medical research covering such subjects as the biochemical aspects of mechanisms of detoxication, brain enzyme systems with particular reference to narcotics, the metabolism of drugs in abnormal mental states, phosphatase of spleen and blood, and studies of physique and mental disorders. During the Second World War he held a commission and worked for the War Office on the analysis of causes of casualties and assessing the efficacy of therapeutic measures. He joined the Chemical Defence Experimental Establishment in 1947, where he has built up a flourishing biochemical section and has become a leading authority on the cholinesterases and their inhibitors.

Mr. R. A. Fairthorne joined the Royal Aircraft Establishment, Farnborough, in 1927, and six years later gained a first-class honours degree in mathematics as a result of private spare-time study. Of the many facets of his work, mention may be made of his studies on scientific and mathematical films, library organization and bibliography, the use of commercial punched-card techniques for scientific computing purposes and the application of statistical methods to aeronautical research. During recent years his notable work has been done on the theoretical principles underlying the handling, classification and communication of technical information.

Dr. A. F. Gibson joined the staff of the Telecommunications Research Establishment, Malvern, after graduating in physics from the University of Birmingham in 1944, but remained at Birmingham for research on luminescence in solids in collaboration with Dr. G. F. J. Garlick. He went to Malvern in 1948, working originally on infra-red photo-conductors, and in 1951 he took charge of the newly formed transistor physics research group. He is an outstanding experimentalist, equally at home in both pure and applied physics.

Dr. G. N. Harvey began his career as an officer in the Royal Navy, in which he again served during the Second World War, having in the meantime acquired both business and industrial experience. During his naval service he was closely associated with degaussing and was made O.B.E. In 1945 he joined the Admiralty Compass Department and worked on the theory and correction of errors in compasses. In 1947 he joined the Fighting Vehicles Research and Development Establishment, and there he has made important advances in such different fields of applied research as optics, navigational systems and servo-mechanisms.

Mr. C. E. Hubbard first went to the Royal Botanic Gardens, Kew, in 1920 as a student gardener and soon after became a technical assistant in the Herbarium under Dr. Otto Stapf, an authority on grasses. On the latter's retirement, Mr. Hubbard was appointed to take charge of this group, which he has made his special study ever since. He spent six weeks studying the flora in Spain in 1924 and a year in Australia during 1930–31 to assist the Queensland Government in the study of the indigenous grasses. He was made O.B.E. for services to science and agriculture in 1954.

Dr. J. L. King joined the Admiralty Research Laboratory in 1942 after studying mathematics in the University of Cambridge, and four years later was assimilated into the newly formed Royal Naval Scientific Service. Dr. King is the author of some twenty scientific reports ranging in subject-matter from hydrodynamics to atomic weapons, most of which, however, have not been published because of security regulations. One notable exception is a dissertation "On the Motion of an Elastic String", which is a basic study related to aircraft catapults. In the near future Dr. King will be returning to the hydrodynamics field as leader of a team which will be primarily concerned with fundamental theoretical investigations into the motion of bodies under water.

Dr. W. J. Kramers studied chemistry at the University of Oxford, and before joining the Ministry of Supply in 1949, he held appointments in industry and at the British Coal Utilization Research Association. His work in the Armament Research Establishment, and more recently the Atomic Weapons Research Establishment, is centred on the development of new ceramic materials. He was responsible for the development and preparation of cerium monosulphide—a material which had not been studied in Britain previously—and other novel ceramic compositions including various metal oxides; this latter work has led to the possibility of developing new high-temperature ceramics.

Dr. F. P. O. Kubaschewski joined the National Physical Laboratory, Teddington, in 1947, where he has made thermodynamical investigations concerning the possibilities of new methods of producing titanium, vanadium and zirconium. He has also been interested in the thermochemistry of metallic alloys in relation to the phase equilibria existing in metallic systems, and has developed novel methods of measuring directly the heats of formation of alloys in the solid state which are of importance in connexion with the mechanism of bonding. He is the joint author, with Mr. E. Ll. Evans, of "Metallurgical Thermochemistry" and, with Mr. B. E. Hopkins, of "Oxidation of Metals and Alloys".

Mr. W. Lawrence took the Mechanical Sciences Tripos at the University of Cambridge in 1926, and then spent several years in radio transmission work in industry. He joined the Signals Research and Development Establishment of the Ministry of Supply in 1941, where he worked originally on the development of mobile telecommunications equipment, and later on cables and special measuring apparatus. During recent years he has been concerned with research on data transmission and speech problems, and in the field of speech synthesis, in particular, his scientific understanding and experimental skill have led to notable advances.

Dr. Roy Markham joined the staff of the Agricultural Research Council Virus Research Unit in 1940 after graduating from the University of Cambridge. His work has been mainly concerned with the biochemistry of viruses, and in particular the function of nucleic acids in virus nucleo-proteins. He has been responsible for the development of a number of techniques for the analysis of nucleic acids and the determination of their structure.

Mrs. B. Naylor, who is a graduate in electrical engineering of the University of Manchester, entered the Royal Aircraft Establishment, Farnborough, in 1936, where for much of her career she has been concerned with research on aircraft engines and accessories and test-plant for them. During more recent years she has worked on combustion problems, on ram-jet development, and on the cooling of supersonic aircraft. She is a qualified pilot and therefore brings first-hand knowledge to the aircraft problems with which she deals. She was made O.B.E. in 1949.

Dr. K. P. Oakley, of the Department of Geology, British Museum (Natural History), is an authority on human and near-human fossil remains, his handbook, entitled "Man the Tool-Maker", on the British Museum's post-war exhibition on man as a tool-making primate being widely used in British and American universities. In co-operation with the staff of the Government Chemist's Department, he has investigated the geological age of a number of fossil human remains of disputed age by fluorine-dating and other methods, and has obtained some remarkable results. In 1953 Dr. Oakley investigated fossil Hominid sites in South Africa and obtained data bearing on the age of the Australopithecines and the Rhodesian and Saldanha skulls.

Dr. G. M. Roper studied mathematics at Cambridge and then was a school-teacher for several years before becoming a mathematics lecturer at the Chelsea Polytechnic in 1941. After doing aerodynamics research in her spare time at the Imperial College of Science and Technology, London, for which she gained a Ph.D., she joined the Royal Aircraft Establishment in 1941, where, in addition to being in great demand as a mathematical consultant, she has done valuable research in the theory of supersonic flow, especially in the study of delta and swept-back wings.

Dr. W. B. Thompson graduated in mathematics and physics from the University of British Columbia in 1945 and later gained his Ph.D. at the University of Toronto for a thesis on thermal convection and the Earth's magnetic field. After part-time research at the Chalk River Laboratories on the energy distribution of plutonium fission fragments, he went to Britain with a senior research fellowship at Harwell, where he has been mainly concerned with the theoretical analysis of the physical properties of highly ionized gases. In addition, he has published papers on thermal conduction in magnetic fields and on the acceleration of cosmic-ray particles.

Dr. D. P. Wilson has been engaged in research at the Plymouth laboratory of the Marine Biological Association since 1926. He first studied extensively the development of polychaete worms, and this led him to examine the external factors controlling settlement and metamorphosis. He has also shown that sea water from some areas is less favourable for larval development than that from others, thus making more understandable the regional differences in the distribution of different species of bottom-living animals. Dr. Wilson is a graduate of the University of Manchester, gaining his doctorate in 1949.

Mr. F. P. W. Winteringham's work at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research has led to the application of radioactive tracer and paper-chromatographic techniques to two lines of investigation concerned with the use of insecticides in the protection of stored foodstuffs: the contamination of food resulting from treatment with fumigants and contact insecticides; and the study of insecticidal action within the body of the insect. In connexion with the latter it has been found possible to label not only the insecticide under investigation but also the enzymes and metabolites in the living insect. This makes it possible to isolate and determine quantitatively, by chromatographic techniques, the component parts and by-products of different metabolic cycles, first in the normal insect and then in the insect affected by the insecticide.

OCCURRENCE OF *BEIJERINCKIA* SPECIES IN THE 'PHYLLOSPHERE'

By Dr. J. RUINEN

Treub Laboratory, Kebun Raya Indonesia, Bogor

In 1949 Derx[1,2] started an investigation into the occurrence of nitrogen-fixing organisms in tropical soils—a question up to then much disputed; but after incidental research in the first half of the century once more of importance in view of the increasing need of fertilizers in a region notoriously poor in nitrogen. After establishing the carbohydrate source and *p*H required for their culture, Derx succeeded in isolating a number of nitrogen autotrophic bacteria from soil and water, namely, *Azotobacter chroococcum* Beijerinck, *A. vinelandi* Lipman, *A. agilis* Beijerinck and *A. indicum* Starkey et De. The last-mentioned species was segregated from the others and placed in the new genus *Beijerinckia* because of differences in the physiological, cultural and morphological properties. The presence of *B. indica* (Starkey et De) Derx and *B. mobile* Derx has been demonstrated in the acid and slightly alkaline soils of Indonesia, of Nigeria, of the savannahs of the Belgian Congo, of the upland rice-fields in Tonga, and of the rice-fields of Surinam[3]. A similar occurrence was reported by Kluyver and Becking[5]. Besides the first isolations from Indian[6] and Malayan[7] soils, the presence of *Beijerinckia* in soils in the tropics, in particular North Australia, was reported by Tchan[8], while Döbereiner cultivated many strains of *Azotobacter*[9] and *A. indicum*-like organisms abundant in acid Brazilian soils (personal communication). *Beijerinckia* has never been reported outside the tropics. It could not be isolated from the soils of temperate zones[5] or from the soils in nurseries in Holland where tropical conditions were maintained during the summer months. Derx[4] suggested that the occurrence of *Beijerinckia* might be due to a possible association with specific tropical vegetation, presumably leguminous plants, or rice, because cold storage does not affect the viability appreciably and the habitats so far reported are all tropical. Kluyver and Becking, on the other hand, pointed out that the prevalence of *Beijerinckia* in lateritic formations and not in other soil types may explain why until now it has been found only in the tropics.

During the period of Derx's research on nitrogen fixation I[10] was studying the interrelation between the different components of the epiphytic vegetation in Indonesia. The main object of these studies was a small epiphytic fern, *Drymoglossum piloselloides* Presl, common not only on trunks and branches, but also having a tendency to settle on leaves, to which it attaches itself by spreading roots and root hairs. Its occurrence in this habitat might be explained by the cuticular excretion of the leaves. It is a striking fact that trees overgrown by this epiphyte decline; and it was proved in a number of cases that fungi living in the rhizosphere of the fern infect the tree-support and cause the die-back of the branches.

In searching for the organisms which might be responsible for this decline and which might, eventually, account for the presence of higher epiphytes, an analysis was made of the rhizosphere-vegetation of the latter. During the years 1952–54 the relation between seven different tree-supports, including barks with rough and smooth surfaces, and ultimately the leaves, and two epiphytes was examined microbiologically. A routine comprising observation under low magnification and plate-culture was followed. Taking the limitations of the method into account, it nevertheless became evident that: (1) in the rhizosphere the fungi prevailed over the bacteria; and (2) in the adjacent areas the bacterial flora was richer. Microscopical observation showed that the fungi were mostly common soil fungi and mild parasites.

The second point, the prevalence of bacteria in the areas not covered by the epiphyte, was investigated in more detail. For this the anatomically simpler leaf surface seemed preferable to the complicated periderm. The same difference in microbe distribution was found. Moreover: (1) the fungal population increased with the age of the leaves; it was practically absent on young ones and became abundant on senescent ones; (2) the bacterial population similarly increased with age, becoming abundant as soon as the leaf was full-grown; (3) the ratio fungi : bacteria was lowest on the full-grown leaf, but appeared to increase on older leaves; (4) the species of bacteria and yeasts in the epiphyllic population seemed characteristic and limited in number; (5) among the bacteria *Mycoplana rubra* (Den Dooren de Jong) Derx et De Vries and *Beijerinckia* sp. occurred frequently; (6) the time of soaking and shaking the leaves before plating influenced the plate-count.

These observations suggested the existence of a characteristic milieu which is conditioned by the leaf, and may be called, in analogy with the rhizosphere, the 'phyllosphere'. (Since the completion of this communication I have seen the article on fungus incidence on cereal leaves in which Last also introduces the term 'phyllosphere' in the same sense (*Trans. Brit. Mycol. Soc.*, **30** (3), 221; 1955).)

As this phyllosphere apparently is a favourable habitat for *Beijerinckia*, more leaves were examined. Leaves from trees and shrubs of different ecological groups collected in different localities in Java, Sumatra and Banka were studied. The sources of the material comprised trees up to 24 m. in height, free-hanging tendrils of climbers, crater-plants, epiphytes and coastal vegetation. The epidermis was examined directly under 900 times magnification. Furthermore, a simple bacterial enrichment technique was used—virtually a modification of Winogradsky's starch method. In 192 out of 196 cases *Beijerinckia* was observed. In a saturated atmosphere at room temperature (varying from 26° to 32° C.) the bacteria appear within twenty-four hours; later they become overgrown by other bacteria, yeasts and fungi, but when this vegetation declines after having exhausted the original medium, *Beijerinckia* colonies emerge from the debris.

The apparent omnipresence of *Beijerinckia* on leaves as a component of a typical vegetation, characterized *inter alia* by a number of slime-producing organisms, opens a new field of tropical botanical and microbiological research.

The importance of the nitrogen-fixing property of *Beijerinckia* has already been demonstrated in the ecological relationship with blue-green algae in rice-fields. It may prove to be still more important in the phyllosphere. It seems quite plausible on one hand that the stream of nutrient salts and metabolites excreted by the cuticle serves as the nutrient medium of the epiphyllic micro-vegetation, while on the other hand the nitrogen fixed by *Beijerinckia* might offer a constant and essential source of bound nitrogen. The latter may be taken up directly by the leaves in the diurnal rhythm of water-content variation, and then transported through the plant body itself. It also may be washed off by the rain together with the leaf excretions and via the soil reach the ordinary upward nutrient stream. A second cycle of nitrogen-fixation in the soil and decomposing leaf litter may support the first-mentioned one.

This may imply that the inexhaustible reserves of atmospheric nitrogen and carbon dioxide in conjunction with the climatic conditions are ultimately the cause of the luxuriant tropical vegetation through the interrelationship of these bacteria and the green plants. Eventually it might explain the wide distribution of *Beijerinckia* throughout the tropics. A closer study of the phyllosphere and the occurrence of *Beijerinckia* and other micro-organisms in this milieu will be important for agriculture and forestry.

The preliminary work and further considerations on this problem will be published in the *Annales bogorienses*.

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SPECTROCHEMICAL ANALYSIS WITH TIME-RESOLVED SPARK SPECTRA

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IT is well known that the main advantage of the high-voltage electric spark as a spectrochemical light-source is that its analytical accuracy is in general the highest of all light sources. Its disadvantage, however, is that its sensitivity is low, which is mainly due to the fact that the spectrum of the electric spark has a continuous background, in which weak spectral lines cannot be observed. Even if the spectrum line/background ratio is high, the background is still highly disturbing in the evaluation of intensities.

It is known from earlier investigations that the background of spark spectra appears in the initial stage of the discharge; in the subsequent stages of the spark the spectrum is practically free from background. Steinhaus, Crosswhite and Dieke[1] introduced a photoelectric procedure, by means of which this background can be separated from the spectrum. We have developed a method by which the background is separated by optical means. This method is capable of giving spectra practically free from background. To this end a high-precision spark source and an optical arrangement containing a rotating mirror are needed. The spectrum may be detected either photoelectrically or photographically.

The optical arrangement is shown in Fig. 1. The reduced image of the light source *A* is formed on the slit *S*2 by means of the concave mirror *M* fastened to the shaft of the synchronous motor *C*. The slit *S*2 is parallel to the plane of the figure, and selects a part of the time-resolved image of the light source. An image of the slit *S*2 for the collimator lens of spectrograph *D* is obtained by means of lens *L*. *S*1 denotes the slit of the spectrograph and *P* the photographic plate.

As the production of a single spectrum requires an exposure of a few minutes, that is, the light of several thousand spark discharges, in order to obtain the result desired, the time-resolved image of the individual sparks must be precisely formed at the same point of the plane of slit *S*2. In other words, the problem requires the precise synchronism of the rotation of the mirror and the initiation of the individual spark discharges. The problem is solved by means of the electronically controlled spark-source introduced by Bardócz[2], in which the spark discharge is initiated with a jitter of a few tenths of a microsecond with respect to a controlling signal. The spark source is controlled by the amplified voltage signal of photocell *I* illuminated by the lamp *H* at each turn of the rotating mirror *M*.

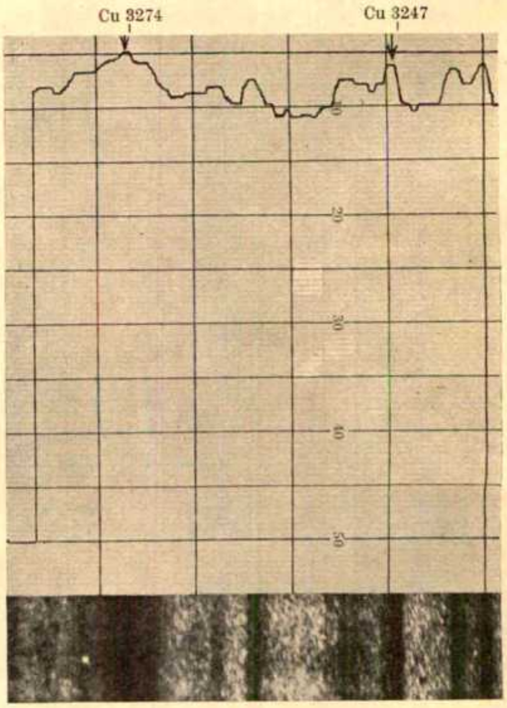

Fig. 2. Lower part: Cu 3274 and Cu 3247 lines in the spectrum of aluminium containing 0·01 per cent copper. Upper part: density curve of the above spectrum as scanned by a recording microphotometer. Magnification of the spectrum, 25 ×

The image of the light-source *A* is adjusted on the slit *S*2 by setting the lamp *H* or the photocell *I* perpendicular to the plane of the figure.

To illustrate the advantages which can be achieved by the above procedure in spectrochemical analysis, Fig. 2 shows part of the spark spectrum of aluminium containing 0·01 per cent of copper, taken in the usual manner, with background. The upper part of Fig. 2 shows the density curve of the spectrum scanned by a recording microphotometer. Fig. 3 shows the same part of the spectrum as photographed by the method described here. The difference between the line density/background density ratios in the two figures is striking. The deflexion of 50 is in both cases that corresponding with the unexposed plate.

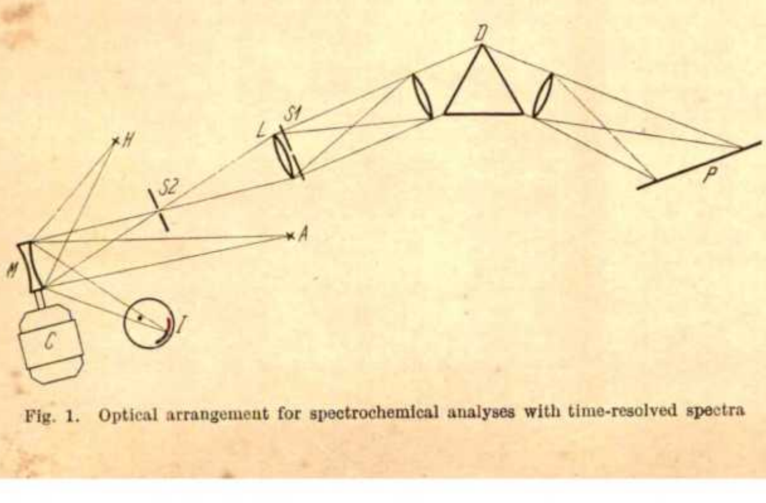

Fig. 1. Optical arrangement for spectrochemical analyses with time-resolved spectra

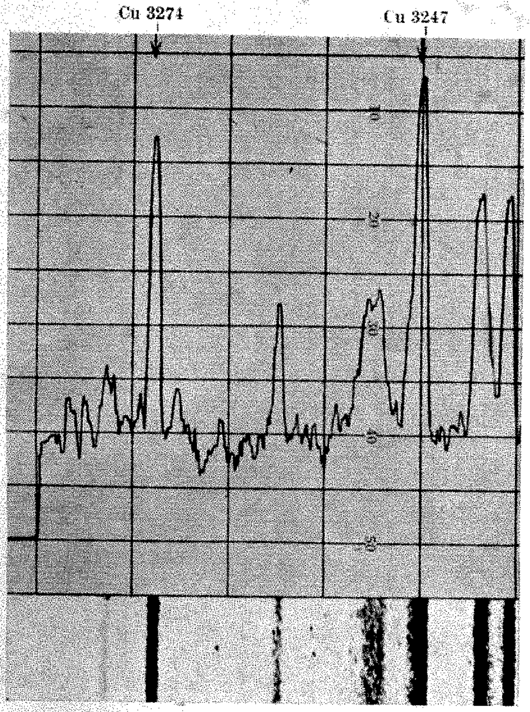

Fig. 3. Lower part: Cu 3274 and Cu 3247 lines in the time-resolved spark spectrum of aluminium containing 0·01 per cent copper. Upper part: density curve of the above spectrum as scanned by a recording microphotometer. Magnification of the spectrum, 25 ×

In taking the spectra of Figs. 2 and 3, the capacity of the condenser of the spark source[2] was 10,000 pf., its charging voltage 20,000 volts, and the frequency of the spark 50/sec. One of the electrodes was aluminium rod containing 0·01 per cent copper and other impurities, and the other a spectroscopically pure carbon rod. The electrode separation was 3 mm. The photographs were taken with a medium-size spectrograph, on Agfa Blau rapid plates. The slit width of the spectrograph was 30 microns. The exposure time of Fig. 2 was 1 min. and that of Fig. 3, 4 min. These exposure times were chosen so that in both spectra the strongest density should be about the same.

The photographs reproduced in Figs. 2 and 3 were taken with the same equipment, except that in the case of Fig. 2 the mirror was still, whereas in the case of Fig. 3 it rotated with a frequency of 3,000 revolutions/min. One side of the mirror was coated with aluminium and the other with dull black paper. The distances *A–M* and *M–S*2 were 403 mm. and 325 mm. respectively. The radius of curvature of the mirror is 360 mm. The travelling speed of the image of the light source on the screen *S*2 was 0·204 mm./microsec. In taking Fig. 3, the light emitted by the spark between 29 and 54 microsec. was used.

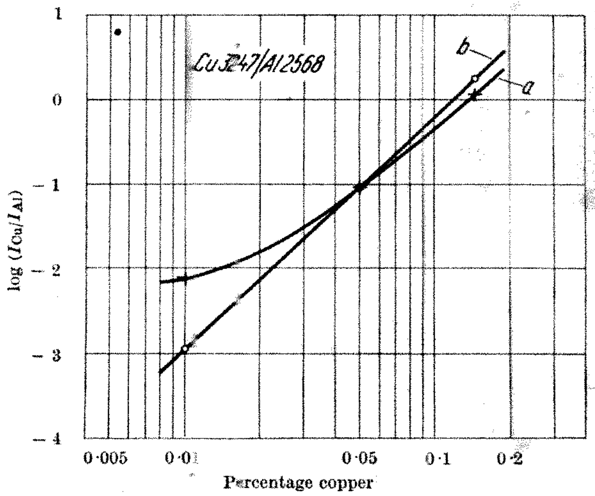

Fig. 4. Analytical curves for the determination of copper in aluminium. Curve *a*: taken in the usual manner. Curve *b*: initial stage of the discharge cut out

Fig. 4 shows two analytical curves for the determination of copper in aluminium. One of the curves (*a*) was taken in the usual manner and the other (*b*) with the initial stage of the discharge cut out. The Cu 3247 and Al 2568 lines were used for plotting the analytical curves. [July 23

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PAPER CHROMATOGRAPHY OF INSULIN

PREPARATORY to carrying out experiments on the incorporation of labelled amino-acids into insulin in beef pancreatic slices, it was necessary to design some method which would allow of the isolation and determination of the insulin in small amounts of tissue with reasonable accuracy and speed. In view of the rather unusual solubility properties of this protein, it appeared possible that some chromatographic separation might be feasible. Several investigators have carried on work of this kind. Porter[1] separated pure insulin from crude preparations by using a silane-treated silica gel column; Porath and Li[2] used a charcoal column successfully. Others have tried to separate various proteins by paper chromatography. Sanger[3] did not obtain notably good results with insulin fractions *A* and *B* because of streaking. However, Robinson and Fehr[4] were able to estimate the percentage of insulin in protamine insulin by using the upper phase from a butanol/acetic/water (3 : 1 : 4) mixture as a chromatographic solvent.

After trying various solvent combinations, we likewise found it possible to isolate insulin from the major part of the contaminating protein by using a similar mixture of butanol, water and acetic acid in a single phase. Insulin on the paper was then determined by staining and reading the depth of colour of the eluate as described below. The preliminary extraction and purification of insulin were carried out by standard methods, with slight modifications[5].

The proteins in about 1 gm. of hashed tissue were precipitated by the addition of 25 ml. of 6 per cent trichloracetic acid. After homogenization, the protein was centrifuged down and washed with trichloracetic acid (5 per cent, 1 ml.). The precipitate was extracted twice at 37° for 2 hr. by shaking with

4-ml. portions of an acidic solvent (15 ml. ethanol, 5 ml. water and 3 ml. concentrated hydrochloric acid), and the *p*H of the combined extracts was adjusted to 8·5–9 with concentrated ammonium hydroxide, after which they were allowed to stand in the cold. Any precipitate was discarded after washing with ammoniacal alcohol. Insulin in the alcoholic solution (about 10 ml.) was precipitated by the addition of about 40 ml. of an alcohol–ether mixture (3 : 5 by volume), and allowing to stand in the refrigerator. After washing this precipitate of crude insulin with alcohol, the soluble part was taken up in 0·3 ml. of the acidic solvent, to which was added 0·1 ml. of 0·1 *N* hydrochloric acid; the total volume then being of the order of 0·5 ml.

This solution was applied to a curtain of Whatman 3 *MM* paper (46·5 cm. × 67 cm.) as a streak of droplets on a line 7 cm. from the upper edge of the paper, dried in air, and chromatographed for 10–12 hr. with a fresh mixture of butanol, water and acetic acid (12 : 5 : 2 by vol.). It has been found advisable to add all the solution in the original streak. If the atmospheric conditions change, the water content of the paper may vary, so that some slight modification in the solvent may be necessary. Under the conditions described, the insulin moves with R_F 0·21 approximately.

After drying the paper at 40°, it was dyed in a tray for 10 min., using a mixture of bromphenol blue 0·05 per cent, mercuric chloride 1 per cent, and acetic acid 2 per cent. Dilute acetic acid was then used to wash out all the excess dye. The insulin streak was cut out and reduced to shreds, which were packed into a small tube to which was added 25·0 ml. of the acidic solvent. After extracting for 45 min., samples were removed, centrifuged to get rid of any paper and the depth of colour determined at 470 mμ. The actual amount of insulin was determined by comparing the colour with that from insulin standards treated in exactly the same fashion. A linear relationship existed between the amount of dye eluted and the amount of insulin applied to the paper in the range 0·1–2·0 mgm. of insulin.

The results of chromatographing liver proteins against insulin with five different solvent systems are shown in Fig. 1. This provides the reason for the selection of the solvent system used. It also indicates that there is probably no significant amount of other protein in the liver extract which behaves like insulin when the proper solvent combination is used. None of a series of other proteins tried, including ribonuclease and serum proteins, behaved as did insulin; although there are indications that glucagon may have very similar properties.

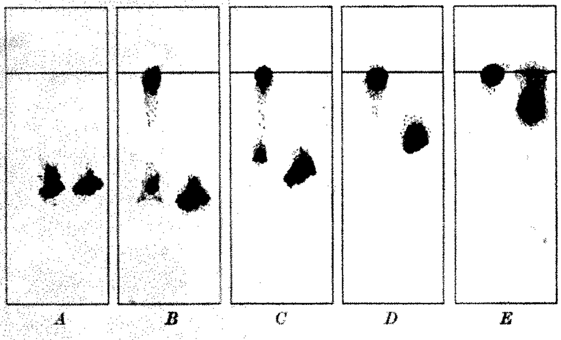

Fig. 1. Chromatography of insulin and extracts of liver. The left-hand spot of each pair is insulin. The solvent mixtures are made up with the following proportions of butanol, water and acetic acid: *A*, 6 : 2 : 0·64; *B*, 6 : 3 : 1·2; *C*, 6 : 4 : 1·52; *D*, 6 : 5 : 1·72; *E*, 6 : 6 : 3·4. All solvent systems comprised a single phase

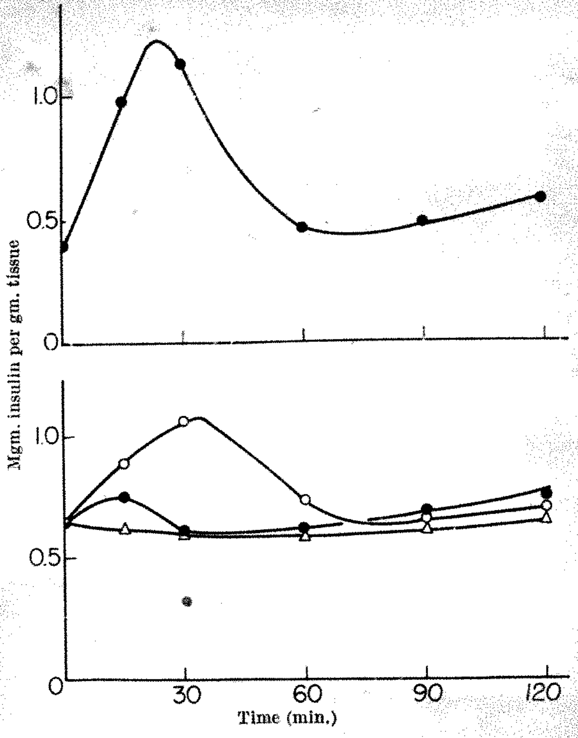

Fig. 2. Changes on insulin content of fœtal beef pancreas following incubation under various conditions

Upper curve: Incubation in 95 per cent oxygen, 5 per cent carbon dioxide. Lower curves: open circles, conditions as for upper curve; closed circles, incubation under 95 per cent nitrogen, 5 per cent carbon dioxide; open triangles, under oxygen in the presence of 10^{-4} *M* dinitrophenol

When insulin was added to an acidic solvent-extract of liver, prepared as indicated above, the recovery of the insulin varied between 92 and 93 per cent, the acidic extract itself containing no detectable amount of the hormone. Insulin recovered from chromatograms was biologically active and when subjected to electrophoresis on paper using veronal buffer (0·05 *M* at *p*H 8·6) it behaved precisely as did insulin.

1-gm. samples of fœtal beef pancreatic slices were incubated in the pyruvate–bicarbonate buffer (*p*H 7·6) described by Anfinsen[6] and the changes in insulin content over a period of two hours at 37° were measured by the method just described. Fig. 2 shows the results when the incubations were carried out in the presence and absence of oxygen and with the addition of dinitrophenol. With oxygen present, the insulin content of the tissue increased during the first 30–40 min. of incubation, but later there was a decrease. In the absence of oxygen no such phenomena occurred. Whether these results are to be attributed to the net synthesis of insulin during the first part of the incubation period, or to the formation of insulin from some precursor, is not clear.

When slices were incubated for 30 min. in the presence of 0·2 per cent glucose, there was an increase in insulin content of 65–72 per cent. Glucose appeared to have a direct effect on insulin production by slices, as it has on the perfused pancreas[7]. Work is in progress to determine if this is an effect of synthesis or secretion, and to determine the effect of other carbohydrates and hormones on insulin production.

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In the course of the development of a procedure for the small-scale isolation of labelled insulin from surviving pancreas slices, a rapid method for the detection of this protein in crude pancreas fractions was required. It was found that the presence of insulin in these fractions could be demonstrated by the use of paper chromatography, and that protein contaminants, when present, were readily detectable in the more highly purified insulin samples. Moreover, further studies showed that this chromatographic procedure was suitable for routine use as a preparative method which then replaced the lengthier procedures[1,2] originally investigated. Hitherto, only the paper chromatography of pure crystalline insulin[3] and pure protamine insulin[4] have been reported.

A large number of solvent systems were tested with crystalline insulin on Whatman No. 1 paper, using descending chromatography. Results obtained with the satisfactory systems are reported in Table 1. In most cases, systems containing 2-butanol gave excellent results, with 2-butanol/1 per cent (v/v) acetic acid (1 : 1) giving the most discrete spots. 20 µgm. of insulin is easily detectable. Some of the properties of this system for crystalline insulin and for crude and partially purified pancreas extracts are reported below.

The R_F of crystalline insulin in this system varies with the amount applied to the paper and with the distance travelled by the solvent front. The following R_F values were found for the corresponding amounts of insulin (given in µgm. in parentheses): 0·33 (200), 0·32 (160), 0·30 (120), 0·27 (80). The dependence of R_F on the distance travelled by the solvent was studied by spotting the insulin solution along an oblique line according to the method of Bowman[6]. The following R_F values were found for the corresponding distances (given in cm. in parentheses) travelled by the front: 0·30 (28·5), 0·29 (25·9), 0·26 (23·2), 0·24 (20·6), 0·23 (17·6), 0·23 (14·9). The R_F values at 6° and at 25° were the same. Ascending chromatograms gave substantially lower R_F values than descending.

Table 1. R_F Values of Insulin in Various Solvent Systems

Solvent system	R_F
2-Butanol/1 per cent acetic acid (1 : 1)	0·30
2-Butanol/1 per cent dichloracetic acid (1 : 1)	0·29
2-Butanol/acetic acid/water (4 : 1 : 5)	0·92
2-Butanol/formic acid/water (4 : 1 : 5)	0·90
1-Butanol/acetic acid/water (4 : 1 : 5)	0·29
Phenol/water (4 : 1)	0·95

The numerical ratios given in column 1 represent the proportions of the volumes of solvents which were mixed. Where two phases resulted, the organic phase was used and the aqueous phase discarded. 50 µgm. of insulin dissolved in 0·05 *N* hydrochloric acid was used in most cases. The positions of the spots were determined by the bromphenol blue method (ref. 5). Development was stopped when the solvent front had moved about 30 cm.

The paper chromatographic technique described here for pure insulin could be used to detect the presence of this protein in the various crude fractions obtained from the procedure of Romans *et al.*[1] provided that the sample to be chromatographed is first dialysed free of salt and that an excessive amount of crude protein is not put on the paper. The amount of insulin present could be estimated approximately by comparison with known insulin spots. Ribonuclease, serum albumin, or pancreas fractions depleted of insulin show no movement. However, crystalline glucagon moves at the same R_F as does insulin. Its presence in insulin samples may readily be detected by paper electrophoresis at *p*H 7·5[7].

For preparative purposes, a modification of the chromatographic procedure was necessary. In the presence of large amounts of non-insulin protein material, the movement of insulin is almost completely inhibited, even on the thicker Whatman papers; a development time of two days is necessary for even slight separation under these conditions. This difficulty could be obviated by using Munktell No. 20 electrophoresis paper, which permitted the insulin to move at its normal R_F, even when the paper was heavily loaded with crude material. In a large-scale experiment, 80 gm. of calf pancreas slices was incubated for 1·5 hr. in the presence of DL-leucine-1-^{14}C. After incubation, the pancreas slices and medium were lyophilized, extracted with acid-alcohol solution[1], the *p*H was adjusted to 6, and the proteins were precipitated with 2 volumes of ethanol and 4 volumes of ether. The precipitate was taken up in 0·05 *N* hydrochloric acid, and the soluble portion was dialysed against distilled water, concentrated, and streaked on to the paper. After elution of the insulin band with 0·01 *N* hydrochloric acid, the insulin was rechromatographed using the same system. A trace of protein remains at the origin. The yield of insulin after elution was 32 mgm. Evidence that the isolated insulin is pure, that it retains its biological potency, and that the labelled leucine is actually incorporated into the insulin molecule will be presented elsewhere[7].

This investigation was supported in part by a research grant (A-428) from the National Institute of Arthritis and Metabolic Diseases of the National Institutes of Health, Public Health Service, and in part by an institutional research grant from the American Cancer Society. We acknowledge with thanks the technical assistance of Miss Barbara Silver in various phases of this work.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Photographic Method for the Study of Insect Migration

THE study of the migration of swarms of the desert locust (*Schistocerca gregaria* Forsk.) has involved the detailed analysis of the flight behaviour of the individual locusts constituting a swarm. Following Gunn *et al.*[1], it has been shown that by placing a camera on the ground with the lens pointing upwards, it is possible to obtain photographs of locusts flying in a swarm which are 'readable' up to the limits set by the lens, the shutter-speed in relation to the ground-speed of the locust, and the emulsion used. These photographs have been useful for determining the orientation of individuals and also, from the size of the images and of a sample of the locusts under observation, the area-density and volume-density of the flying locusts in the layer of the swarm resolvable by the camera.

A further development of this technique, using a camera modified to give two images of each locust on each negative separated by a known interval of time, has made it possible to record also the track and ground-speed of the individual locusts. By including in the field of view of the lens a wind vane, and also recording the corresponding wind-speed, the air-speed of the flying locusts can be estimated. An *F*.24 aerial survey camera was used, with a focal-plane shutter and a control unit (type 35) which can be set to give exposures automatically at any time interval between 3 and 50 sec. on a 100-exposure film in an interchangeable magazine. A modified shutter-blind was made with two ⅛-in. slits instead of one, at a distance of 1½ in. from each other, giving at the appropriate tension the sequence 1/500 sec. exposure – 1/50 sec. interval – 1/500 sec. exposure. The interval of 1/50 sec. between exposures gave locust images usually separated clearly but not by too great a distance for the pairing of corresponding images. An electric counter of post-office type, recording the revolutions of an electric anemometer, was fitted to the camera in place of the usual clock recording system. With the automatic control taking photographs at known time-intervals, each photograph thus recorded the speed and direction of the wind as well as the course and track of each locust, for which both ground-speed and air-speed could be estimated. The material is still in course of analysis; it has been found to provide evidence not only of the behaviour of the locusts but also of the fine structure of turbulent air.

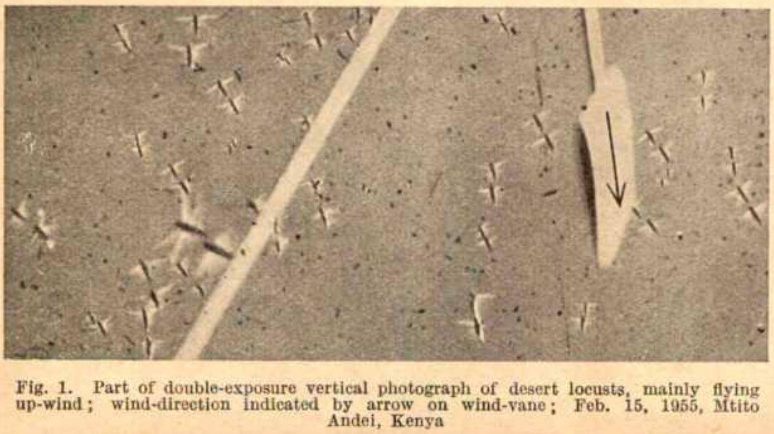

Fig. 1. Part of double-exposure vertical photograph of desert locusts, mainly flying up-wind; wind-direction indicated by arrow on wind-vane; Feb. 15, 1955, Mtito Andei, Kenya

I wish to thank Mr. L. Jackson, of the Williamson Manufacturing Co., Ltd., Willesden, for his co-operation in the manufacture of the shutters.

H. J. SAYER

Desert Locust Survey,
Nairobi, Kenya. Nov. 10.

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Genetical Effects of Radiations from Products of Nuclear Explosions

PROF. J. B. S. HALDANE's letter[1] on the genetical effects of radiation resulting from nuclear explosions raises the question of the relative dose-rates to man and to *Drosophila melanogaster* arising from natural sources of ionizing radiations. It appears to have been generally assumed that the background dose-rates to the gonads of all species are identical, whereas they are likely to differ considerably. The gonads of the *Drosophila*, for example, are exposed to both environmental β- and γ-rays, but those in most mammals are screened entirely from external β-rays and partly even from γ-rays. In Haldane's argument, deductions about radiation effects in *Drosophila* appear to have been carried over to the human case without allowing for this difference.

The suggestion that the radiation dose needed to double the human mutation-rate is a little more than 3 r. per generation is based by Haldane on the following arguments, set out in his Croonian Lecture[2]:

(1) ". . . it follows that human mutation rates are about twice those of Drosophila per nuclear division and about one two-hundredth of those of Drosophila per day."

(2) "It has been calculated that natural radiations and particles of high energy will account for only 0·001 of the mutations in Drosophila".

(3) "It is clear that if so they may account for about a fifth of those in man, and in view of the uncertainty of our knowledge as to the efficiency of particles from K40 and cosmic rays in producing mutations, and the different radiosensitivity of different genes, it is quite possible that radiation may account for most human mutation."

No reference is given for statement (2), but the result quoted is that given by Lea[3], where the fraction 0·001 is deduced on the basis of the known number of mutations produced per unit dose in *Drosophila* and an estimated background dose-rate of 50 ionizations per c.c. per sec., or 2·2 mr. per day, giving 0·05 r. in the life-span of the fly. This dose-rate, given by Lea[3] as a "generous estimate" based on the measurement of the natural leak of ionization chambers, must by its magnitude include ionization due to external β-radiation. By comparison, the background dose-rate which affects human soft tissues, including the gonads, is about 0·26 mr. per day[4], amounting to the value usually quoted of 3 r. in thirty years. This is only one-eighth of the dose-rate used in the calculations on which the fraction of 0·001 in statement (2) is based and, if allowance for this is made in the argument of statement (3), the background radiation could account only for some 2·5 per cent of the human mutation-rate. Moreover, with regard to the role of potassium-40, the estimated dose-rate for man includes the radiation from the tissue content of potassium, the β-particles of which have approximately the same relative biological efficiency as γ-rays[5]. The proportion of the mutation-rate thus attributed to background radiation, namely, 2·5 per cent, is so much less than the figure of 20 per cent derived by Haldane in statement (3) that considerations other than the purely physical must be adduced if his contention that natural radiation accounts for most human mutation is to be supported.

It can be shown that, in this estimation of the fraction of the human mutation attributable to background radiation, the result depends only on the radiation-induced rate for *Drosophila* and the gonad dose to man. The dose-rate assumed for *Drosophila* determines the radiation fraction for that insect but does not affect the fraction estimated for humans. The argument in statement (3), based on the fraction for *Drosophila*, is only valid if the two species receive the same dose-rate.

In applying Russell's data[6] on radiation-induced mutations in mice to estimate the part played by radiation in human mutation, Muller[7] has also translated to the human case an estimated *Drosophila* background dose-rate of 0·045 r. in four weeks, getting, without further qualification, a gonad dose of 17·5 r. in thirty years. This figure is six times that usually taken as representative of areas of the world when the ground radioactivity is not exceptionally high, and is about four times the value which can be deduced from Sievert's results[8] for persons living in the average type of house in Stockholm, a region of admittedly high local radioactivity. Use of a generation-dose of 3 r. in Muller's calculation, however, leads to the conclusion that, in ordinary circumstances, about 4 per cent of the mutation-rate in man could be attributed to background radiation.

In the present lack of more detailed information, it might reasonably be taken that the gonad dose in man is due principally to cosmic rays, local γ-radiation and radiation arising from tissue potassium. The screening factor of tissues overlying the human gonads has not so far been determined, but, for local γ-radiation, it is probably about 2 when averaged for the male and female of the species. In *Drosophila melanogaster*, or other small insects, the dose from external β-radiation and perhaps also a contribution from α-radiation must be added to the γ-ray dose. Tissue potassium, however, will contribute little to the total because the β-particles of potassium-40, having mean ranges of 2 mm. in tissue, can leave only a negligible fraction of their energy in the organs of small dimensions in which they arise.

It is likely that more precise data will become available on the background dose-rates to man and to animal species used in genetical studies. Until then the above considerations would appear to be relevant to the assessment of the part played by background radiation in human genetics.

Note added in proof. Muller (*Bull. Atomic Scientists*, 11, No. 9, Nov. 1955; see *Nature*, Jan. 21, p. 103) has recalculated the fraction of the human mutation-rate attributable to natural radiation as lying between 8 and 16 per cent, on the basis of a gonad dose of 6 r. in 25–30 years. This gonad dose appears to be higher than measurements have so far indicated for regions outside known radioactive areas and is twice the value taken as representative for Britain.

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University, Leeds, 2. Nov. 2.

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I MUST thank Prof. F. W. Spiers for pointing out some of the errors in the basis on which I suggested in 1948 that most human mutations might be due to the action of photons or particles of high energy. Perhaps, however, he was not quite accurate in writing of my "contention that natural radiation accounts for most human mutation". I stated that this was "quite possible", and still hold that opinion. Further, his estimate of the dose received by *Drosophila* may be a little low, since the larvæ spend their life embedded in a medium containing appreciable amounts of potassium. Wright[1], in rough agreement with Spiers, has suggested that about 0·00015 of mutations in *Drosophila melanogaster* are due to radiation and rapid particles. Thus my provisional figure of 20 per cent should probably be reduced to about 2·5 per cent. But Russell[2] finds a mean mutation-rate at seven mouse loci of $2\cdot5 \times 10^{-7}$ per roentgen, which is about fifteen times the rate in *Drosophila*. This suggests that 30–40 per cent of human mutations might be due to high-energy events. Since these estimates are extremely uncertain, I still do not think it impossible, or even very improbable, that most human mutations may be so caused. This hypothesis gives an upper limit to the possible harmful effect of induced radioactivity. Even if, as I hope, this limit is too high by a factor of ten or even a hundred, it seems worth stating, if only because, while suggesting a more serious situation than some physicists have calculated, it decisively negates prophecies of wholesale racial degeneration resulting from experimental atomic explosions.

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Imprinting in Animal Behaviour

A RECENT symposium on imprinting[1] focuses attention on a very important aspect of animal behaviour. Although Thorpe[2] and Verplank[3] have emphasized that imprinting should be considered in relation to other types of learning, one aspect which does not appear to have received much consideration is the question of the relevance of imprinting to ideas on the evolution of learning and of instinctive behaviour.

I would first like to direct attention to an anatomical parallel which may be helpful. In *Drosophila*, heat-shock at an appropriate stage results in the development of the cross-veinless phenotype.

Waddington[4] has shown that selection of those individuals which give the maximal response to the environmental heat stimulus builds up a genotype the reaction norm of which is gradually altered so that cross-veinlessness becomes more and more readily developed. Finally, a stage is reached where the environmental stimulus is no longer necessary, and the animals show the cross-veinless character without the necessity for heat treatment.

In the evolution of a fully innate behaviour pattern evoked by a releaser, it seems possible that a similar process may have occurred. It is difficult to imagine that the process could begin otherwise than with the making of an appropriate response, probably imperfectly performed and subject to trial and error, and with learning of a simple conditioning type involved in the determination of the situation in which the response is made. From this stage there will be rapid selection, on one hand for more perfect performance of the motor response, and on the other for the shortening of the conditioning period, provided the environmental stimulus (or some special part of the total stimulus situation) remains constant. As in the case of cross-veinless, this should result in the building up of a genotype giving the motor response in more and more perfect form with the learning period more and more curtailed. The final result will be the innate pattern evoked by its releaser. But may not imprinting represent a penultimate stage on this route, a stage in which the motor response has been perfected and the learning period has become vestigial but has not yet disappeared ?

If this interpretation is valid, then some curious facts receive a possible explanation. Thorpe[5] has pointed out that in birds the characteristic song of the species is sometimes innate, sometimes imprinted and sometimes fully learnt. Even closely related species may differ in this character in a manner which is at first sight puzzling. If, however, these actually represent stages in the evolution of the innate pattern which has not yet been fully attained in all species, then the situation is comprehensible.

This, however, cannot be the whole story. If we refer again to anatomical parallels, we see that in many cases an adaptive 'developmental response' is innate—the classical case is the callosities of the ostrich ; but in other cases the adaptive response remains a response to a necessary environmental stimulus—muscle hypertrophy with use and skin cornification in response to rubbing are the classical examples. In these latter cases it is easy to appreciate that the adaptive response to the stimulus is a more efficient device than a fully innate response would be. Full cornification of all skin areas potentially liable to rubbing might save the minor discomfort of a few blisters, but would detract greatly from tactile sensitivity and ability to do fine work ; and maximal development of all muscles at all times would be physiologically wasteful. It is therefore relevant to ask, in the case of imprinting, whether in some cases there may not be a selective reason for the retention of the vestigial learning period, that is, whether the imprinting situation may not be more advantageous than a fully innate response would be. I believe that this is true in 'olfactory conditioning' of insects to their animal or plant hosts, of the type described by Thorpe[6] in the case of *Nemeritis*. Here, so long as recognition of the host is imprinted, no genetical change in its chemical constitution will rid it of its insect parasite or predator. Imprinting automatically keeps pace with any such change, whereas in the case of an innate response to a specific chemical stimulus, any mutation giving rise to a changed odour would render the host immune to attack.

There are other cases in which there also appear to be reasons for the imprinting period being retained. Verplank[3] suggests that in species showing parental care imprinting should occur most frequently in those the young of which are active very shortly after birth or hatching. This, I believe, may be a sort of evolutionary concession to the imperfectly developed sensory faculties of the newly born or hatched young. Since they are active and must be protected, a following response is necessary ; but if their sensory faculties are as yet defective and the parent is at first little more than a moving object, then, perforce, the response must be to 'moving object'. At the same time, recognition of the parent must develop as rapidly as possible ; and the most effective solution is what is actually found—an innate following response to any moving object, followed by fairly rapid imprinting. If this is correct, then we should find not only the correlation of imprinting with early locomotion suggested by Verplank, but also that speed of imprinting should be correlated with the development of sensory discriminatory abilities.

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Environmental Factors influencing Gonadotrophin Assay in the Rat

IT has hitherto been assumed that environmental factors play their part in establishing the final characteristics of a population predominantly as modifiers of development[1,2]. This is clearly so when the end-products of cellular activity, as expressed in relatively stable anatomical structures, are under examination. When, however, attention is directed to the potentialities of an organ or tissue by measuring the rate of cellular activity, as in the response of tissues to the action of drugs, the environment can be expected to play a more immediate part.

Studies of the influence of factors in the environment of the immature female rat receiving serum gonadotrophin have revealed that they take a major part in determining not only the sensitivity of the ovarian-weight response, but more especially the variability within the group.

The following is a description of the test and a tabulation of representative results : Two days following weaning at 21–26 days old, each immature female rat is injected subcutaneously with 50 international units of 'Antostab' serum gonadotrophin in 0·2 ml. of distilled water. A similar injection is given on the three subsequent days in the morning, making a total of 200 international units in four days. The rats are killed on the fifth day and the ovaries dissected and weighed (mgm.) fresh after blotting on filter paper. All the injections are made immediately after the operator's hands have been washed, as the presence of smells from fæces or disinfectant on the hand was found to depress the response.

Effect of Changes in Cage Conditions

12/group 4/cage
Litter mates together

Cage	Mean (mgm.)	Coefficient of variation (per cent)
Unchanged	122	13·4
Daily change	87	18·9
Litter mates distributed over treatments		
Unchanged	117	6·6
Daily change	80	14·0

Effect of Non-recurrent Changes in the Social Environment
(In this test the animals were redistributed each day in such a way that they did not encounter any of their litter mates during the rest of the test. Since this test involved a new cage for each rat that was placed with new cage mates, the cages of all the groups were changed each day)

16/group 4/cage
Litter mates together at start

No. of changes	Mean (mgm.)	Coefficient of variation (per cent)
0	99	8·3
4	111	17·9

Effect of the Number of Rats per Cage
(The size of cage was doubled for six and eight rats per cage in order to keep the area per rat roughly constant.)

No. in cage and date of test	Mean (mgm.)	No. in group	Coefficient of variation (per cent)
1 (25.2.55)	80	12	24·3
2	114	12	4·8
4	111	12	7·3
6 (13.5.55)	96	12	18·0
8 (18.5.55)	87	16	15·2
Repeat test			
1 (8.6.55)	160	12	30·6
2	212	12	5·7
4	231	12	8·5

Note that the response in the second test was nearly twice that in the first. This change in sensitivity is occasionally encountered and is usually termed 'seasonal variation'. On this occasion, however, the increased sensitivity lasted only a matter of a few weeks

Effect of Size of Cage

8/group 2/cage

	Mean (mgm.)	Coefficient of variation (per cent)
Large	135	12·1
Medium	151	6·4
Small	157	28·6
	8/group	8/cage
Large	145	8·9
Medium	159	8·9

The medium cage is twice the size of the small cage and the large cage is twice that of the medium. The dimensions of the small cage are 9 in. × 12 in. × 6 in. high.

The response of the rats to follicle-stimulating hormone was clearly modified by the environment in which the rat was placed during the test. It is thus necessary to consider the interaction between the genotype and the environment as taking place in two ways. On one hand, environmental influences will modify development and so bring about variability in responsiveness to drugs within a population. On the other, the environment will cause variation by differences in the responsiveness of different animals to the pattern of stimuli present during the period when the drug is acting. These two categories may well interact to some extent separately with the genetic background. Moreover, since the immediate effect of the environment on the action of drugs appears in large part to be a nervous response, the environmental contribution to variability arising out of influences affecting the behaviour of the animals may be more closely linked to the genetics of the nervous system than to other hereditary differences.

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Environmental Factors affecting Hairiness in Mosquito Larvæ

Rosen and Rozeboom[1] have described a wide range of variation in larval hairiness in the *Aedes scutellaris* group of mosquitoes in Polynesia, and have shown that hairiness is conditioned by some environmental factor common in, but not restricted to, tree-holes. A similar situation has now been discovered in the related *Aedes albopictus* in Singapore; here, larvæ from tree-holes frequently have many of the body hairs longer, stouter and with more branches than in the normal form (Fig. 1). A colony established from hairy larvæ produced only normal larvæ in the laboratory, and the hairiness is clearly produced by some environmental factor. Rearing experiments showed that larvæ raised in the contents of some, but not all, tree-holes became hairy; siblings from the same batch of eggs, reared in tap water plus yeast, or in grass infusion, were normal. The related *Aedes aegypti* also gave hairy larvæ when reared in the appropriate medium, but *Culex fatigans* larvæ were not affected.

Since larvæ mature in five days in grass infusion, but may require up to fifteen days in tree-hole contents, it seemed possible that length of the growth period might affect hairiness. This was tested by rearing at different levels of nutrition; but no such effect could be detected. Also to be considered are the microflora and fauna of the tree-hole water, mainly crustaceans, rotifers, fungi and bacteria. However, cultures produced by inoculation of boiled grass infusion, when tested, gave no increase in hairiness. The living organisms, then, do not appear to play any direct part.

Rosen and Rozeboom[1] offer evidence that hairiness is associated with the presence of organic debris in the water; when this was removed by filtration, normal larvæ resulted. This has been tested for *A. albopictus*. Larvæ were first reared in supernatant fluid from a tree-hole culture, renewed daily; these proved to be as hairy as those from the original culture. Larvæ were then reared in tree-hole water filtered twice through Whatman's No. 1 paper; also, for comparison, in a water suspension of the debris, and in the original water. The two latter cultures gave all hairy larvæ; but those from the filtrate were also hairy, though to a reduced degree—specimens ranged from typically hairy down to almost normal. Finally, water, known to produce hairiness, was passed through a Seitz filter under sterile conditions, and two cultures were set up; in one, air-borne bacteria, etc., were allowed to accumulate, and the

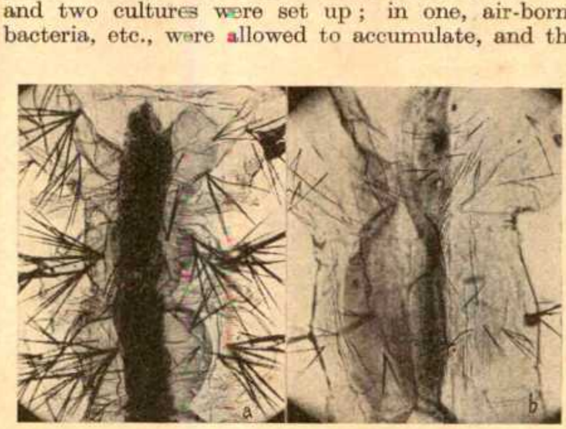

Fig. 1. *Aedes albopictus*, base of larval abdomen: (*a*) hairy larva; (*b*) normal larva

other was re-inoculated with bacterial film from the original culture. Both were almost colourless, as compared with the original deep brown colour, showing that much colloidal matter had been removed. Larvæ of *A. aegypti* were tested in these; growth was slow, and only a few reached maturity, but these showed no increase in hairiness when compared with controls.

These experiments, and those of Rosen and Rozeboom, suggest strongly that the factors producing hairiness reside in some non-living particle, commonly found in tree-hole water. In this case the particles appear to be much finer than was the case in Polynesia. In attempts to produce such particles in the laboratory, tests have been made of infusions of sawdust and suspensions of crude lignin, but none of these has caused any increase in hairiness of *A. albopictus* larvæ.

The nature of these particles is to be investigated further and the full results will be published in due course. Acknowledgments are due to Mr. Cheong Chee Hock for assistance with the photomicrographs, and to Dr. Lim Kok Ann for carrying out the filtration described above.

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Distribution of Physiological Races of *Phytophthora infestans* (Mont.) de Bary in Northern Ireland

Early reports on the distribution of physiological races of *Phytophthora infestans* (Mont.) de Bary showed that specialized races occurred only in districts where resistant potato seedlings were raised and grown[1-3]. Furthermore, it was considered that the unspecialized race, later designated race 0, was the only one to cause disease in commercial potato crops.

More recent work, however, has shown race 4 in Holland[4], and a mixture of race 0 and race 4 in Canada[5], to be the 'common race'.

A further contribution to our knowledge of the distribution of the physiological races of *P. infestans* may now be made from a survey carried out in Northern Ireland. Diseased potato foliage was collected from all parts of the country in 1954 with the view of ascertaining the identity of the most widespread race(s). A further collection from a locality at which many potato varieties, including many *Solanum tuberosum* × *Solanum demissum* hybrids, were being grown was also made in order to obtain as many different physiological races of the fungus as possible. The isolates of the fungus were cultured on pea-meal agar at 15–18° C. and identified by the detached leaf technique, using the variety British Queen and Black's set of single-gene differentials as the differential host series.

From seventeen commercial varieties (all *S. tuberosum* derivatives), seventy-three isolates of the fungus were obtained. Of these, seventy were identified as race 4 and the remaining three as race 0. These latter occurred on the varieties Arran Victory, Ulster Supreme and British Queen.

A total of nineteen isolates was obtained from the hybrid varieties. Of these, six remained unidentified due to lack of pathogenicity, and from the reactions of the remainder race 1, race 2, race 4, races 1, 2, races 1, 4, and races 1, 2, 4 were identified.

It is evident that at least seven physiological races of *P. infestans* are present in Northern Ireland but only one, race 4, has a widespread distribution.

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Rhizoctonia in Natural Grassland Soils

An investigation into various aspects of the microbiology of natural grassland soils is being carried out in these laboratories to serve as a guide in future studies on the microbiology of soils under introduced pasture grasses.

The native 'low tussock grasslands'[1] of New Zealand, with *Poa* and *Festuca* spp. dominant, cover approximately 7 million acres and occur mainly in the South Island. Areas are found from sea-level to 3,000 ft. and they provide extensive grazing for sheep. Three locations were chosen for sampling, one in the North Island on soil derived from volcanic ash (Waiouru) and two in the South Island, one on soil derived from sandstone (Bealey) and the other on soil derived from schist (Alexandra).

In a study of the mycology of these soils, the screened immersion-plate technique[2] and a plating method described by Warcup[3] were employed in parallel studies. Modified screens were employed in the former by constructing them with sides to form a shallow box. When assembled, the sides of the screens fitted closely over the sides of the boxes carrying the agar-coated plates in a manner similar to the fitting of Petri dish halves. 2 per cent distilled water agar was used, and the diameter of the screen apertures was reduced to ⅛ in. Isolations were made from ten sites in each location in the spring, summer and autumn seasons of 1953–54. A total number of 1,669 specimens of mycelium were isolated by the screened immersion plates, and, of these, 831 specimens exhibited features of hyphal morphology similar to those shown by strains of the fungus *Rhizoctonia solani* Kuhn[4].

The predominance of *Rhizoctonia* mycelium as shown by screened plates was a constant feature in the three locations, the fungus occurring in both top and subsoil. In contrast, mycelium of *Rhizoctonia* was not recorded on any occasion with the plating method, although a number of other fungi were isolated. The failure to obtain *Rhizoctonia* by this method may be associated with the difficulty of maintaining transfer cultures on potato dextrose and malt agars.

In the extensive literature pertaining to soil mycology studies, there are few references to the occurrence of *Rhizoctonia* in isolations[5]. The majority of references concerning this much-studied fungus deal with pathogenic activity, and the direct isolation of the organism from sources other than infected material is seldom recorded.

The remarkable occurrence of *Rhizoctonia* in screened plate isolations in contrast to its absence in soil plates led to the application of other techniques to confirm the presence of *Rhizoctonia* mycelium in these tussock grassland soils.

Rossi–Cholodny[6] slides were prepared from the Waiouru soil and on microscopical examination showed widespread occurrence of *Rhizoctonia* mycelium. Examples of the previously recorded[7] hyphal contact association between actinomycetes and soil fungi, including *Rhizoctonia*, were also observed.

Agar-soil films devised by Jones and Mollison[8] were prepared from the soil at Waiouru, and hyphæ exhibiting characteristics associated with *Rhizoctonia* were recorded.

Finally, blocks of soil were brought to the laboratory and broken open along natural fracture lines by hand and directly examined with the aid of the incident-light equipment of a Leitz 'Ortholux' microscope. Mycelium with features associated with *Rhizoctonia* were observed frequently (see Fig. 1). By freehand manipulation with a sterile needle under incident light, portions of such mycelium were removed to normal microscope slides and identification confirmed.

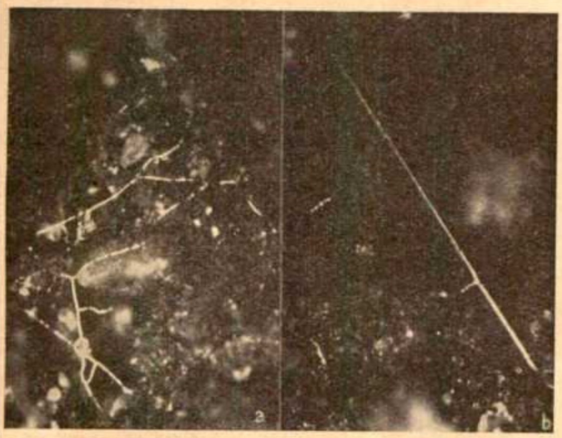

Fig. 1. *Rhizoctonia* hyphæ in natural grassland soil. Photographed by incident light with 35-mm. 'Alpha' reflex camera and extension tube. (*a*) × 75 ; (*b*) × 125 approximately

The results have shown that the soil plating technique was unable to give a true indication of the fungus flora of these soils, as there was no evidence to show the presence of *Rhizoctonia* as active and widely occurring mycelium.

The abundant occurrence of one of the Mycelia Sterilia in screened immersion plates is claimed to be strong evidence that this technique isolates fungus specimens in the mycelial state from soil.

Results will be published in full at a later date.

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Mycelial Aggregation of Sand Soil under *Pinus radiata*

THE influence of soil micro-organisms upon the physical condition of soil has received some attention in recent years. Various workers[1] have shown that fungi and bacteria and their associated metabolic products are capable of affecting the structure of soils. Fungi act largely by the entangling effect of their hyphæ, and bacteria produce cementing and binding substances of a polysaccharide nature[2].

The present communication records the observation in the field of fungal mycelia occurring in quantity in soil, possibly associated with a measurable difference in structure.

During a survey of the sand soils of the Manawatu County, a difference was noted between Himatangi sand under manuka scrub (*Leptospermum* spp.) and this soil under *Pinus radiata*. Himatangi sand before afforestation was a weakly gleyed, yellow-brown sand, melanized by scrub, rushes and sedges. Under manuka the topsoil consists of seven inches of black, sandy soil with a weakly developed and very friable nutty structure (10–20 mm.). Under *P. radiata*, close to the bases of individual trees in a twenty-five year old plantation, the topsoil has a more fluffy appearance and a more strongly developed structure ; individual aggregates, although friable, tend to cling together and some pressure is needed to separate them.

Within the soil under *P. radiata* trees there is a visible, very extensively ramifying network of fungal hyphæ, associated with tufts of yellowish mycelium. The hyphæ occur in great abundance and invest sand particles and aggregates to such an extent that a degree of physical cohesion is imparted (see Fig. 1).

Three samples of Himatangi sand under manuka and three under *P. radiata* were taken from nearby sites and several physical measurements were made (see Table 1).

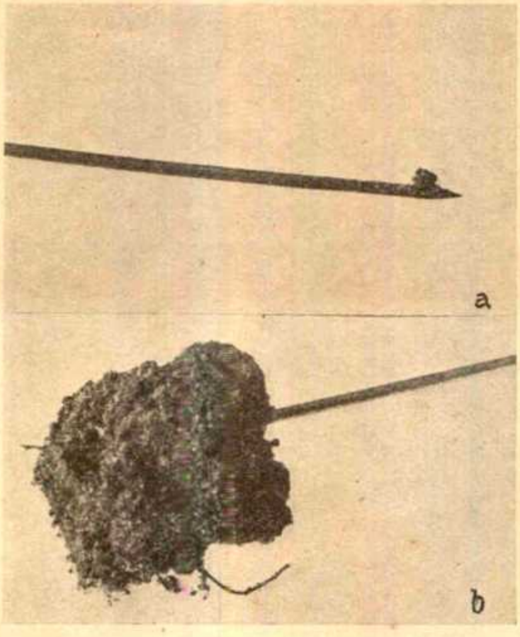

Fig. 1. Aggregation of sand soil by fungal hyphæ : (*a*) under *Leptospermum* spp., (*b*) under *P. radiata*. Approximately natural size

Table 1

	Under *P. radiata*	Under *Leptospermum* spp.
	Means and 95 per cent confidence levels	
Total porosity (per cent)	58·2 ± 2·9	58·1 ± 4·1
'Large pores' (per cent)	24·9 ± 7·8*	12·3 ± 10·5

* Significant difference at the 5 per cent level.

Total porosity per cent is defined as :

$$\frac{\text{Volume of air in undisturbed sample}}{\text{Total volume of undisturbed sample}} \times \frac{100}{1}$$

The percentage of 'large pores' was measured by saturating undisturbed samples with water and then draining at a tension of 50 cm. water ; it is expressed as :

$$\frac{\text{Volume of pores drained}}{\text{Total volume of undisturbed sample}} \times \frac{100}{1}$$

No difference in stability of soil aggregates between the two sets of samples could be determined by standard wet-sieving methods, because the aggregates from both sites disintegrated with these techniques. However, when transferring saturated samples it was noted that a certain amount of the samples fell away. This manipulation was standardized and samples were weighed before and after handling, and the 'ability of aggregates to cohere' is expressed as :

$$\frac{\text{Weight of sample after handling}}{\text{Weight of original sample}} \times \frac{100}{1}$$

The large difference in variances between the two sites makes it impossible to compare these results by a t test. However, there appears to be a relatively greater cohesion in aggregates in samples taken from under *P. radiata* ; for example,

Under *P. radiata*	Under *Leptospermum* spp.
98·9	93·3
98·9	95·6
98·7	89·2

As the total porosity of the two soils is not significantly different, it is possible that the increase in 'large pores' per cent and the probable increased cohesion in soil under *P. radiata* could be attributed to the entanglement of soil particles by extensive fungal mycelia.

Microscopical examination showed that the predominant hyphæ possessed abundant clamp connexions, indicating that the mycelia largely belonged to species of the Basidiomycete group. Sporophores of *Rhizopogon rubescens*, *Clathrus cibarius* and *Geastrum plicatum* were often collected and small agarics occasionally seen on the area. It is not known whether the mycelia are of one species or of a mixture of several species. The visible tufts of yellowish mycelium appeared to be loose strands of many hyphæ (see Fig. 2) extending between decomposing plant fragments, whereas the more generally occurring hyphæ ramified extensively about sand particles and small aggregates (see Fig. 3) and particularly about decomposing fine root fragments. (Figs. 2 and 3 were photographed by incident light with a 35-mm. 'Alpha' reflex camera and extension tubes.)

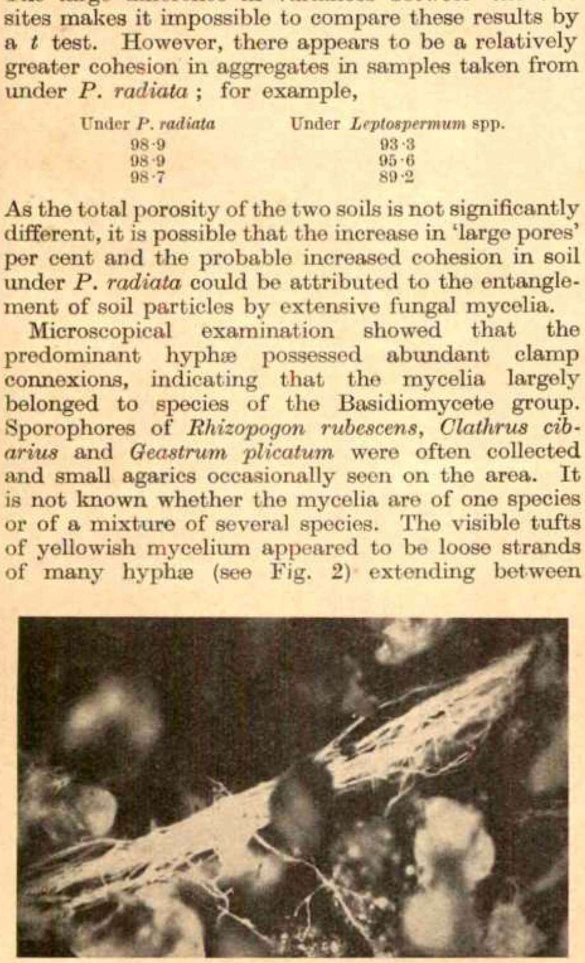

Fig. 2. Hyphæ forming a loose strand in sand soil under *P. radiata*. × 75 approximately

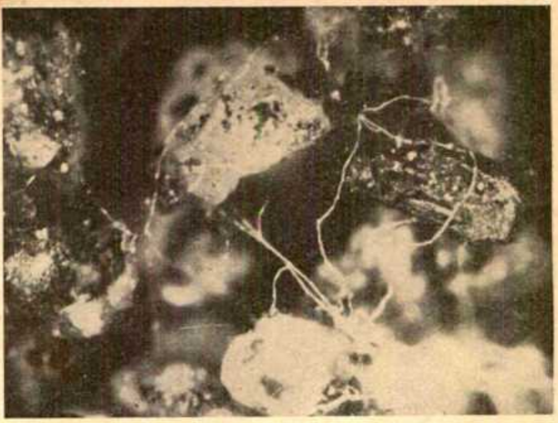

Fig. 3. Hyphæ investing sand grains in sand soil under *P. radiata*. × 160 approximately

Hyphæ were of four types : (*a*) yellowish, roughened-encrusted, septate hyphæ, 3–4 microns in diameter with clamp connexions ; (*b*) brown, very slightly roughened, septate hyphæ, 3–4 microns in diameter without clamp connexions ; (*c*) hyaline, roughened-encrusted, septate hyphæ, 2·0–2·5 microns in diameter with clamp connexions ; (*d*) yellowish, smooth, septate hyphæ, 3–4 microns in diameter with clamp connexions. Types (*a*) and (*b*) were associated with the strands of mycelium, whereas (*c*) and (*d*) occurred more generally within the soil.

The occurrence of Basidiomycete mycelia in such abundance in sand soil under *P. radiata*, sufficient, apparently, to produce a measurable difference in structure, appears worthy of record. Further observations are being carried out on this phenomenon and on grey 'bleached spots' occurring in this sand, which may be associated with the above condition.

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Aug. 12.

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A Gigantic *Holoptychius* from Dura Den

THE Upper Old Red Sandstone deposits of Dura Den in Fife are world-famous as a source of fossil fish, among which the dominant genus is the crossopterygian *Holoptychius*. Extensive collections are extant from excavations sponsored by the British Association in 1913 and from the work of earlier investigators.

A new fossiliferous stratum, some 35 ft. above the classical horizon, was found at Dura Den in 1954. From this there has just been recovered the central region of a *Holoptychius flemingi* very much larger than any individual yet recorded. Measurements suggest a fish from eight to nine feet in length and a foot in girth. The remarkable size of this specimen merits a mention of the discovery.

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A Biological Factor inhibiting the Effect of Cortisone on Antibody Formation

PREVIOUS investigations in the adult white rat[1] have shown that intramuscular administration of cortisone can depress the hæmolysin response after a single intraperitoneal injection of sheep erythrocytes. The effect of cortisone is dependent on (1) the dose of antigen, (2) the dose of hormone, and (3) the time of administration of hormone (location in time in relation to the antigen injection). At the respective dose-levels (per 100 gm. weight) of 4 mgm. a day of cortisone and 2 ml. of a 0·03–0·3 per cent suspension of sheep erythrocytes the following time limits were found: a maximum effect was obtained when cortisone was given for three days, beginning two days before the antigen injection and ending with an injection on the day of antigen injection. The lack of significant effect of hormone injections after the day of antigen injection indicates that an early phase of the production of antibody is disturbed by the action of cortisone.

Of considerable interest in this connexion are investigations on the effect of total body irradiation on antibody formation (see footnote 2 for references). Several reports have indicated that a short initial period of the antibody production process is especially sensitive to damage produced by exposure to X-rays. There is thus a striking temporal similarity between the effects of cortisone and X-rays on antibody metabolism.

Investigations by Jacobson and his associates[3] on rabbits and rats have demonstrated that the depressing effect of X-rays on antibody formation is largely abolished by lead shielding of the spleen during irradiation. In the following experiments it has been shown that spleen or thymus cells from intact donors have a similar protective effect on rats treated with cortisone.

The test effect was the primary hæmolysin response in the rat and the experimental conditions those outlined in the first paragraph. Cortisone was given for six days, beginning four days before the antigen injection. The animals were bled on the fifth and seventh day after the antigen injection. The hæmolysin titre of serum was determined by a conventional method (titration by double dilution steps, guinea pig complement, sheep cells, incubation at 37° C., centrifugation and reading against a scale). The cell suspensions were prepared as follows: spleens or thymus glands were taken from adult rats weighing 200 gm. and 300 gm. The organs were finely minced, passed through a metal screen and suspended in a mixture of saline (2 parts) and Tyrode solution (1 part). Larger fragments, connective tissue, etc., were eliminated by filtration through sterile gauze. The cells were spun down at 1,500 r.p.m. for 10 min. and then resuspended in saline–Tyrode. The volume of the suspension was adjusted to contain cells from half a spleen (or a corresponding amount of thymus) in 3 ml., which constituted the standard dose. This dose, which was injected intraperitoneally, contained between 3 × 10^8 and 7·5 × 10^8 nucleated cells. Most of these cells appeared to be in a good condition when examined in a phase-contrast microscope.

Table 1. EFFECT OF INTRAPERITONEAL INJECTIONS (DURING 4 DAYS) OF HOMOLOGOUS SPLEEN CELLS FROM INTACT DONORS ON ANTIBODY RESPONSE IN RATS TREATED WITH CORTISONE
Immunization: single intraperitoneal injection of sheep erythrocytes (on day 0). Antibody: hæmolysins measured on the fifth day (day 0 + 5) after the antigen injection and expressed as negative logarithm of the titre

Group	Treatment	No of rats	Hæmolysin titre		P
			Mean ± ε (mean)	Difference ± ε (diff.)*	
I	Suspending agent of hormone	5	3·44 ± 0·44†	2·30 ± 0·64	< 0·01
II	Susp ag. horm. + spleen cells‡	5	4·38 ± 0·50†		
III	Cortisone + spleen cells‡	5	4·24 ± 0·40	3·10 ± 0·62	< 0·01
IV	Cortisone = controls	5	1·14 ± 0·47	—	

* Difference between the group mean and the mean of the control group (IV).
† Difference between the means of group II and I = 0·94 ± 0·57 ($P > 0·1$).
‡ Spleen cells were given from day 0 until day + 3.

In the first experiment (Table 1) two injections of spleen cells were given daily for four days beginning 5 hr. after the antigen injection. Cortisone alone produced a significant reduction of the hæmolysin response. When spleen cells were administered to animals treated with hormone, the mean antibody titre was significantly enhanced and there was no depression of the antibody response. In other experiments (Table 2) it has been shown that the same result can be produced by only one injection of the same dose of spleen cells if it is given on the day of antigen injection (hitherto injected 2 hr. after the antigen). Thymus cells seem to have the same effect (Table 2). Injections of spleen cells on the first, second and third day after the day of antigen injection have not been significantly effective. As shown in Table 2, the administration of spleen cells one day (22 hr.) before the antigen injection did not protect antibody production against cortisone.

In two experiments it has been shown that disintegration of spleen cells (grinding in a homogenizer at high speed) destroys their protective effect on antibody formation. Subcutaneous administration of intact cells gave no demonstrable enhancement of antibody response in animals treated with hormone.

Table 2. EFFECT ON ANTIBODY RESPONSE IN CORTISONE-TREATED RATS OF A SINGLE INTRAPERITONEAL INJECTION OF HOMOLOGOUS SPLEEN CELLS ON THE DAY BEFORE (DAY – 1) OR THE DAY OF (DAY 0) ANTIGEN INJECTION, OR (2) HOMOLOGOUS THYMUS CELLS ON DAY 0. Immunization and antibody determination as in Table 1, with the exception that hæmolysins were measured on day + 7.

Group	Treatment	No. of rats	Hæmolysin titre		P
			Mean ± ε (mean)	Difference ± ε (diff.)*	
I	None	9	1·89 ± 0·36	1·50 ± 0·41	< 0·01
II	Cortisone + spleen cells day – 1	8	0·35 ± 0·24	–0·04 ± 0·31	—
III	Cortisone + spleen cells day 0	7	3·43 ± 0·44	3·04 ± 0·45	< 0·001
IV	Cortisone + thymus cells day 0	9	2·03 ± 0·51	1·64 ± 0·55	< 0·01
V	Cortisone = controls	9	0·39 ± 0·20	—	

* Difference between the group mean and the mean of the control group (V).

The present results suggest that the spleen and thymus cells contain or, more probably, produce a factor, or have a cellular function, essential for some initial, cortisone-sensitive phase of the antibody production process.

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Inhibition of Influenza Virus Hæmagglutination by a Brain Lipid Fraction

THERE exists a rather ill-defined group of complex lipids that could be subsumed under the name of 'mucolipids'. These substances, while possessing constituents commonly considered characteristic of the cerebrosides, share some properties with the mucoproteins. Thus, they are soluble in water and include amino-sugars and a nitrogen-containing acid which gives rise to a violet colour with Bial's reagent and to a colour reaction with *p*-dimethylaminobenzaldehyde without previous treatment with alkali. We shall here refer to the substance yielding a direct Ehrlich reaction as 'direct chromogen', since we are not in a position to decide whether we are dealing with sialic acid[1], which was first isolated from submaxillary gland mucin[2], or with neuraminic acid[3] found in a group of lipids later designated as gangliosides[4]; nor indeed whether these two compounds differ.

Lipids of this type appear to have been encountered frequently in the older literature; but two fractions have been investigated in some detail, namely, the gangliosides occurring in nervous and other tissues[4,5], and strandin, a high-molecular lipid complex from brain[6]. The latter, to be exact, is stated to contain less than 1·5 per cent of neuraminic acid; but there can be little doubt that, as we shall show below, by a procedure similar to one of the methods used in the isolation of strandin (the 'partition-dialysis method'[6]), a lipid fraction can be obtained that contains about 20 per cent of 'direct chromogen' (compare also Chatagnon and Chatagnon[7]).

We have found that the lipid material isolated from the grey matter of ox brain by partition-dialysis, though having much in common with the gangliosides, can be distinguished from the latter: it possesses, in contrast to the ganglioside preparations tested, a strong inhibiting action on the agglutination of chicken erythrocytes by influenza virus. The isolation of the inhibiting lipid preparation was carried out at low temperature. Portions of freshly obtained grey matter were treated with 10 parts (v/w) of chloroform–methanol (2 : 1, v/v) in a high-speed mincer for 2 min.; the filtrate was subjected to dialysis in large 'Cellophane' bags against frequent changes of a 30-fold volume of distilled water for three days; the aqueous portion of the dialysis residue was reduced to about 0·7 per cent of its initial volume by rapid evaporation *in vacuo* at 30°; the concentrated solution was, after repeated dialysis as before, clarified by centrifugation (2,100 *g*, 30 min.) and freed of water by evaporation in the frozen state in a vacuum.

A typical preparation (prep. *IL*-1) accounted for about 0·3 per cent of the starting material and had nitrogen 3·9 per cent, phosphorus 0·7 per cent and a low iodine value (about 17). It contained 23 per cent hexose, identified as galactose, 4·5 per cent amino-sugar, identified as chondrosamine, and 20 per cent 'direct chromogen'. The absorption spectra resulting from the reaction of the chromogen with *p*-dimethylaminobenzaldehyde, diphenylamine, and Bial's reagent closely corresponded to those reported for sialic acid[8]. The study of other components is not yet completed; for example, a fatty-acid fraction and a number of amino-acids, of which several have been identified tentatively and which appear to constitute a polypeptide moiety yielding a weak biuret reaction and a single dinitrophenyl derivative.

Influenza virus (type *A*, *PR*8 strain), in the form of infective chorioallantoic fluid, was heated to 56° for 30 min. for use as 'indicator' virus in tests for inhibition of hæmagglutination. Under the conditions of assay, five hæmagglutinating units were regularly inhibited by a minimum of 10–20 μgm. of preparation *IL*-1, and in concurrent assays by a minimum of 2–5 μgm. of urinary mucoprotein[9].

For use in enzymic experiments, concentrated influenza virus (*PR*8) was prepared by centrifugation of fully infective chorioallantoic fluid (25,000 *g*, 1 hr.). The hæmagglutinating titre of the sedimented virus, taken up in a small volume of buffered saline (nine parts of 0·9 per cent sodium chloride, one part of 0·01 *M* phosphate buffer, *p*H 7·2) was twenty to thirty times that of the original chorioallantoic fluid. The lipid preparation, after incubation with concentrated active virus at 37° for 22 hr., lost completely its capacity to inhibit 'indicator' virus hæmagglutination, and 24·5 per cent of the 'direct chromogen' was split off in a dialysable form. Lipid treated with concentrated active virus at 4° for 22 hr., however, lost virtually none of its inhibitory potency, and no dialysable split products were found. Incubation with the receptor-destroying enzyme of *Vibrio cholerae* (30°, 24 hr.) also brought about complete inactivation and removed 39 per cent of the 'direct chromogen'. The power to inhibit virus hæmagglutination was also abolished by treatment with crystalline trypsin.

The success of further purification of the lipid material depended upon the procedures employed. When the separation by 'partition-dialysis'[6] was again applied to the isolated preparation, 64 per cent of the starting material was recovered as a fraction of undiminished inhibitory activity, containing 21 per cent of 'direct chromogen', and soluble in water, chloroform–methanol, moist benzene, and methanol. Procedures in which glacial acetic acid or pyridine were employed resulted in inactivation, though refluxing for 1 hr. in boiling chloroform–methanol or heating at 37° for 24 hr. in neutral aqueous solution did not affect the activity materially.

Two ganglioside preparations were also examined and proved completely inactive as inhibitors of hæmagglutination; they had been isolated, respectively, from the brain of a case of Tay-Sachs idiocy and from ox brain. The first-mentioned preparation also underwent 'partition-dialysis', as did the active lipid fraction *IL*-1 discussed before; it contained 32 per cent galactose, 5·4 per cent chondrosamine (as the hydrochloride), and 24 per cent of 'direct chromogen'. No amino-acids could be found in paper chromatograms of an acid hydrolysate. The receptor-destroying enzyme of *V. cholerae* attacked this lipid to a slight degree, effecting the detachment of 7 per cent of the total chromogen.

The presence of the 'direct chromogen' clearly is not the only requisite for inhibiting activity[10]. One gains the impression that the lipids discussed here may belong to a series of substances of increasing complexity and molecular size, leading from the monomeric cerebrosides to the gangliosides and then to mucolipids in which the presence of a polypeptide moiety is necessary for the inhibitory activity to become noticeable.

This work, some aspects of which will form the subject of a detailed communication, has been supported by the Life Insurance Medical Research Fund and the Office of the Surgeon General, Department of the Army, Washington, D.C. One of us (A. R.) held a predoctoral research fellowship of the United States Public Health Service. We are grateful to Dr. R. H. Barnes, of Sharp and Dohme, Inc., for the receptor-destroying enzyme.

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Levels of Thyroid and Thyrotrophic Hormones in the Blood of Rats at Various Stages of the Œstrous Cycle

A COMPARISON was made between the levels of thyroid and thyrotrophic hormones in the blood of female albino rats during the four stages of the œstrous cycle. The procedure used was that adopted by D'Angello and Gordon[1], namely, 'the stasis tadpole method'. Serum was obtained from the blood of the rats, which were divided into four groups of five or six each according to the vaginal smear reading. These groups were of pro-œstrous, œstrous, metœstrous and diœstrous rats. The tadpoles were divided into five groups, one of which was the untreated control. The others were injected with seven injections of 0·01 ml. of serum obtained from the four groups of rats on alternate days. Twenty-four hours after the last injection the tadpoles were killed with chloroform, fixed in susa and stored in 80 per cent alcohol. Their hindlimbs were then measured with a micrometer; this was used as a criterion of thyroid hormone activity. The height of the epithelial cells of the thyroids of tadpoles was used as an indication of the level of thyrotrophic hormone in the blood of the different groups of rats. The results are shown in Table 1.

Table 1. THYROID AND THYROTROPHIC HORMONE-LEVELS IN THE BLOOD OF RATS AT THE STAGES OF THE ŒSTROUS CYCLE

Phase of cycle	No. of tadpoles	Mean increase of hindlimb above control (mm.)	Mean increase of height of epithelial cells above control
Pro-œstrus	17	1·02 ± 0·12*	0·69 ± 0·14*
Œstrus	13	1·58† ± 0·11	1·89† ± 0·15
Metœstrus	15	1·07 ± 0·08	0·64 ± 0·07
Diœstrus	22	0·84 ± 0·06	0·66 ± 0·07

* Standard error. † Significantly higher than other groups.

It appears clearly that thyroid activity increases during the œstrus phase when compared with the other three stages of the cycle. The rate of metamorphosis of the tadpoles injected with the serum obtained from this group of rats was the greatest. The increase of hindlimb above the control was 1·58 ± 0·11 mm. The rate of metamorphosis was at its lowest in the tadpoles injected with the serum obtained from diœstrous rats.

The level of thyrotrophic hormone in the blood of these animals parallels closely the state of the thyroid. Thyrotrophic hormone was found to be produced at its highest level during œstrus. These findings agree with previous observations which indicated that the uptake of iodine-131 by rat thyroids is at its highest during œstrus[2], and that the level of thyrotrophic hormone in the rabbit is higher during œstrus than during pseudopregnancy[3].

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Amino-Acid Metabolism of *Nicotiana* Leaves after Removal from Plant

VICKERY *et al.*[1] have shown that after removal from the plant, *Nicotiana* leaves show a marked increase in the total soluble nitrogen (ammonia, amide and amino-nitrogen) whereas the insoluble protein nitrogen decreases. An attempt has been made in the present work to study, in detail, the amino-acid metabolism in such leaves using the technique of horizontal migration paper chromatography[2].

The free amino-acids originally present in the leaves, at 0 hr., show interesting variations after plucking. Though the content of tyrosine (R_F 0·66) does not show any notable increase, alanine (R_F 0·59) and glutamic acid (R_F 0·52) increase up to 120 hr. in the dark, after which they show a marked decrease. In light alternated with twelve hours of darkness, alanine and glutamic acid go on increasing until 144 hr., after which they show a slight decrease at 168 hr. Proline (R_F 0·63) shows interesting variations under conditions of both light and dark. Proline starts disappearing from the detached leaves when the latter are kept in the dark and becomes untraceable at 144 hr.; but in light alternated with darkness, it persists even up to 168 hr. without decreasing.

The content of aspartic acid (R_F 0·47) shows marked variations with time after removal from plant. It increases considerably during the first 72 hr. in the dark, after which it starts decreasing, reaching its minimum at 192 hr. It is important to note that in light (alternated with 12 hr. of darkness) the content of aspartic acid continues to increase, even up to 168 hr. The content of histidine–lysine (R_F 0·36) in the plucked leaf increases progressively in light and continuous dark even up to 168 hr. In the later stages, due to excessive formation of asparagine, the histidine–lysine band becomes superimposed by the thick asparagine band to form an asparagine–histidine–lysine complex. Asparagine (R_F 0·37) makes its appearance in the free state at 48 hr. after plucking and continues to accumulate up to at least 192 hr.

Apart from the changes in the various free amino-acids originally present in the leaves, other amino-acids also appear. Phenylalanine (R_F 0·83), and valine and methionine (R_F 0·76), which cannot be traced at 0 hr., make their appearance only 48 hr. after plucking and in the dark. They increase up to 120 hr., when they show the maximum depth of the bands. At 144 hr. and onwards valine–methionine is absent, but phenylalanine persists up to 192 hr. In light alternated with twelve hours of darkness, at 48 hr. after plucking, only valine and methionine appear, while phenylalanine appears only at 72 hr. Their content then increases up to 144 hr. in light, after which they are slightly reduced. It is to be noted that valine–methionine is not altogether lost even up to 168 hr. after plucking the leaves and in the light.

Multiple development of the chromatograms has shown that in light (alternated with 12 hr. of darkness), a new band, of R_F 0·51 lower than aspartic acid and higher than asparagine, is formed just after 48 hr. after plucking and goes on increasing up to 168 hr. This band is absent in the leaves kept in the dark. Multiple development of the chromatogram separates the lower bands, but it results in the formation of a phenylalanine–valine–methionine complex at the top as a thick broad band.

The possibility exists that the new range of free amino-acids are formed as a result of hydrolysis of insoluble leaf protein. The decrease with time in the amount of free amino-acids in leaves after removal from the plant suggests these are probably being used up in respiration. The persistence of proline in the light and the appearance of the new band suggest that some light-reacting systems are also involved in the metabolism of plucked *Nicotiana* leaves.

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Nuclear and Cytoplasmic Volumes in the Hepatic Cells of the Fœtal Sheep

In an investigation of the development of the individual hepatic cell in the fœtal sheep, a new method was used to measure the volume of the nucleus and cytoplasm at different stages of development.

Material was fixed in Rossman's fluid (9 parts of a saturated alcoholic solution of picric acid to 1 part of 10 per cent neutral formalin), embedded in paraffin, sectioned at 5μ, and stained with hæmatoxylin and eosin. Measurements of the apparent length and breadth of twenty nuclei were made on each section. Nuclei were chosen at random, but measurements were made only on those the greatest diameters of which lay within the section as seen by focusing up and down. From these measurements the nuclear volume was calculated, making the assumption that the nucleus was in the form of a prolate spheroid with greatest diameter in the plane of the section and not at right angles to it. This method may involve a slight under-estimate of the nuclear volume in rare cases (in fact the greatest diameter usually lies in the plane of the section at right angles to the direction of 'section compression'), but it is unlikely to affect significantly the averages for each section. The mean nucleo-cytoplasmic ratio was then measured by the method of Chalkley[1]. Four series of observations each containing twenty-five 'hits' on nuclei were made for each liver, the average of the four values of the ratio so obtained was taken and the standard error of the mean used as an index of the error of the estimate. From the values of nuclear volume and nucleo-cytoplasmic ratio thus obtained, the cytoplasmic volume and the total cell volume were calculated.

The results of the measurements so far made are shown in Table 1. Although they provide no statistically significant evidence of change in the nuclear, cytoplasmic or total cell volumes between the 29-mm. stage and term, there is a suggestion that the nuclear volume may diminish slightly and the cytoplasmic volume increase; and this is supported by the fact that there is a statistically significant increase in the nucleo-cytoplasmic ratio over the same period. The positive regression coefficient is significantly different from zero ($0·05 > P > 0·025$). The results for the 22-mm. and 26-mm. fœtuses further suggest that prior to the 29-mm. stage the cytoplasmic volume and thus the nucleo-cytoplasmic ratio are increasing rapidly.

This apparent turning point at the 29-mm. stage may be correlated with the fact that histochemical investigation shows that glycogen first appears in the sheep fœtal liver at that time. As demonstrated in the chick[2], the appearance of glycogen coincides with "the loss of enzymatic activity necessary for the respiratory catabolism of glucose" and thus marks an important step in the development of the hepatic cell. It may well therefore be associated with a

Table 1

Serial No.	Fore-head–rump length (mm.)	Mean nuclear volume (cu.μ)	Mean cyto-plasmic volume (cu.μ)	Mean total cell volume (cu μ)	Mean nucleo-cytoplasmic ratio
1	22	127±9	368±36	495±49	2·91±0·20
2	26	135±6	514±39	649±49	3·79±0·23
3	29	150±9	652±45	802±55	4·34±0·17
4	38	171±8	756±68	927±83	4·43±0·35
5	54	130±6	684±39	814±46	5·25±0·17
6	56	149±7	894±55	1,043±65	6·01±0·22
7	61	156±8	824±82	980±97	5·27±0·44
8	106	142±6	716±62	858±74	5·05±0·38
9	116	166±8	818±84	984±101	4·94±0·46
10	131	114±8	541±46	655±56	4·74±0·21
11	230	137±6	679±47	816±56	4·96±0·26
12	265	155±8	707±37	862±45	4·57±0·08
13	290	147±6	741±84	888±100	5·56±0·58
14	345	159±6	998±80	1,157±93	6·29±0·48
15	375	127±8	675±56	802±67	5·30±0·27
16	380	168±8	1,158±80	1,326±91	6·88±0·33
17	440	126±6	644±59	770±71	5·09±0·41
18	450	112±3	675±48	787±56	6·05±0·40

The index of variation used is the standard error of the mean.

retardation in the rate of growth of the hepatic cell cytoplasm.

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Synthesis of Long-Chain Fats by Bacteria isolated from Human Fæces

WE have recently isolated an organism from the stool of an adult human subject that is capable of synthesizing significant quantities of fatty material, which become visible on the surface, from a fat-free medium. The fat is neutral in character, liberating fatty acids on hydrolysis, and can be removed from the surface by dissolving it in ether. It is colourless and melts below body temperature. Some of its properties are shown in Table 1. Relatively little fat is present in the medium and organisms, and has not so far been investigated.

Table 1

Saponification value	190	Reichert value	42·1
Acid equivalent	294	Free fatty acids (as oleic)	0·27 per cent
Iodine value	49·5	Phospholipid (as lecithin)	0·7 per cent

The fat was prepared by inoculating a fat-free glucose peptone medium and allowing the fat to accumulate on the surface. The organisms were Gram-positive, and were observed in short chains and pairs. The organisms do not retain sudan black, but the fat produced in the medium stains readily with 50 per cent sudan black or sudan IV. (The organisms appear to resemble *Streptococcus faecalis.*) The growth of bacteria and the synthesis of fat are stimulated by the presence of folic acid as shown in Fig. 1.

These organisms were obtained from a patient with steatorrhœa under treatment with folic acid, and from the amounts obtained under these *in vitro* conditions, namely, 200 mgm. in four days in 10 ml. of medium, it would appear that fat synthesis of this type might make a significant contribution to fæcal fat. This possibility is being studied in other patients, and at the same time the properties of the fat and the factors affecting the quantity of fat formed are being more fully investigated.

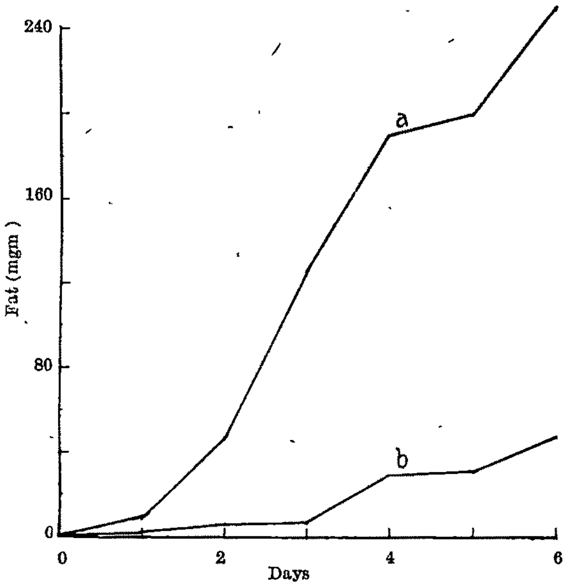

Fig. 1. 10 ml. glucose/peptone in each tube. (*a*) With folic acid; (*b*) without folic acid

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Aug. 23.

Amino-Acid Patterns of Urine and Blood Plasma in a Cystinuric Labrador Dog

IT was shown by Lassaigne more than 130 years ago that cystine calculi may occur in the urinary tract of dogs. Canine cystinuria has since been recognized widely. Thus, more recently, 3 per cent of urinary calculi removed surgically from dogs in Holland and in Denmark[1] were composed of cystine, and 18 per cent in England[2], where White found them to be the commonest type (55 per cent of cases) causing urethral impaction. Canine cystinuria, with or without calculus formation, is said to be common also in France. Cystine calculi have been recorded from many breeds of dogs[2-4], but not hitherto from the Labrador. Furthermore, no study of the amino-acid patterns of the urine and plasma has previously been described; and hence it was not known if canine cystinuria is etiologically analogous with human cystinuria. If it were so, the usefulness of the cystinuric dog as a model for investigation of the human condition would be enhanced.

The subject of this communication is a male Labrador which first developed acute urinary retention in June 1951 when seven years old. Numerous small vesical calculi, and some impacted in the urethra near the penile bone, were removed surgically. A similar attack followed in November 1952, and also required urgent surgery. The animal was then placed on a reduced protein diet, and daily potassium citrate to alkalinize the urine; but, in spite of this, another crisis requiring surgical intervention occurred in October 1954.

Dent and Rose[5], in a study of fifteen cases of human cystinuria by means of two-dimensional paper chromatography, found that excessive urinary excretion of lysine invariably accompanied cystine, and that abnormal excretions of arginine and ornithine varied. The opportunity was therefore taken, after the second attack in this dog, of determining whether or not the amino-acid patterns in the urine and the plasma differed from those in human cystinuria.

One specimen of urine was obtained from the dog in November 1954, and a second specimen five weeks later. A sample of plasma was obtained with the second specimen of urine. Both specimens of urine gave strongly positive reactions for cystine with the sodium cyanide/nitroprusside test, and the typical cystine crystals were observed in the deposits after centrifuging.

The plasma was deproteinized, and the resultant liquid and the two specimens of urine desalted, oxidized and chromatographed by methods outlined by Dent[6]. 500 μl. of deproteinized and desalted plasma, and amounts of desalted urine corresponding to 250 μgm. of total nitrogen (Kjeldahl), were spotted on to 60-cm. squares of Whatman No. 4 paper, and were run in phenol saturated with water, followed by collidine–lutidine. The final positions of the amino-acids were revealed by spraying with a solution of 0·1 per cent ninhydrin in butanol, and examining after 24 hr. at room temperature.

Unidimensional chromatograms on Whatman No. 1 paper were run in butanol/acetic acid/water (4 : 1 : 5) using amounts of urine equivalent to 250 and 500 μgm. of nitrogen. No ornithine was detected after treatment with vanillin followed by alcoholic potash and heating. Histidine was detected in both specimens of urine by repeating the unidimensional runs in collidine–lutidine, and spraying with Pauly reagent.

In the first specimen of urine, cystine and lysine predominate, superimposed on a pattern consisting of glycine and taurine with traces of alanine, glutamine, serine, glutamic acid and methyl histidine. Traces of leucine and/or *iso*leucine and aspartic acid were obtained in the first specimen only, whereas threonine (confirmed by running with an authentic specimen) and β-alanine and/or citrulline were detected in both specimens of urine. Arginine was not detected in abnormal quantities.

In contrast to the affected dog, chromatography of a catheter specimen of urine obtained as a control from a healthy Labrador bitch nine months old revealed only a trace of cystine and no lysine. The amino-acid pattern consisted of glycine and taurine, with traces of alanine, glutamine, serine, methyl histidine and glutamic acid. The nitroprusside test for cystine was negative, and no cystine crystals were detected in the deposit after centrifuging the urine.

The amino-acid pattern of the plasma from the affected dog shows a small spot due to cystine (in contrast with the large spot found in the urine), supporting the view that we are dealing here, as in the human form of the disease, with a defect of tubular reabsorption of cystine from the glomerular ultrafiltrate. A similar mechanism would also account for the presence of lysine and threonine in the urine, since neither of these amino-acids was detected in the urine of the control animal.

The amino-acid pattern of the urine from this cystinuric dog is therefore, apart from threonine, identical with that found in cases of human cystinuria, while the finding of a low plasma-cystine points to a similar etiology.

Our thanks are due to Dr. Leon Duckett, who performed the surgery. One of us (C. W. C.) wishes to thank the Nuffield Foundation for a grant.

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Formation of Calcium Superoxide

In connexion with an investigation on the formation and structure of certain alkaline-earth peroxides and superoxides, the dehydration of the compound $CaO_2.8H_2O$ has been studied. It has been proved that drying this hydrate with phosphorus pentoxide at room temperature will not yield pure CaO_2, but a substance with the following approximate composition: $Ca^{2+}(O_2^{2-})_{0\cdot87}(O_2^{-})_{0\cdot05}(O^{2-})_{0\cdot11}(H_2O)_{0\cdot10}$

The presence of superoxide ion (O_2^-) has been established by means of both chemical methods and by measuring the magnetic susceptibility.

The composition of this substance indicates that the dehydration is associated with a disproportionation of the following kind:

$$O_2^{2-} = (1-y)\,O_2^{2-} + \tfrac{2}{3}y\,O_2^{-} + \tfrac{2}{3}y\,O^{2-}$$

where y represents the degree to which the peroxide ions (O_2^{2-}) have been disproportionated.

Since the substance is hydrous, it is probable that the oxide ion exists as a hydroxide ion. Warming the dehydration product leads to an increase in the y-value, which, in the temperature interval 100–250° C., approaches 0·5. Heating to higher temperatures will cause decomposition.

X-ray photographs of the preparations have been taken using the Guinier method. In all cases the photographs exhibit only one phase with tetragona symmetry. The a-axis is constant, but the c-axis increases slightly with increasing y. The following values have been obtained: $a = 5\cdot03$ A.; $c = 5\cdot95$–$5\cdot97$ A.

Intensity calculations and density determinations indicate that the phase concerned has a variable composition. It can be described as a compound CaO_2 with a CaC_2-structure where some of the O_2^{2-}-ions (peroxide ions) in statistical distribution are substituted by O_2^--ions (superoxide ions) O^{2-}-ions, and OH^--ions. Some of the Ca^{2+}-ions are also substituted by O^{2-}-ions.

The results obtained thus indicate that the composition of the phase can be described by the formula

$$6(1-y)CaO_2\cdot 2yCa(O_2)_2\cdot 2yCaO\cdot 2yCa(OH)_2$$

where y ranges from $\sim 0\cdot1$ to $0\cdot5$.

This formula seems to be valid in all cases, where any warming has taken place of the product dehydrated at room temperature. Preparations obtained by dehydration at room temperature only are more hydrous than those which correspond to the general formula mentioned above.

If, on the other hand, the dehydration o $CaO_2.8H_2O$ is carried out directly at a temperature greater than 40° C., a phase is obtained the structure of which seems to be a superlattice of the tetragona phase mentioned above.

These investigations, which also include corresponding compounds with other cations as well as peroxide hydrates, will be described in detail in a forthcoming publication.

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Sept. 13.

Homogeneous and Heterogeneous Graphitization of Carbon

It is well known that, on heating to temperatures between 1,700° and 3,000° C., some carbons show a continuous and homogeneous development of the three-dimensional structure of graphite, whereas in others the structure does not develop beyond the stage of small regions of 'turbostratic'[1] order. It has been shown[2] that graphitization is impeded when there is strong cross-linking between the small ordered regions (which are formed in all carbons at low temperatures), and also when there is random orientation between neighbouring ordered regions. Of these two factors, the latter is the more fundamental. At sufficiently high temperatures, cross-linking is always destroyed[2]; but, where random orientation exists, no homogeneous graphitization occurs.

In most non-graphitizing carbons, however, a small quantity of highly graphitic carbon is formed, as a separate phase, at some temperature above 2,000° C. This phenomenon has been interpreted in the following way[2]. When a carbon in which the ordered regions are strongly cross-linked in three dimensions is heated to high temperatures, great internal stresses develop; the system of cross-linking imposes a low overall thermal expansion, whereas the expansion coefficient of the ordered regions must be at least as great as that of graphite. This results in local breakdown of the cross-linking, followed by a corresponding local crystallization of the carbon under pressure, the process continuing until the internal stresses have been relieved to such an extent that no further breakdown of the cross-linking occurs.

Thus, we see that, although cross-linking prevents the homogeneous development of a graphitic structure, it promotes the heterogeneous formation of a small quantity of highly graphitic carbon in non-graphitizing carbons.

The above observations provide a possible explanation of some results obtained in an investigation of the influence of the oxidation of a coal on the graphitization of a coke prepared from it.

A coking coal which normally yielded graphitizing carbons was oxidized in air at 110° for periods up to twenty days. Samples withdrawn after different periods of oxidation were then heated at 2,700° C. It was found that short periods of oxidation of the coal (up to about five days) decreased the graphitization of the carbon. After longer periods, however, the graphitization again increased, but it now occurred heterogeneously instead of homogeneously; the X-ray diffraction patterns of the carbons showed clearly the presence of a mixture of highly graphitized and non-graphitized material (cf. ref. 2) rather than a single, partially graphitized phase[3].

These results suggest that mild oxidation of a coal leads to cross-linking which inhibits crystallite growth in the carbon, whereas in carbon formed from strongly oxidized coals the system of cross-linking is so strong that heterogeneous graphitization is promoted.

This interpretation was confirmed by a similar series of measurements made on a non-graphitizing coal oxidized in air at 110° C. for periods up to sixty days, and afterwards heated to 2,700° C. Both the raw coal and the coal oxidized for four days yielded carbons which showed neither homogeneous nor heterogeneous graphitization. A trace of heterogeneously formed graphitic carbon was first observed in the sample oxidized for fifteen days. Longer periods of oxidation resulted in the heterogeneous formation of larger quantities of graphitic carbon, the proportion reaching 9 per cent after sixty days of oxidation. Thus in this case, again, the strengthening of cross-linking brought about by oxidation increased the heterogeneous formation of graphitic carbon.

It therefore appears that graphitization can occur by two quite distinct processes. Homogeneous graphitization occurs in carbons in which neighbouring ordered regions lie in near-parallel orientation, and in which cross-linking is weak[2]. Heterogeneous graphitization results when cross-linking is so strong that, when it starts to break down at high temperatures, localized forced crystallization under pressure occurs.

Since heterogeneous graphitization involves the breakdown of cross-linking, it sets in at a higher temperature than homogeneous graphitization. The graphitic product, however, is more highly graphitized than a product of homogeneous graphitization at the same temperature, since it is crystallized under pressure.

The experiments described above were carried out during 1950 at the Laboratoire Central des Services Chimiques de l'État, 12 quai Henri IV, Paris. I am indebted to M. J. Méring for many helpful discussions.

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Diffusion of Interlayer Water in Vermiculite

A convenient optical method for studying the diffusion of water molecules in vermiculite is outlined below. The effect has similarities to that employed by Tiselius[1] in his studies of diffusion in the zeolites; but, in this instance, it can be observed in reflected or transmitted light and is not a birefringence effect. Although magnesium vermiculite is referred to particularly, vermiculites saturated with cations other than magnesium behave in a similar (although not identical) manner.

When a flake of magnesium vermiculite, which has been partially dehydrated to the phase containing single sheets of interlayer water molecules (d_{001} = 11·59 A.), is allowed to become rehydrated, a dark line is observed to enter the flake at the edges and gradually converge on the centre. Inspection under the microscope reveals that the first moving boundary is followed by a second which is much fainter and travels at a slower rate (Fig. 1). These boundaries represent wave-fronts of water molecules diffusing into the crystal. The first and stronger of the two is caused by a phase change corresponding to an expansion of the lattice in the *c*-direction from 11·59 A. to 13·82 A., and the second by a smaller lattice expansion from 13·82 A. to 14·36 A.[2]. The reverse process, namely, dehydration, is rather more difficult to observe.

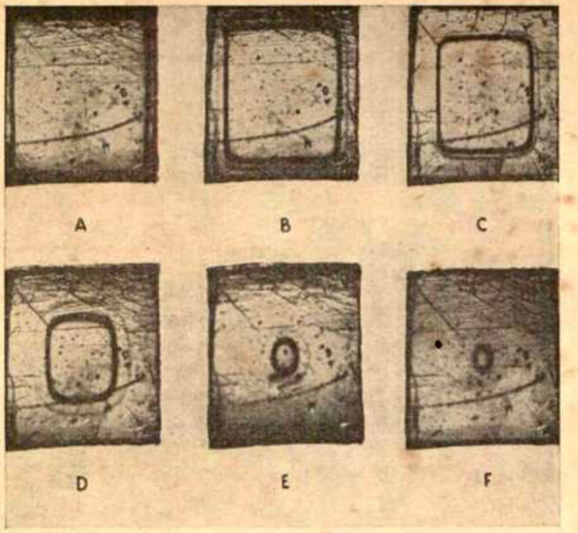

Fig. 1. Photographs taken at intervals during the diffusion of water molecules into a partially dehydrated magnesium vermiculite crystal

It is evident from Fig. 1 that the rate of diffusion in the plane of the layers for each phase-change is equal in all directions. Perpendicular to this plane the diffusion is effectively nil. Rate measurements indicate that the distance travelled is proportional to the square root of the time taken, in agreement with the requirements of the theory of diffusion. With a flake 2 mm. square, rehydration takes several minutes at 20° C. and 50 per cent relative humidity. The appearance of the crystal in section at an intermediate stage of the hydration process is shown diagrammatically in Fig. 2. Considerable distortion of the silicate layers must occur at the phase boundaries, especially where mutual displacements of the silicate layers are involved as in the 13·82 A.–14·36 A. transition. The elasticity of the silicate layers is evinced by the fact that the process may be repeated a number of times without appreciable diminution in the sharpness of the boundaries.

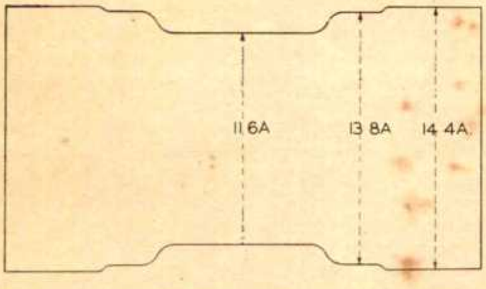

Fig. 2. Sectional diagram of a magnesium vermiculite crystal at an intermediate stage of rehydration (approximately to scale)

Under suitable conditions, the formation of organic complexes can also be followed by this method.

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Sept. 28.

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Electroluminescence in Disordered Zinc Sulphide

IN recent times a detailed study has been made of the structure of zinc sulphide crystals[1], and of the solid-state properties, particularly electroluminescence[2], of this compound. Of the many factors which may influence the electrical and optical properties of zinc sulphide, little attention has so far been paid to the effect of the modifications which can occur in the crystal structure. In addition to the well-known cubic (sphalerite) and hexagonal (wurtzite) forms, single crystals of zinc sulphide can also be obtained with a one-dimensional stacking disorder of the hexagonal (0001) planes[3]. This disorder may exhibit a periodic arrangement resulting in the formation of polytypes[1]. Although no experimental work seems to have been published linking electroluminescence with disorder, Schneer[4] has, from theoretical considerations, suggested that there may be some connexion; in addition, the electroluminescent properties of some zinc sulphide phosphors have been tentatively ascribed to a partial transformation from hexagonal to cubic[5].

Experiments in these laboratories have led us to believe that electroluminescence both in single crystals and in powders may be associated, in some circumstances, with the phenomenon of one-dimensional disorder. Needle-shaped crystals of zinc sulphide, prepared by a sublimation technique and activated by thermal diffusion of copper from the crystal surface, were seen to exhibit parallel streaks of blue electroluminescence in a manner very similar to that described by Diemer[6]. Examination under the polarizing microscope, between crossed nicols, revealed bands of interference colours; from an X-ray examination these bands were found to be perpendicular to the *c*-axis of the crystal, and to originate from random one-dimensional stacking disorders. The electroluminescent streaks were observed to be strictly parallel to these colour bands; this is clearly demonstrated in the accompanying photographs. In Fig. 1*a* a crystal between crossed nicols is shown, the interference colours appearing, of course, as different shades of grey; Fig. 1*b* is the light pattern produced in the region between the electrodes by an alternating field of 10 kc./s. The streaks of light are clearly parallel to the coloured bands, although not all the bands have an associated electroluminescent streak. Observations of the blue electroluminescent streaks and colour bands, simultaneously, give a precise confirmation of this parallelism, but in a monochrome photograph they would be indistinguishable. The pattern remains unchanged regardless of the alteration of the field direction produced by change of electrode positions; the overall brightness, however, does alter and is a maximum when the field is in the same direction as the streaks and bands.

A second batch of crystals, subjected to an identical activation treatment, had a higher apparent brightness, and optical and X-ray examination suggest a more extensive disorder. These crystals displayed many more light sources, both in the form of streaks and points, than were apparent in the needle-type crystals described above. The streaks of electroluminescence were again in alignment with the colour bands.

In the case of powders, it was found that, in a particular series of zinc sulphide – copper electroluminophors, maximum brightness was associated

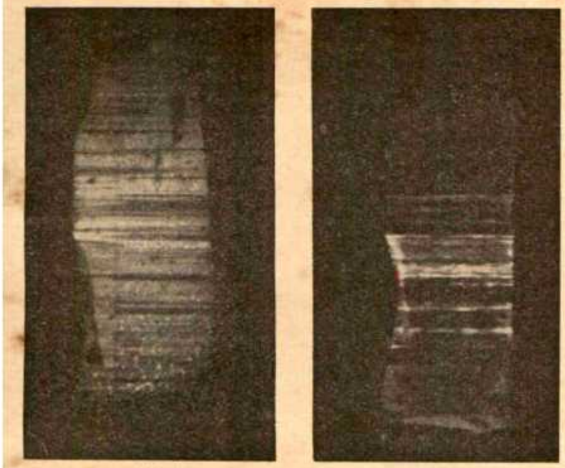

Fig. 1. Electroluminescent crystal of zinc sulphide activated with copper. (a) Between crossed nicols; (b) electroluminescence under 10 kc./s. Magnification, × 60

with a high degree of stacking disorder, as revealed by diffuseness in certain X-ray powder reflexions, and by single-crystal photographs of the constituent crystallites.

These observations may be explained by a non-uniform distribution of emitting centres or by a non-uniform electric field. In either case, the non-uniformity could be due to disordered regions, possibly because activator atoms diffuse readily along disorder boundaries. In this connexion it may be noted that some of the crystals which displayed blue electroluminescent streaks also luminesce under ultra-violet excitation. The ultra-violet luminescence is apparently distributed evenly throughout the body of the crystal, so that the centres involved are uniformly distributed. This perhaps supports the second possibility, although it is not certain that the luminescence originates at the same centres in the two cases.

Although disorder may not be a necessary condition for electroluminescence, particularly as both cubic and hexagonal electroluminescent zinc sulphide phosphors have been reported[2], these results suggest that a suitable environment of copper activator, such as is provided by boundaries between ordered regions of zinc sulphide, can provide conditions particularly favourable for electroluminescence.

It is perhaps significant that silicon carbide also possesses the dual properties of electroluminescence[2] and one-dimensional disorder[1].

The work is being continued and further results should help to assess the influence of crystal structure on the solid-state properties of zinc sulphide.

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Empirical Relationship between the Excitation Energy of the *F*-band and Physical Constants for Alkali Halides

The excitation energy for a $1s - 2p$ transition in an electron associated with a hydrogen-type impurity embedded in a dielectric medium with high-frequency constant K_0 is

$$\frac{3}{8}\,\frac{e^2}{K_0 R} \tag{1}$$

where R is the Bohr radius, 0·529 A.

If R is taken as the radius of cation instead of the Bohr radius, then it is found empirically that the ratio of the excitation energy of the F-band to the expression (1) is close to unity for a large number of alkali halides containing F-centres.

The values of this ratio for various alkali halides are given in Table 1.

Table 1

Salt		LiF	LiCl	NaF	NaCl	NaBr	NaI
Ratio		1·0	1·0	1·12	1·06	1·06	1·08
Salt	KF	KCl	KBr	KI	RbCl	RbBr	CsCl
Ratio	1·24	1·16	1·13	1·17	1·20	1·15	1·64

The reason that the CsCl ratio differs from the other twelve ratios might well be due to its different crystal structure.

Values of R have been taken from Pauling, L., *J. Amer. Chem. Soc.*, **49**, 765 (1927), and those of K_0 from Hojendahl, K., *K. Danske Vidensk. Selskab*, **16**, No. 2 (1938).

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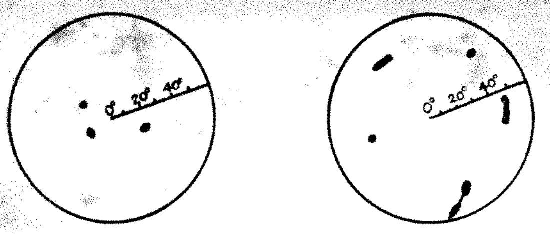
Deformation Characteristics of Hafnium

Because of its high nuclear cross-section, high melting point and good resistance to corrosion and oxidation, hafnium is being considered for practical application in the nuclear engineering field. Appreciable quantities of the material are being produced as a by-product of the production of pure zirconium.

Using small samples sectioned longitudinally from the periphery of hafnium crystal bar, the deformation characteristics of the material were studied. Cracking appeared when the metal was cold rolled 25–30 per cent total reduction. In spite of such precautions as previous vacuum annealing and small passes—1 per cent or less—10 per cent total deformation appeared to be the top limit which could be expected by cold rolling without intermediate annealing. Slightly elevated temperatures, however, seemed to make the material much more plastic. At 500° C., approximately 200° below the recrystallization temperature, the reduction by rolling was found to proceed to almost any practical reduction without cracking. Compression deformation was found to be possible to 90 per cent total reduction at 300° C.

Using a reflexion integrating pole-figure goniometer technique, the orientation of the deformed material after severe etching was studied, and on the basis of preliminary determinations was found to be very similar to the preferred orientations previously reported for titanium[1].



0001 pole figure   10$\bar{1}$1 pole figure

Fig. 1. Hafnium of 99·9 per cent purity after 78 per cent compression. Compression axis normal to plots

The compression texture was found to be [0001] rotated 15°–30° from the axis of compression. The basal plane rotation appeared to be predominantly around a 10$\bar{1}$0 rotational axis. A typical compression texture of a large-grain crystal bar material is shown in Fig. 1. Each 0001 peak would appear to be due to a single grain.

The rolling texture is very similar with the 0001 plane rotated 10°–25° around a 10$\bar{1}$0 rotational axis. Little or no directionality was apparent. In rolling at 500° it was noted that the sample increased considerably in width as well as in the rolling direction, indicating that this deformation may be similar in effect to compression deformation.

This type of texture could be accounted for by 11$\bar{2}$2 and 11$\bar{2}$1 twinning and 10$\bar{1}$2 twinning where the hexagonal axis is rotated from the compression axis and also by $\{0001\}$ $<11\bar{2}0>$ and $\{10\bar{1}1\}$ $<11\bar{2}0>$ slip.

We thank Mr. Roger Sutton, of the Argonne National Laboratory, and Dr. Earl Hayes, of the U.S. Bureau of Mines, for supplying the material used in this investigation, and Dr. Robert Gibney for making available the X-ray diffraction facilities of the Los Alamos Scientific Laboratory.

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A Simple Tonometer

An apparatus has recently been developed in connexion with the work of linguists which promises also to be useful to investigators of speech in the deaf. Linguists who study tonal languages such as Chinese and many of the African languages have had in the past to rely almost entirely on the subjective process of listening, in order to determine the all-important pitch of each syllable. The oscillograph is not a practical proposition for dealing with thousands of words. Teachers of the deaf are faced with the fact that intelligibility depends not only on correct enunciation and rhythm, but also on the rise and fall of the voice. The latter accomplishment has proved too difficult save for the more gifted pupils, as it has been undemonstrable.

The tonometer I describe would appear to provide assistance to both these classes. It consists of three units—a microphone, an amplifier, and the tonometer itself. The two principles governing the apparatus are the sympathetic vibration of reeds, and the selective vibration of reeds. It consists of three units: the soundboard, the reed-bank and the oscillator. The soundboard is of wood, about 9 in. long and 3 in. wide, pivoted at both ends to allow of free vibration. On it is fixed the reed-bank. This is a metal comb with 66 slots to keep the reeds in position. On the rear side is a row of retaining screws to hold the back ends of the reeds. These have a triple suspension: each reed passes between three parallel metal bars running the length of the comb, over the first, under the second and over the third, and so on, the vibrating portion projecting through the teeth of the comb. Between the suspension and the holding screws is a metal bar through which pass the tuning screws, one to each reed. By adjusting these, the vibrating part of the reed is either lengthened or shortened. The reeds are spread over a range of two octaves, which allows for the speech-range of adult male speakers of differing natural pitch. The tuning for treble voices would be similar but higher. The tuning needs to be accurate, the distance between the reeds being 2 vibrations per sec. in the bass and 3–4 vibrations per sec. in the middle and high registers. This fine tuning necessitates a special technique described below.

The oscillator is a simple balanced-armature vibrator, the vibrator itself being coupled to the soundboard, and the oscillator connected to the amplifier.

The tuning was accomplished thus: gramophone records were made giving the pitch of each semitone required. The first reed (say *C*) was tuned from the record by sympathetic vibration, the radiogram loud-speaker circuit being connected to the oscillator. Then *C*♯ in like manner. The three intermediate reeds were tuned like this: when reed *C* was vibrating at maximum amplitude, the next reed above it was tuned to vibrate at half its amplitude, and the middle of the three reeds to about a quarter of its amplitude. The same was now done working backwards from *C*♯. If the behaviour of the reeds was uniform, the semitone was divided with sufficient precision. And so on for all the reeds.

A scale is fixed in front of the reeds giving the name of each semitone, and there are movable pointers to assist in plotting the moving reeds during speech.

When a person speaks, only those reeds (and their immediate neighbours) vibrate, the frequency of which is that of the sound produced by the speaker. Thus waves of movement are seen on the reed-bank and it is quite easy to watch the rise and fall of the voice. It is also easy to train oneself to reproduce on the reed-bank a given rise and fall demonstrated by another speaker.

It will be seen that here is an apparatus giving linguists an objective reading for speech intonation: it is also a means whereby teachers of the deaf can show by their own speech (for example, saying 'Good morning') how the voice should rise and fall, noting on the scale the appropriate intervals. Deaf pupils can practice until they produce on the tonometer the same intervals. They will thus be enabled to achieve that correct rise and fall of the voice which is essential to intelligible speech.

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 6

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. W. Williams: "An East Coast Survey".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "What should be our National Fuel Policy?" Opening Speaker: Mr. E. F. Schumacher.

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Capt. H. F. Jackson: Presidential Address.

University College London (in the Chemistry Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. K. Alder (Cologne): "Some Recent Aspects of Diene Synthesis".*

Society of Chemical Industry, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Meeting on "Cost Accounting in the Chemical Industry".

Tuesday, February 7

Institution of Chemical Engineers (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. P. Fraser and Mr. P. Eisenklam: "Liquid Atomization and the Drop Size of Sprays".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. R. Thomas: "Some Hydraulic Investigations in Connexion with the Wadi Tharthar Project, Iraq".

Physical Society, Acoustics Group (at the British Institute of Recorded Sound, 38 Russell Square, London, W.C.1), at 5.30 p.m.—Dr. W. H. George: "Determination of Tone-Colour".*

Scientific Film Association (at the Science Museum, South Kensington, London, S.W.7), at 6.30 p.m.—Dr. J. C. G. Gilbert: "Physics and Underwater Research".*

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. H. W. Melville: "A Study of the Chemistry of Radical Reactions by Radioactive Tracer Techniques".

Wednesday, February 8

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. E. M. Deloraine: "Pulse Techniques, with particular reference to Line and Radio Communication".

Society of Chemical Industry, Microbiology Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Mr. W. D. Burnet: "The Manufacture of Whisky".

Thursday, February 9

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. T. F. Macrae: "The Research Work of Glaxo Laboratories Ltd.".

Society of Instrument Technology, Control Section (at Manson House, Portland Place, London, W.1), at 6 p.m.—Annual General Meeting. Prof. A. Tustin: "The Scope for Feedback Control and Automatic Calculation in Industrial Mechanization".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. L. G. Fairhurst: "Propellers for Military and Civil Aircraft".

Thursday, February 9—Friday, February 10

Society of Chemical Industry, Food, and Oils and Fats Groups (at the Wellcome Research Institute, 183 Euston Road, London, N.W.1)—Joint Conference on "Recent Advances in the Knowledge and Uses of Phospholipids in Foods".

Friday, February 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting followed by Annual General Meeting.

British Psychological Society, Social Psychology Section (in the Electrical Lecture Room, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Mr. C. Slaughter: "Some Psychological Implications of an Anthropological Community Study in England".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. J. F. Baker: "The Steel Skeleton".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Principal Scientific Officer (with a second-class honours degree or equivalent in chemistry or chemical engineering, and a knowledge of physical chemistry and of the aspects of physics and mathematics required for the analysis of chemical engineering problems) in the Research and Development Branch, Risley, near Warrington, Lancs, to take charge of a small group engaged on theoretical studies relating to the design and performance of chemical and process plant—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group H.Q., Risley, near Warrington (February 10).

Assistant Lecturers or Lecturers (2) in the Department of Physiology—The Registrar, The University, Liverpool (February 11).

Lecturer in Education—The Registrar, The University, Reading (February 18).

Assistant Lecturer in Zoology—The Principal, Royal Holloway College, Englefield Green, Surrey (February 20).

Deputy Director (with a degree in mechanical or chemical engineering and long experience in a research laboratory in a position of responsibility, and a knowledge of estimation, erection and operation of plants and machineries (including pilot plants)) of the Fuel Research Institute, Council of Scientific and Industrial Research, India—High Commission of India, Establishment Department, Aldwych, London, W.C.2, quoting 4/98A. (February 20).

Senior Lecturer in Psychiatry—The Registrar, The University, Manchester (February 20).

Lecturer (preferably with experience and research interests in statistical mechanics and thermodynamics) in Theoretical Chemistry in the Department of Physical and Inorganic Chemistry—The Registrar, The University, Bristol 8 (February 22).

Lecturer in the Department of Pathology—The Secretary, The University, Edinburgh (February 25).

Lecturer or Assistant Lecturer in Physics—The Registrar, The University, Leeds 2 (February 28).

Chemists and a Bacteriologist, for dairy laboratory work in New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting A.3/4/47 (February 29).

Lecturer in Plant Physiology at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

Lecturer (preferably with research interest in semi-conductors) in Physics—The Registrar, The University, Nottingham (February 29).

Lecturer (preferably with special qualifications in ultra-high frequency techniques) in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (February 29).

Official Fellow in Mathematics—The Warden, New College, Oxford (February 29).

Professor of Nuclear Physics—The Dean, Faculty of Science, Giza, Egypt (February 29).

Assistant Experimental Officer (preferably with a degree in botany or agricultural botany) in the Plant Pathology Department, for work on cereal diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 109 (March 1).

Assistant Lecturer (with a special or honours degree in geology) in Geology (Palæontology), and an Assistant Lecturer (with a special or honours degree in mathematics) in Mathematics (including Geometry)—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (March 1).

Professor of Inorganic Chemical Technology—The Dean, Faculty of Engineering, Cairo University, Giza, Egypt (March 1).

Lecturer or Assistant Lecturer in Mathematical Statistics—The Registrar, The University, Manchester 13 (March 10).

Assistant Lecturer or Lecturer in Mathematical Statistics in the Department of Applied Mathematics—The Registrar, The University, Liverpool (March 12).

Lecturers (3) in Geology—Secretary of University Court, The University, Glasgow (March 12).

Chair of Physics—The Secretary, The University, Exeter (March 15).

Lecturer in Microbiology—The Registrar, The University, Reading (March 24).

Chair of Physical Chemistry at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, March 26).

Chair of Physics at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 31).

Director (with a wide knowledge of plant pathology (particularly of tropical crops) and experience in research of the subject, administrative ability and experience, literary taste, and some knowledge of languages) of the Commonwealth Mycological Institute, Kew—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (May 31).

Assistant Conservator (with a university degree in forestry) of Forests, Sierra Leone—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.61/15/04.

Chemist (with a first- or second-class honours degree in chemistry or equivalent qualification and at least three years postgraduate research experience) with the Ministry of Supply at Farnborough, Hants, to take charge of a laboratory engaged in research and development work on textiles in relation to their use in Service equipment and clothing—The Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.37/6A/AA.

Chief Laboratory Technician in the Physics Department—The Secretary, Northern Polytechnic, Holloway, London, N.7.

Demonstrators in Physics and Demonstrators in Organic Chemistry—The Registrar, The University, Nottingham.

Experimental Officer (preferably with a degree in physics or mathematics and previous laboratory experience, or at least H.S.C. in science subjects or equivalent) in the Nuclear Physics Division, to take charge of the construction and operation of a neutron velocity selector for the new research reactor Dido—The Establishments Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 474.

Experimental Officer (with at least H.S.C. in science subjects or equivalent qualifications, a good general knowledge of physics with some idea of the basic concepts of nuclear physics, and preferably with several years experience in a physics laboratory) in the

Nuclear Physics Division, to help organize a small team working on the measurement of neutron spectra in reactors—The Director, Atomic Energy Research Establishment (Recruitment), Harwell, Didcot, Berks, quoting 484.

Instructor, Assistant Professor or Lecturer (preferably with a doctorate in physics or mathematics and an interest in nuclear or solid state physics) **in Physics**—The Chairman, Department of Physics, Western Reserve University, Cleveland 6, Ohio, U.S.A.

Lecturer in Agricultural Chemistry—The Principal, Shuttleworth College, Old Warden Park, Biggleswade, Beds.

Metallurgist (with a first- or second-class honours degree or equivalent qualification in metallurgy, and several years metallurgical research experience, preferably in the field of non-ferrous metals) at a Ministry of Supply Establishment at present in S.E. London, for research and development in the field of less common non-ferrous metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.18/6A/AA.

Physicists and **Electrical Engineers** (with a first- or second-class honours degree or equivalent in physics or electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.490/5A/AA.

Principal Lecturer (with high academic qualifications, and preferably some industrial experience) **in Food Science**—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow C.1.

Professors (with a post-graduate degree or diploma and considerable teaching experience) **of Anatomy, Physiology, and Pharmacology**, at a new Medical College to be established at Chittagong, East Bengal—The Recruitment Officer, Education Division, Pakistan High Commission, 39 Lowndes Square, London, S.W.1.

Radiographer in the X-Ray Diagnostic Department—The House Governor, Westminster Hospital, St. John's Gardens, London, S.W.1.

Scientific Officers (with at least a second-class honours degree in chemistry or equivalent qualifications) and **Experimental Officers** (with H.S.C. in science subjects, including chemistry or equivalent qualifications, together with some experience in inorganic chemistry or analysis), to work on the development of methods for carrying out special inorganic chemical preparations and of techniques for depositing thin films by a variety of physical and chemical procedures—Establishments Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting reference 472

Senior Lecturer in Metallurgy; **Assistant**, Grade B, **in Mechanical Engineering**; and **Assistants**, Grade A, **in** (*a*) **Chemistry** and (*b*) **Structural Engineering**, at Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough.

Senior Metallurgist, Principal Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in metallurgy or equivalent qualification, preferably with experience of failure investigations, a good knowledge of metallography and at least three years postgraduate research experience) at the Royal Aircraft Establishment, Farnborough, Hants, for metallurgical investigations of failures and defects in aircraft parts, and to take part in the metallurgical research of the department—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting F.12/6A/AA.

Senior Scientific Officer (with a first- or second-class honours degree in physics, and at least three years postgraduate practical experience of electronics with the ability to apply it to research problems) to lead a small team engaged on novel physical research problems involving the techniques of mass spectrometry and radioactive measurements—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 1001/34.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Films in Human Relations. Pp. 24. (London: Scientific Film Association, 1955.) 2*s*. 6*d*. [2411

British Broadcasting Corporation: Engineering Division. Monograph No. 3: The Visibility of Noise in Television. By Dr. R. D. A. Maurice, Dr. M. Gilbert, G. F. Newell and J. G. Spencer. Pp. 23. (London: British Broadcasting Corporation, 1955.) 5*s*. [2411

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 947, Vol. 248 (24 November 1955): An Interpretation of Gravity Anomalies in the Eastern Mediterranean. By J. C. Harrison. Pp. 283–325. (London: Royal Society, 1955.) 13*s*. 6*d*. [2411

Department of Scientific and Industrial Research. Road Research Laboratory. Road Note No. 14: Prevention of Wet-Weather Damage to Surface Dressings. Second edition. Pp. 9. (London: H.M. Stationery Office, 1955.) 9*d*. net. [2411

Nuffield Foundation. Report for the year ended 31 March 1955. (Tenth Report.) Pp. 125. (London: Nuffield Foundation, 1955.) [2411

Report of the Royal Commission on the Civil Service, 1953–55. (Cmd 9613.) Pp. viii+238. (London: H.M. Stationery Office, 1955.) 6*s*. 0*d*. net. [2811

Special Report from the Select Committee on Nationalised Industries, together with the Proceedings of the Committee Minutes of Evidence, and Appendices. Pp. vi+41. (London: H.M. Stationery Office, 1955.) 2*s*. 6*d*. net. [2811

Office of the Lord President of the Council. Advisory Council on Scientific Policy: Committee on Scientific Manpower. Report on the Recruitment of Scientists and Engineers by the Engineering Industry. Pp. 31. (London: H.M. Stationery Office, 1955.) 1*s*. 3*d*. net [3011

The National Gallery, 1938–1954. Pp. 124+20 plates. (London: The National Gallery, 1955.) [3011

Colonial Office. Colonial Research, 1954–1955. (Reports of the Colonial Research Council; Colonial Products Council; Colonial Social Science Research Council; Colonial Medical Research Committee; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Insecticides Committee; Colonial Economic Research Committee; Tsetse Fly and Trypanosomiasis Research Committee; Colonial Fisheries Advisory Committee; Director, Anti-Locust Research Centre, and Research Matters not covered by the above Reports of the Specialist Bodies. Pp. 316. (Cmd. 9626.) (London: H.M. Stationery Office, 1955.) 9*s*. net. [212

Annual Report of the West African Cocoa Research Institute, 1954–55. Pp. 110. (London: Crown Agents for Oversea Governments and Administrations, 1955.) 5*s*. [612

Other Countries

United States Naval Observatory. Circular No. 62: Positions Areas, and Counts of Sunspots, August, 1955. By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U.S. Naval Observatory, 1955.) [2111

Companhia de Diamantes de Angola (Diamang). Servicos Culturais. Dundo—Lunda—Angola. Museu do Dundo. Subsidios para o Estudo da Biologia na Lunda. Estudos Diversos 11: The Odonata of N. Angola (Part 1). By Cynthia Longfield. Neuropteren aus Angola. Von E. Handschin und W. Markl. Angolan Tingidae (Hemiptera). By Carl J. Drake. Carabidae (Coleoptera) de l'Angola (Première Partie). Par P. Basilewsky. Termites du centre et du sud-ouest de l'Angola récoltés par A. de Barros Machado. Par Charles Noirot. Pp. 150. (Publicacoes Culturais, No. 27.) (Lisboa: Companhia de Diamantes de Angola, 1955.) [2111

Report of the South African Museum for the period ended 31 March, 1955. Pp 26. (Cape Town: South African Museum, 1955.) [2111

Bulletin of the American Museum of Natural History. Vol. 107, Article 1: A Historical Review of the Mollusks of Linnaeus. Part 3: The Genera *Bulla* and *Voluta* of the Class Gastropoda. By Henry Dodge. Pp. 1–158. (New York: American Museum of Natural History, 1955.) 2 dollars. [2311

University of Calcutta. Institute of Nuclear Physics. Pp. ii+58. (Calcutta. Institute of Nuclear Physics, 1955.) [2411

West African Institute for Oil Palm Research. Quarterly Progress Report, No. 14 (July 1st, 1955, to September 30th, 1955). Pp. 23. (Benin City, Nigeria: West African Institute for Oil Palm Research, 1955.) [2411

Yale Peabody Museum of Natural History. Postilla. No. 21: A New Fruit Pigeon from the Philippines. By S. Dillon Ripley and D. A. Rabor. Pp. 2. No. 22: Additions to the Ornithogeography of the Yucatán Peninsula. By Raymond A. Paynter, Jr. No. 23: A New White-throated Spinetail from Western Brazil. Pp 4 By S. Dillon Ripley. Pp. 2. (New Haven, Conn.: Yale Peabody Museum of Natural History, 1955.) [2411

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark Bulletin Hydrographique pour l'Année 1951. Publié par le Bureau du Conseil, Service Hydrographique. Pp. x+131. (Copenhague: Andr. Fred Høst et Fils, 1955) 45 kronor [2411

Skrifter fra Danmarks Fiskeri- og Havundersøgelser Nr. 16: Vandløbenes Regulering og Fiskenes fri Gang. Av Knud Larsen. Pp. 33. 4 kronor. Meddelelser fra Danmarks Fiskeri- og Havundersøgelser. Ny Serie, Bind 1. Nr. 9: Transplantation of Plaice to Tølsted and Visby Broads in the Limfjord 1928–1951. Av J. B. Kirkegaard. Pp. 18. 4 kronor. Nr. 10: Fish Population Analyses in Some Small Danish Trout Streams by Means of D C. Electro-Fishing, with special reference to the populations of Trout (*Salmo Trutta* L.). Av Knud Larsen. Pp. 70+8 plates. 20 kronor. (København: I Kommission Hos C. A. Reitzel, 1955.) [2411

Zeszyty Naukowe Politechniki Lodzkiej. (Science Bulletin of the Lodz Institute of Technology.) Nr. 1: Mechanika (Nr 1). Pp. 127. Cena zl. 11.70. Nr. 2: Chemia (Nr. 1). Pp. 138. Cena zl. 13,30. Nr. 3: Mechanika (Nr. 2). Pp. 134. Cena zl. 13,30. Nr. 4: Wlokiennictwo (Nr. 1). Pp. 120. Cena zl. 17. Nr. 5. Chemia Spozywcza (Nr. 1). Pp. 88. Cena zl 14. Nr. 6: Chemia (Nr 2). Pp. 89 Cena zl. 12,50. Nr. 7: Mechanika (Nr. 3). Pp. 140. Cena zl 22. Nr. 8: Elektryka (Nr. 1). Pp. 101. Cena zl. 15,50. Nr. 9: Chemia (Nr. 3). Pp 96. Cena zl. 13,50. (Lodz: Panstwowe Wydawnictwo Naukowe, 1954 and 1955.) [612

International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd, 1954. Vol. 10, Part 5: Commission 5 on Radio-Astronomy. Pp. 114. (Brussels: International Scientific Radio Union, 1955.) 125 Belgian francs; 18*s*.; 2.50 dollars. [612

Bulletin of the Indian Council of Ecological Research. Vol. 1, No. 1. (October, 1955.) Pp. 22. (Dehra Dun: Indian Council for Ecological Research, 1955.) [612

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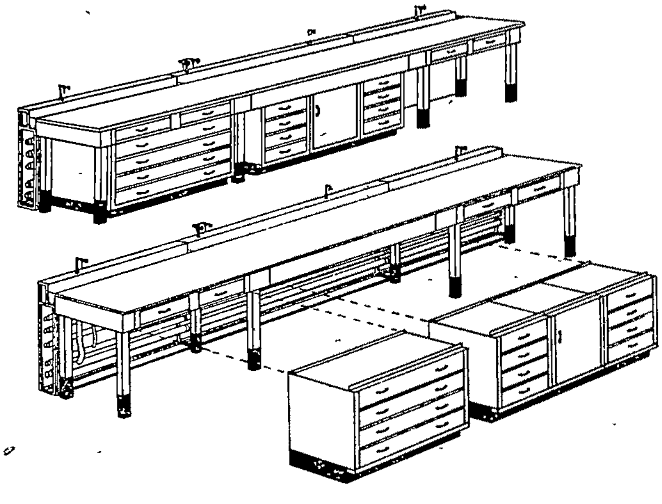

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OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

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Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. The closing date for the receipt of applications, in London and South Africa, is March 26, 1956.

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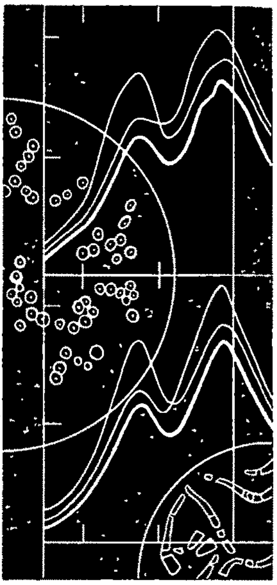

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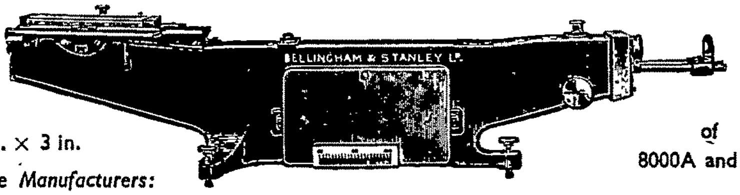

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PRESERVATION OF THE COUNTRYSIDE IN BRITAIN

EVEN a cursory reading of the sixth annual report of the National Parks Commission, which reports to the Minister of Housing and Local Government, and that of the Nature Conservancy, which reports to the Lord President of the Council, cannot fail to reveal how much the two bodies have in common (see p. 264 of this issue). The latter is essentially a scientific body, the work of which is of profound importance to agriculture and forestry, water supply, coastal defence and meteorology, and for decisions about the use of land in general. None the less, sound policies of conservation depend at every step on scientific research carried out in intimate contact with land management and advisory and educational work, and the Conservancy is already finding it increasingly difficult to maintain a policy of free access in face of thoughtlessness and destructiveness on the part of a minority of the public. The National Parks Commission likewise finds increasing need for public support and understanding and, at the Conference of Park Planning Authorities which he convened last July, the Minister of Housing and Local Government said that in the end the only sure guardians of the national parks are the people themselves; national parks will be assured of the money they need and safe against encroachment or mutilation to the extent that the public visits them and values them.

What are required above all, by the Nature Conservancy no less than by the Park Planning Authorities and the National Parks Commission, are the support, encouragement and stimulus of an informed and critical public opinion; and these must come, not merely from the comparatively small number of enlightened workers in the open-air and scientific societies, to whom the Commission and Conservancy and the country at large owe so much, but also from an awakened public conscience throughout Britain. This is as true of the work of both bodies generally as it is in respect of problems, such as the study of the restoration, or even the maintenance, of the Broads, which they are handling in collaboration. The creation of local nature reserves or the voluntary action by national and county trusts and societies, for which the Nature Conservancy pleads, can only come as a result of that understanding and support.

Both reports contain encouraging evidence of the growth of such understanding and of increasing willingness to co-operate, just as they indicate how much more is required. The proper enforcement of the Protection of Birds Act, 1954, which is of vital concern to the Conservancy, on account of its responsibility for nature reserves and other areas which are or will be sanctuaries, ultimately rests on the inculcation of a wider understanding and knowledge of birds. The response to the Conservancy's letters to owners of sites of special scientific interest, however, has been most encouraging and appears to testify to the existence of a large fund of goodwill and readiness to co-operate, although in Scotland only a start has been made with such notifications and systematic notification in Wales has not yet begun.

The National Parks Commission regards its expanding activity in the field of information and publicity accordingly as of primary importance, and this is no less true of the Nature Conservancy. In this field of education it is probable that the official efforts of the two bodies could be supplemented by that of voluntary bodies such as the open-air societies and various scientific societies, both professional and amateur. The efforts of such bodies are, however, limited, like that of the Conservancy and the Commission themselves, by lack of finance, and here we touch on a second common note in both reports.

The Nature Conservancy points out that, as was forecast last year, its meagre grant-in-aid of £154,500 was quite inadequate for a programme of scientific work that already promises to yield returns within even a few years that will write off its cost many times over. Work on the fencing of reserves and on long overdue woodland operations has had to be postponed, as well as surveys and experiments, and grants for scientific studies and for postgraduate training had to be cut to an entirely inadequate level while the burden of rehabilitating and bringing into a satisfactory state of management even the existing reserves is rapidly increasing.

This failure to provide the necessary funds for research and conservation, including the acquisition of nature reserves, must result in loss or damage which will be felt by science and by the community many years after the transient minute saving in the current national budget has been forgotten. The point is not laboured by the Nature Conservancy, which is largely content to let its scientific record speak for itself; but it says little for the Lord President of the Council or the Committee of the Privy Council for Agricultural Research and Nature Conservancy, that the challenge presented no less clearly and firmly in the Conservancy's previous report has received no comment during the year. The position of the Nature Conservancy in the nation's organization for research appears to be long overdue for reconsideration, and should be pressed in the debates on the Agricultural Research Bill now before Parliament.

The matter is one which might well receive urgent attention from the Parliamentary and Scientific Committee, for an adequately financed Nature Conservancy is in a position to contribute out of all proportion to magnitude of effort. Both in ecological research and in conservation, success depends upon the fullest understanding and team-work between specialists who, but for the Conservancy, with its comprehensive responsibilities, might never meet. Already, with scanty resources, the Conservancy can report encouraging progress in promoting contacts, in initiating ecological studies and filling gaps, with benefits to biological research at the universities as well as to the Conservancy's own work; and it should not be overlooked in this connexion that the main recommendation from an inspection of the Conservancy's administration which the Organization and Methods Division of the Treasury was invited to make during the year was that conservancy should be recognized as the central executive task of the Conservancy, thus reducing the conflicting responsibilities of research scientists in applied scientific fields.

The responsibility for seeing that the financial needs of the Nature Conservancy are adequately met thus clearly lies with the Lord President of the Council; but scientists working in related fields also have a responsibility for seeing that their professional bodies make effective representations on the matter to the appropriate research councils. The financial needs of the National Parks Commission are also acute; but the position is entirely different and the prospects of an early improvement appear to be somewhat brighter provided effective public support is forthcoming. It will be noted that the report of the National Parks Commission gives no information on finance, although it is made plain year after year that the difficulties in administration arise mainly because the cost of administering and improving or safeguarding the national parks has been thrown essentially on the local authorities. The Commission has never been provided with funds of its own adequate, for example, to pay the cost of some measure required to safeguard amenity in a park area, which it is manifestly unreasonable to expect an individual owner or even a local authority to bear unaided, even if they had sufficient resources.

The purposes for which the Exchequer may pay grants amounting to 75 per cent of the total are detailed in the National Parks and Access to the Countryside (Grants) Regulations, 1954; but when it is realized that even a park authority warmly commended by the Commission for its activity and vigilance, such as the Peak Park Planning Board, spent less than £1,000 out of £27,000 on positive functions, thus qualifying for grant in the period April 1952–March 1954, and that the estimated expenditure of the Commission in 1953–54 was only £21,114, the parsimony with which the national parks in Britain are treated is obvious. In an earlier report the Commission had even had to record its inability to find the funds for printing the 'Country Code'.

The Conference of Park Planning Authorities last July also discussed a proposal that legislation should be introduced to make available from the National Land Fund moneys to be applied for national parks purposes. In July 1954 a report from the Committee on Public Accounts had recommended to the Treasury consideration of the desirability of legislation to return to the Exchequer some part of the large and growing balance of the National Land Fund, as being in the Committee's view a substantial amount of public money for which there was no foreseeable need. In 1946 the then Chancellor of the Exchequer had specifically mentioned the possible use of the fund for national parks purposes, and the Commission now expresses the view that use of such moneys in this way would be in line with the original intention of the Fund and provide an earnest of the Government's positive interest in national parks. It believes that if a specified sum were made available annually for a number of years ahead, both the Park Planning Authorities and the Commission could make forward plans on long-term projects, and initiate and promote a really effective national parks programme.

These views were urged on the Minister by the Commission in a letter dated February 24, 1955; but the Minister replied that the suggested provision could not be provided in the 1955 Finance Bill but would require a special Act. It is proposed accordingly to press the Minister to find some way by which grants from the Fund can be made available, and in the meantime some suggestions are made for amendment of the National Parks and Access to the Countryside Act, 1949, which should go far to remove this main weakness of the Act—not so much that the principal responsibility for administration of the parks should rest with the local authorities as that the financial burden should be borne by them. The Commission would remove, for example, the 75 per cent limit on the maximum grant and extend the purposes for which grant is payable to include, for instance, the creation of new footpaths and bridleways, the maintenance of warden services, the organization of information services, and anti-litter work. It also suggests that contribution should be payable to a developer in a national park area in respect of additional expenditure incurred by reason of conditions attached to planning consent in the interest of amenity, and that grants should also be permitted toward the administrative expenses of park planning authorities and towards administrative expenses incurred by local authorities in completing long-distance routes.

The Commission believes that amendment of the Act of 1949 on these lines and financial provision from the National Land Fund would give a new impulse to the creative side of national parks administration, the beneficent results of which would soon become apparent. Adequate financial provision, however imperative and beneficial, would not in itself remove the chief danger which threatens the work of both the Nature Conservancy and the National Parks Commission. That danger is the encroachment on national park areas and nature reserves, whether contemplated or already designated or declared, by the Service departments, the public corporations and even local authorities. The two most glaring instances cited in the present report are the decision of the Derbyshire County Council in principle to support a private Bill in the House of Commons for the establishment of a motor-racing circuit on public roads in the Peak District National Park, and the Manchester Corporation's objections to the route of the Pennine Way in the Longdendale valley.

The National Parks Commission, having inspected two alternative proposals by the Derbyshire County Council, is unable to see how any possible proposals would be consistent with the maintenance of the area as a national park. The action of the Derbyshire County Council can, of course, be rectified by alert public opinion when at last the Bill is presented to Parliament, and such public opinion, as Mr. Duncan Sandys has pointed out, is the only ultimate safeguard. In the Longdendale dispute, the Minister has upheld the contention of the Manchester Corporation, in the face of the sustained protest of the National Parks Commission; with an alert and informed public opinion, the proposal would never have been made.

The irruption of party politics into local government may be one factor that has made the larger local authorities less alert and responsive to the claims of amenity and nature conservation than they should be. The major threats, however, still come from the Service departments and the large public corporations, although both the Nature Conservancy and the National Parks Commission in these reports refer to an increasing readiness of the Service departments to consult with them on their proposals and to steps taken to facilitate consultation at the earliest possible stage. None the less, at the close of the year, the Conservancy was objecting to a number of major projects, adoption of which would involve heavy damage to the scientific interest of St. Kilda and Loch Druidibeg in the Outer Hebrides, the geologically important parallel roads of Glen Roy in Inverness, Bilston Glen in Midlothian, the fine beech woods near Aston Rowant and the important Breckland area at Cavenham Heath. There is also concern as to the effect on wild life of the decision of the Central Electricity Authority to build an atomic power station on the Severn Estuary within six miles of the Wildfowl Trust directed by Mr. Peter Scott, and another at Bradwell, on the River Blackwater, which is the wintering ground of a high proportion of the brent geese in Europe.

The threat to the proposed nature reserve in South Uist and to St. Kilda arises from the proposed Hebridean guided missiles range announced by the Government on July 27. In reply to a question in the House of Commons on October 25, the Minister of Defence stated that safety requirements demanded that a guided missiles range should be in a less populated area and also avoid congested air and shipping routes and extensively fished areas; it must also be associated with radar and airfield facilities. These considerations narrowed the choice of sites in the United Kingdom to the Outer Hebrides, and South Uist had been selected after a reconnaissance of the islands there. When specific proposals had been formulated in the light of the survey now proceeding, the interests concerned would be given the opportunity to lodge objections and a public local inquiry would be arranged if necessary.

This statement, and the subsequent debate in the House of Lords on October 27, reveal the inherent weakness of the existing procedure, under which, in effect, the Service departments are judges in their own cause, and the dilemma with which we are increasingly confronted in a small island such as Great Britain. As Lord Polworth remarked in opening the debate, the needs of defence must take first place; but he challenged the view that technical needs must have absolute priority on every occasion. There are other values in our civilization which the Services exist to defend and preserve. Pressed to an extreme, claims on land could leave us with nothing worth defending.

The scientific, as well as the cultural, interests affected by the proposal were emphasized by Viscount Elibank and by the Earl of Haddington, who referred to the importance of South Uist as a breeding ground for such rare birds in the British Isles as the red-necked phalarope and the hen harrier, and for more than half of our greyleg geese, and of St. Kilda for the Manx shearwater, Leach's petrel and puffins, as well as the archæological importance of South Uist. Lord Carrington, who replied, was content, however, rather to argue the value of a range in Britain instead of overseas than to answer either the social, cultural or scientific objections; though he acknowledged the need to preserve undisturbed as far as possible the wild life of the islands.

Lord Polworth withdrew his motion, but the particular project clearly calls for further discussion; and, if it is essential for the project to proceed, the Government would be wise to deal with the general issue in such a way as to facilitate carrying with it general consent of the country. If proposals involve not merely the disturbance of a particular community but also the destruction of an irreplaceable cultural and scientific heritage, it is important that the decision should be seen to be justified on full consideration of all that is involved and of what the scientific implications may be. Such decisions can never be easy, but too great care cannot be taken to remove all grounds for the suspicion that the judgment may have been made by some interested party without adequate regard to its implications in other fields. Public opinion remains the ultimate safeguard; but the Government could do more to promote the formation of an informed public opinion, and to remove the undoubted danger that difficult decisions of this kind may spread a wave of defeatism and disappointment that offsets much of the advantage to defence inherent in the decision.

LANGUAGE OF THE EMOTIONS

The Expression of the Emotions in Man and Animals

By Charles Darwin. Pp. xi+372+15 plates. (New York: Philosophical Library, 1955.) 6 dollars.

THE scientific study of expressive movement and action began with Sir Charles Bell's famous "Anatomy and Philosophy of Expression", first published in 1806. Important contributions from the Continent of Europe did not come until half a century later, in the work of Duchenne (1862), Gratiolet (1865) and Piderit 1867). Darwin's own studies of expression date at least from 1838, although his book was not published until 1872. Continental scholars, especially students of the origin and development of language, have shown a sustained interest in this subject; but since the work of Darwin there is little to report from Britain, perhaps because the demeanour of the natives is less demonstrative than it is across the Channel.

Darwin's investigation is marked by the comprehensiveness of his sources as well as by an acute sensibility in detecting the finest nuances in human expression. His data consist of observations of infants, the aged, the insane, the commoner animals, photographs, and paintings and sculptures of the great masters. This is supplemented by reports on the behaviour of diverse ethnic groups and cultures obtained from thirty-six observers living in Australia, China, India, Africa and North and South America.

The origin and development of all the expressive actions in man and animal he attempts to explain by means of three principles: the principle of serviceable associated habits; the principle of antithesis; and the principle of the direct action of the nervous system on the body.

Judged by present-day standards of statistical technique, his methods of sampling and of drawing inferences would perhaps scarcely be considered adequate. We do not share his faith in "associationism". Nor would we speak of "thrills of nerve-force" or of the inheritance of tricks and gestures. Yet somehow his conclusions do not seem any the less convincing; the high quality of his initial observations appears to make up for any lack in quantitative precision. The idea that a flood of new cybernetic light would be thrown on his subject by substituting 'communication' for 'expression', as seems to be implied by Dr. Margaret Mead in her preface, is perhaps a little sanguine.

Blushing, to which Darwin devotes an entire chapter, seems to him to stand in a class apart. He regards it as the most peculiar and the most human of all expressions. We cannot cause a blush by physical means—that is, by any action on the body. The mind must be affected: "thinking what others think of us, excites our blushes". We do not expect him to accept Burgess's view that blushing was specially designed by the Creator in order "that the soul might have sovereign power of displaying in the cheeks the various internal emotions of the moral feelings". The hypothesis he prefers rests on his belief that our powers of attention can influence the capillary circulation. He cites many eminent anatomists and physiologists, including Holland, Laycock, Carpenter, Paget and Johannes Müller, in support of his view that attention or consciousness concentrated on any part of the body produces some direct physical effect on it. But he admits that the means whereby attention—"perhaps the most wonderful of all the wondrous powers of the mind"—is affected is an extremely obscure subject. How far removed he is from those who believe that consciousness and attention are nothing more than occult qualities gratuitously introduced into the palpable world of anatomical 'reality', a world in which one is at most permitted to say that "the brain makes up its mind"!

He concludes that expressive actions are in general inherited and that only a few expressive movements, such as those of the hands in prayer, are learnt. The fact that the chief expressive movements are the same throughout the world he regards as affording an argument that we are descended from a single parent-stock, which must have been almost human before the divergence of the "races".

It is to be hoped that this new edition of Darwin's work, which has not by any means yet received the study it deserves, will serve as a reminder that there is an inner life of human emotion of which actions and gestures are simply manifestations. The scientific study of emotional experience is therefore not merely the lining of physiology.

JOHN COHEN

AMERICAN METHODS OF MATERIALS TESTING

The Testing and Inspection of Engineering Materials
By Prof. Harmer E. Davis, Prof. George Earl Troxell and Prof. Clement T. Wiskocil. (McGraw-Hill Series in Civil Engineering.) Second edition. Pp. xv+431. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 49*s*.

THE testing of materials is a fundamental necessity at some stage in all manufacturing or constructional processes. To what extent it can be treated as a particular subject for a course of instruction depends, of course, upon the educational establishment concerned. This book has been written as a text-book for such a course. The authors state in the preface that it is their aim "to provide a general treatment of the principles and problems of testing with specific reference to the mechanical properties of engineering materials and to establish the basis for the inspection of these materials". As such, it is a good review of mechanical testing in a wide form and has a very comprehensive reference list. It is written for Americans and refers entirely to standard specifications in the United States; hence there are limitations on its usefulness in Great Britain.

Two introductory chapters deal with the nature of the problem and the general features of mechanical testing. In Chapter 2, one is immediately struck by the difference in American and British practice by the use of 'yield strength' instead of the synonymous 'proof stress'. Chapter 3 covers load and strain measurement and inspection gauges. A notable omission in the otherwise comprehensive survey of strain gauges is the vibrating wire gauge.

Static (that is, tensile, compressive, etc.) tests are covered in great detail in the next two chapters, and hardness tests in Chapter 6. The Vickers diamond-pyramid hardness test, however, receives only half a page. Chapter 7 deals with impact tests and has certainly been brought up to date by reference to recent work on the dependence on temperature of notch brittleness of steels.

Fatigue and creep are the subjects of Chapter 8, but are covered very briefly compared with previous subjects, having only twenty-four pages devoted to them. On p. 220 the authors state the well-known fact that duralumin does not show a well-defined endurance limit, but then quote a value for it on p. 221. Non-destructive methods of flaw testing are outlined in Chapter 9 and include visual, X-ray, γ-ray, magnetic, electric and ultrasonic methods. Chapter 10 is a useful chapter on analysis and presentation of data and mainly deals with elementary statistics of observation. Chapter 11, entitled "The Principles of Inspection", deals with the organizational aspect of the problem and is concerned with the inspector, his qualifications, duties and responsibilities.

Part 2 is a section on laboratory work in testing and inspection, and outlines a series of twenty-four exercises that would make a suitable course. The appendixes include a brief summary of the principal mechanical properties of the more-important metals and non-metallic constructional materials. The book would form a good guide to a technical college course on mechanical testing, but would not be suitable in a university curriculum except as a reference book to American methods. K. J. Pascoe

DETERGENTS IN THE FACTORY

Industrial Detergency

Edited by Wm. W. Niven, Jr. Pp. iv+340. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 70*s*. net.

Cleaning is an operation widely employed in industry. As the introduction to this book points out, it may constitute the major basis of the industry as in laundering; it may be an inherent part of the process by which the finished product is made, as in metal plating; it may safeguard the quality of the finished product, as in the food industry; or it may add to general efficiency, as in plant maintenance. Great technological advances have been made during recent years, and the declared aim of the book is to give a comprehensive treatment of industrial detergency, a subject to which few books have been devoted in their entirety.

A very brief chapter is entitled "The Fundamentals of Detergency". The author admits that this may be a misnomer and that no attempt has been made to discuss the physical chemistry of detergent systems. Other texts need to be studied to obtain a proper understanding of the subject. The chapter on detergent materials is more adequate. Evidence is given to rebut a commonly held belief that the action of synthetic detergents is unaffected by water hardness, and it is emphasized that not all surface-active compounds are detergents. Examples of commercial products are restricted mainly to those of American manufacture.

All cleaning operations must be designed according to the characteristics of the substrate being cleaned, and therefore classification according to industry has been adopted, seven authors contributing to this section of the book. Because of this, some overlapping has occurred, for example, in the chapters on detergent materials and the laundry industry. The latter chapter deals almost exclusively with practice in the United States. The advantages of including a controlled amount of water in dry-cleaning baths are becoming more and more appreciated, and some discussion is given of the theory underlying this addition, although I do not agree that dirt redeposition is adversely affected by the presence of limited amounts of adsorbed moisture on wool in certain detergent systems.

Subsequent chapters deal with detergency in the textile and food industries. Little is known of the effect on man of the ingestion of small quantities of detergents over a prolonged period, and it is therefore appropriate to emphasize the importance of thoroughly rinsing away detergents, so that subsequent contamination of foodstuffs prepared in plant cleaned by them does not occur. Much that is said in the individual chapters on foods and beverages, the dairy industry and dish-washing applies equally to all these applications and could more conveniently have been dealt with under one main heading. The final chapters are devoted to the metals industries and to general industrial cleaning, which covers a range of applications from simple floor-cleaning to the complex treatment of aircraft.

One of the problems in any application of detergents is the selection of those products which are most suitable for the purpose. The evaluation of detergents is not dealt with for every application described in the book, and although the information is available elsewhere, its inclusion would be appropriate in a comprehensive manual of this nature. Nevertheless, the book contains a great deal of useful information concerning American methods in a wide range of cleaning processes. R. E. Wagg

ORGANIC REACTIONS

Organic Reactions

Edited by Roger Adams, A. H. Blatt, Arthur C. Cope, David Y. Curtin, Frank C. McGrew and Carl Niemann. Vol. 7; pp. viii+440; 72*s*. net. Vol. 8; pp. viii+437; 96*s*. net.
(New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953–54.)

Each of the volumes in this series consists of a number of chapters, dealing severally with a single reaction capable of wide application, or sometimes even with a particular phase of such a reaction. The series was begun in 1942, and from its inception it has progressed under the wise direction of Prof. Roger Adams as editor-in-chief, assisted by changing teams of skilled and experienced collaborators.

These successive volumes provide a welcome aid to the practising organic chemist, having his habitation in these latter days in the midst of a deep and rapid river of literature which threatens to rise and engulf him. The life-line of "Beilstein" and similar publications so often falls short of his needs that supplementary devices have become essential if he is to keep his head above water. In other words, the practitioner of organic chemistry needs something that will enable him to make a quick, comprehensive and up-to-date survey of the current position in his particular field of work. "Organic Reactions" renders this kind of service by assembling the requisite information under the heads of specific reactions of outstanding importance, thereby bringing about a dissection of a vast body of published material into manageable units. Experience has shown the great practical value of this method of classification, although, of course, it cannot be claimed to meet every need.

The limited goal of each chapter renders possible a surprisingly thorough coverage of the material and publications concerned. Chapter 6 in Vol. 8, on the metalation reactions with organolithium compounds, may be taken as a typical example. A section of forty-seven pages includes an introduction followed by concise accounts of the mechanism and scope of the reaction. Other types of metalating agents are then mentioned; and details of experimental conditions and procedures are followed by a tabulated summary of such reactions to be found in the literature up to the end of 1952, the yield and literature reference for each of a couple of hundred compounds being given. The seven chapters of Vol. 7 include, among others, the Pechmann reaction, the Skraup synthesis, the von Braun cyanogen bromide reaction, and the epoxidation and hydroxylation of ethylenic compounds with organic peracids. Vol. 8 contains eight chapters, including catalytic hydrogenation of esters to alcohols, the Sommelet reaction, the metalation reaction with organolithium compounds, and β-lactones.

Some of the cathedrals and other noble buildings in Britain enjoy partial relief from their burdens through the activities of associations of 'friends': Prof. Adams and his collaborators, fulfilling a similar beneficent function for molecular edifices, might well be hailed as 'friends of organic chemistry'.

JOHN READ

NEW METHODS OF SCHOOL TEACHING IN AUSTRALIA

Teacher, Pupil, and Task

Elements of Social Psychology applied to Education. Edited by O. A. Oeser. Pp. xiii+196. (London: Tavistock Publications, Ltd., 1955.) 18*s.* net.

IN 1953 a refresher course for teachers, carried out by the method of group discussion, was held at the University of Melbourne, and fourteen contributors to this book, all of them teachers in the University or in training colleges, were leaders of these discussions and have prepared the book in response to a demand by the teachers for a reference manual. The editor, O. A. Oeser, who also contributes two chapters, is professor of psychology at Melbourne.

It would seem that the teachers might have profited by a longer and more thorough treatment of the topics discussed—although suggestions are given for further reading. As it is, the separate sections of the book differ considerably in method of treatment, and in general satisfactoriness. The chapters on testing and on examinations are simple and straightforward; but they are not sufficiently detailed, and neither is that on vocational and educational guidance. The chapter on 'the problem child' is as adequate as is possible in covering such a complex subject in a small space.

But the most interesting and most controversial part of the book deals with the promotion of good social relations between staff and pupils, and of the pupils with each other. It is recommended that the natural social affinities of the children should be assessed by Moreno's sociometric technique; that classes should be divided up into small groups, on the basis of these affinities and of similar ability; and that the groups should carry out their school work as a group activity, with the teacher suggesting and guiding rather than giving direct instruction. Now the suggested method undoubtedly offers points of great interest; and it seems possible that it does promote highly desirable easy and friendly social relations. It is also claimed to make the children more active and more interested, and to stimulate them to work better. But little evidence is available to substantiate this claim.

It seems unlikely that the more intelligent children would profit by these methods in studying the more arduous and difficult subjects. Indeed, the result might be to produce the type of individual described in American society by David Riesman in "The Lonely Crowd": the individual whose sole purpose it is to get on well with others, to adapt his behaviour flexibly to his society, and to do what is expected of him by others. Perhaps the authors have no such intention. But it would be disastrous if such procedures were adopted uncritically, without further experimental test, to the neglect of the intelligent and highly individualistic child, whose particular interests and initiative require individual encouragement and strenuous adult teaching.

SOCIAL ANALYSIS OF LIFE IN A MENTAL HOSPITAL

The Mental Hospital

A Study of Institutional Participation in Psychiatric Illness and Treatment. By Dr. Alfred H. Stanton and Dr. Morris S. Schwartz. Pp. xx+492. (London: Tavistock Publications, Ltd., 1954.) 35*s.* net.

DURING the past ten years American sociologists and social psychologists have shown great interest in the analysis of subordinate institutions within their society and, in particular, in studies of prison and of mental-hospital communities. This focus of attention has been influenced no doubt by contemporary events, which have directed attention to the overcrowded State prisons and State hospitals as social problems of some urgency. In the latter case, the quickening of theoretical interest has been due in no small measure to a series of papers by A. H. Stanton and M. S. Schwartz which began to appear in 1949. The three-year study of the functioning of a mental-hospital ward, on which these reports were based, is the subject of this book.

If there is one generalization which can be safely made about any human institution, it is that it is not perfect. Social analysts, like psycho-analysts, find it easier to recognize failures of function than to do justice to systems which work smoothly. The great merit of this work is that it subjects to careful scrutiny all those aspects of mental-hospital life (such as the formal administration, the daily interactions among patients and between patients and personnel) which tend to be taken for granted and ignored. In repeated instances, the authors have demonstrated that patients' illnesses can be aggravated or relieved in response to events occurring in this social penumbra. Their discoveries are often too true to be altogether welcome. Already they have provoked reactions from incensed administrative psychiatrists; but the data and their interpretations remain, to be confirmed or modified by other social scientists.

Two criticisms may legitimately be directed against this work. First, it is disappointing that original explanatory concepts are so rare; most are derived from established inter-personal theory, and the most original of all (the effect upon a patient's mental state of covert disagreement between two of those in charge of him) now appears to be attributable to previous observations by Suzurek. Secondly, with some notable exceptions, there are all too few instances where the *verstehende* concept (an intellectually satisfying explanation) has been confirmed by systematic, statistically significant, observations. This defect is in part a measure of the pioneering quality of the authors' work, and can be remedied. A valuable section of the book, which will interest everyone concerned with mental-hospital practice, is the review of recent sociological studies in this field.

G. M. CARSTAIRS

ORGANIZATION OF DEFENCE RESEARCH IN BRITAIN

By CHAPMAN PINCHER

THE organization of defence planning in Britain has undergone a revolution since the beginning of the Second World War. Whereas scientists were previously regarded with some suspicion by fighting men as being usually impracticable dreamers, defensive planning is now dominated by scientific thought and methods.

This change would have been inevitable following the emergence of nuclear bombs, guided missiles and other extremely intricate devices; but Britain got off to a good start in post-war defensive thinking because the formulation of policy was already being guided by scientists. This was largely due to the efforts of a few pioneers like Sir Henry Tizard, whose foresight resulted in such war-winning devices as radar.

The present system dates from the establishment of the Defence Research Policy Committee under Tizard in 1946. This Committee dominates the picture and must be considered in some detail.

The Committee is responsible to the Minister of Defence. It consists of fourteen men, the permanent chairman, the Deputy Chief of Naval Staff, Deputy Chief of the Imperial General Staff, Deputy Chief of Air Staff, Deputy Controller (Research and Development) Admiralty, Scientific Adviser to the Army Council, Scientific Adviser to the Air Ministry, Chief of the Royal Naval Scientific Service, Chief Scientist of the Ministry of Supply, Controller of the Navy, Controller of Supplies (Munitions) Ministry of Supply, Controller of Supplies (Air) Ministry of Supply, Controller of Guided Weapons and Electronics, Ministry of Supply, and Secretary of the Department of Scientific and Industrial Research (see p. 260).

A special subcommittee deals with atomic matters and co-opts experts such as Sir William Penney. Special *ad hoc* panels are occasionally set up to take advantage of specialist brains in the universities and in industry.

Since August 1954 the chairman has been Sir Frederick Brundrett, who previously served as deputy to Sir Henry Tizard. Sir Frederick is also scientific adviser to the Minister of Defence and with the additional influence of membership of several other committees is currently the commanding figure in the defence research field.

The Defence Research Policy Committee is purely advisory and has no executive powers; but once its conclusions are approved by the Chiefs of Staff and Minister of Defence, they cannot be changed without the Committee's further agreement.

The cycle of events begins with the formulation of weapons *requirements* by the Chiefs of the separate Services. The Service officers who are responsible for the formulation of requirements are the Deputy Chiefs who are members of the Committee. At this stage these men have a general idea of the performance they want in new weapons and are guided in keeping the requirements within the bounds of practicability by the individual scientific advisers attached to their staffs. It will be noticed that the scientific advisers to the Army Council, Air Ministry and Admiralty (the Deputy Controller (Research and Development)) also figure on the Defence Research Policy Committee.

The Staff requirements are then passed to the Controllers in the Supply Ministry, in the case of the Army, Royal Air Force and Naval Air Services. The general Naval requirements are passed to the Controller Admiralty. (Again it will be seen that these four men also sit on the Defence Research Policy Committee.)

In the Ministry of Supply and Admiralty scientists examine the research and development problems raised by the requirements to consider how they can be met with available resources. They study the questions of man-power, materials, research equipment and techniques. Their considered opinion then goes back to the Service Chiefs who originally formulated the requirements.

It is at this stage that the requirements, by this time usually modified in the light of the opinions already passed to them, are considered by the Defence Research Policy Committee, which it will be seen contains the officers in the several departments who hold executive responsibility for the various aspects of the work. The Committee's prime function is to ensure that the whole defence programme is kept within the limits of the country's resources and finance and that there is no unnecessary overlapping of research effort between the Services. The Service demands are invariably well in excess of possibilities, and the Defence Research Policy Committee does the pruning.

The Committee normally meets once a fortnight. The agenda has been fixed and there is a firm rule that the members must have been notified at least a week in advance of every item to be discussed. This means that the members have had ample time to consider the subjects before the meeting begins.

To do its preliminary work the Committee has a small staff which is carefully selected both from the point of view of ability and security.

There is a full-time staff consisting of a Forces representative and a scientist from each Service with an administrative under-secretary from the Defence Ministry. The Defence Research Policy Committee appoints a scientist to act as the chairman of this full-time staff annually.

In addition there is a part-time staff which is entirely scientific consisting of one representative from each Service, the Ministry of Supply and the Naval Scientific Service. These men remain in their normal posts but devote about half their time to Defence Research Policy Committee work.

The men chosen for these staffs must have special aptitude for viewing the nation's defence problems as a whole without being unduly biased by loyalty to their particular Service.

The Defence Research Policy Committee gets guidance on strategic policy in the form of directives from the Staff Chiefs and the Minister of Defence, which enable it to assign inter-service priorities for those requirements and projects which are considered feasible.

These priorities are, of course, in general terms. Final decisions on precise priorities in individual experimental establishments must necessarily be taken by the supply Ministries, which know the day-to-day situation concerning facilities.

When agreement has been reached by the Defence Research Policy Committee and the resulting programme approved by the Chiefs of Staff and Minister of Defence, executive action is put in hand by the Ministry of Supply or the Admiralty. The work is then begun at one of the Government experimental establishments, or is farmed out to industry.

These Government establishments are numerous and employ several thousand scientists and engineers. Among the best known are the Royal Aircraft Establishment at Farnborough, Hants, the Telecommunications Research Establishments, Malvern, the Fighting Vehicles Establishment at Chobham, the Microbiological Research Department and Chemical Defence Research Establishment at Porton, the Admiralty Signal and Radar Establishment at Portsmouth, and the Admiralty Research Laboratory at Teddington. Atomic weapons research requirements are passed from the Ministry of Supply to the Atomic Weapons Research Establishments of the Atomic Energy Authority at Aldermaston, Berks.

Many industrial firms have set up substantial departments and in some cases entire factories for defence research and development.

Through its staff which visits the experimental establishments and industrial concerns involved, the Defence Research Policy Committee is kept informed on how projects are progressing. From time to time projects have to be modified or occasionally scrapped because they are not working out according to plan, have been made obsolete by events or for economy reasons.

The duties of the Committee so far described deal with clear-cut applied research. There is a special Research Sub-committee which concerns itself to ensure that the more nearly fundamental research for defence purposes carried out in Government establishments is kept on what appear to be the most profitable lines. Clearly even in fundamental research carried out with public funds, limits have to be set much more closely than in the universities.

It will be seen that the Committee does not usually initiate projects, but functions mainly by modifying the proposals of others. Nevertheless, it does exert considerable influence on future projects through its annual report called the Defence Research Policy Review, which is, of course, a highly secret document. The first part of the review is a progress report, but Part 2 is a "Way Ahead" section dealing with future requirements.

For such wide strategic surveys the Committee needs to be informed on some aspects of foreign weapons developments. This information is supplied by the Staff working in the Defence Ministry which controls the Joint Intelligence Bureau (see *Nature* of March 26, 1955).

The Committee looks into special fields two or three times a year to produce detailed reports on such subjects as guided missiles, radar, and signals communications. It also examines and co-ordinates draft annual estimates on research and development submitted to the Ministry of Defence by the Admiralty and Ministry of Supply.

The views of the Committee are continually made known to the Cabinet by the Defence Minister, who is kept advised of the Committee's activities through the chairman. As pointed out in *Nature* of January 7, p. 18, the Defence Minister has been given responsibility for framing general policy governing research and development. In this connexion he relies heavily on the chairman of the Defence Research Policy Committee, who is also his personal scientific adviser.

Not only is the chairman in constant touch with the Defence Minister but he is also occasionally invited to sit in at meetings of the Cabinet's Defence Committee. In addition, he is in regular touch with the Chiefs of Staff and frequently attends meetings of their Committee, which now has a permanent chairman (Sir William Dickson) based in the Ministry of Defence.

Thus the chairman of the Defence Research Policy Committee is able to ensure that its members are in turn kept aware of the Government policy which must overshadow all defence planning.

AUTOMATIC CONTROL IN THE PROCESS INDUSTRIES

MUCH attention has been directed recently to the potentialities of automatic control as a means of increasing industrial efficiency, particularly by the use of electronic measuring and control equipment and, above all, by employing electronic computers. Rapid advance towards the completely automatic factory has been predicted and serious misgivings have been raised about the social consequences of employing more and more automatic equipment in place of men to control factory operations.

Consideration of the completely automatic factory and its implications for society as a whole can, however, safely be confined for the time being to the light engineering industries, in which the mass production of components is carried out by machines on a production line. The automatic control of such production lines has already been highly developed in specific cases and will, no doubt, be extended rapidly in the near future. In the process industries, however, a completely automatic factory is still a long way off and, if it ever comes into existence at all, it will be based on a steady evolution of technique rather than on spectacular revolutionary advances. Individual sections of, say, oil refineries or chemical works are at present automatically controlled to a large extent. They could not in many instances be successfully operated without their automatic control systems; but on the other hand they still demand the presence of human operators to reset the automatic controllers to meet the needs of changing conditions.

The process industries have been steadily developing and applying automatic control over the past thirty years, and the number of operators employed is consequently already small. Economies in operation, due to improved automatic control systems, will not result in general from the decrease of this small number of operators but rather from improved efficiency of operation. The problems to be overcome in the further development of automatic control in the process industries are, therefore, purely technical and unlikely to involve questions arising from redundancy of operators.

The object of the very considerable amount of research and development being carried out in the field of process control is to make available the full potential of automatic control to decrease production costs. This object can only be achieved by taking account of the requirements of the control system when the process and plant are being designed. To do this, the designer must be able to calculate the characteristics of the process and plant, and to predict the effect of modifications to their design on all aspects of operation—including control. This must require a quantitative knowledge of those characteristics of process and plant which determine their controllability.

It is self-evident that when a control system has to take action, it must either correct a disturbance in conditions or effect a desired change in them. Thus, to design and adjust a control system it is necessary to know how the plant and process respond to changing conditions; that is to say, it is necessary to know the 'dynamic' characteristics of plant and process as well as their characteristics in steady conditions.

The development of automatic control techniques in the process industries has been very severely hampered by lack of knowledge of these dynamic characteristics. Until they can be calculated, control systems cannot be designed quantitatively. In related fields, such as the design of electrical amplifiers or of servo-systems to control machines, a much more quantitative approach to control system design is possible because the dynamic characteristics of the controlled system itself can be calculated with much more accuracy.

Since 1946 there has been a noticeably increasing emphasis, in the papers written on process control, on the necessity for studying the dynamic characteristics of processes and plant, and for enlisting the assistance of all concerned with their design and operation in obtaining the data required, by experiments on the factory.

The engineers responsible for the development and design of processes, and the engineers responsible for the design of their control systems, have a common interest in obtaining these data and in collaborating to develop the technique of process control system design. They must also collaborate closely with those responsible for operating process plant, on which the necessary experiments to obtain data must be carried out. The plant designer, who is often a chemical engineer, must play a vital part because he will have the responsibility of incorporating in the plant the design features which these investigations will show to be desirable for improving controllability.

The importance of close collaboration between the engineers concerned with the design and operation of processes and plants and the control system designers has been stressed repeatedly during the past few years. The most recent and authoritative statement on this subject was made by Sir Harold Hartley in April 1955, in his presidential address to the Institution of Chemical Engineers. In this address the problem is clearly stated as follows:

"In the chemical and process industries, the whole tendency is towards continuous plants with the economies they offer in capital cost, man-power and throughput—whenever the volume of production is sufficiently great. Such continuous plants have demanded a large amount of instrumentation and automatic control and one of the main purposes of a pilot plant is to investigate the instrumentation required. In many cases the plants have been designed and the instruments and control added later, and in fact all processes are really manually controlled because every major load change in general requires re-setting of the desired values of all the controls. Electronic devices are much quicker and more accurate than the human senses, and with appropriate servo-mechanisms they offer great advantages. With the rapid advances in the design of automatic controls, design engineers have been able to make considerable improvements by the incorporation of the latest standard instruments as they come on the market. Recently this approach to the process design problem, the addition of controls to process flow sheets, has reached something of a stalemate. It is now clear that the major advances will only be achieved if the use of automatic control is considered in the earliest design stages. This means that there must be consultations between the chemical engineer and the automatic control engineer from the earliest stages and a sympathetic understanding between them.

"We must move on from the stage of adding process controls in an empirical manner. This is not an easy matter, however, and it will call for a basically new approach to the problem of process design. Two difficulties appear to stand out. First there is a grave shortage of automatic control engineers with the necessary experience. Coupled with this is the shortage of chemical engineers with sufficient understanding of the theoretical approach to automatic control. Secondly, there is an almost complete lack of the information on plant and process characteristics which is required to enable automatic controls to be applied in a scientific way. Thus we have to face a dual problem of education and training on the one side and lack of quantitative data on the other."

Some six months earlier, Sir Harold had proposed a joint conference between the Institution of Chemical Engineers and the Society of Instrument Technology—the membership of which includes the majority of those actively interested in developing and applying automatic control in the process industries. This proposal was welcomed by the Institution and the Society alike as a means of attacking the "dual problem of education . . . and lack of quantitative data".

The need for the conference was very clearly demonstrated by the attendance of about eight hundred engineers, physicists and mathematicians at Church House, Westminster, on October 4, when the proposed conference was held. Both the size of the attendance and the very representative cross-section of engineering interests it represented afforded clear proof of the interest in the subject of discussion, namely, "Automatic Control in the Process Industries".

The first object of the Conference was defined in the following words by Mr. John Oriel, president of the Institution of Chemical Engineers, in his opening address. "The time has passed when instrumentation could be looked upon as a luxury; nowadays, with much of our plant designed for continuous operation, often with high throughput and with very severe operating conditions, the control is an essential part of the process itself, and the design of the plant is incomplete unless full account has been taken of the instrumentation. The need, therefore, for the closest collaboration between the instrument technologist and the chemical engineer during the design, development and operation stages is of the greatest importance. The need for a complete understanding of each other's problems cannot be over-estimated." Mr. Oriel thus placed the emphasis firmly on the need for close collaboration between those who develop and design control systems and those who develop and design processes and plant, and the necessary basis for such collaboration is stated unambiguously; namely, "a complete understanding of each other's problems".

The Conference was therefore essentially educative and the papers were carefully arranged to give as concisely as possible, and in the simplest terms, the basic information required by the chemical engineer to enable him to appreciate the requirements of the control system when designing processes and plants, and the necessity of carrying out investigations on full-scale plant in order to obtain information about the mechanism governing its behaviour as part of the control system.

It may well be asked at this stage why the chemical engineer has not become familiar with the basic principles of automatic control during his academic training, and why he cannot supply the information about his processes and plants which is required by the control system designer. These two questions must therefore be answered; but first it must be emphasized that the real significance and importance of this Conference rests on the fact that it marks the recognition of the problem which the questions pose, and represents the first step in a combined attempt by the plant designers and control system designers to solve it.

Education of the Chemical Engineer in Control System Design

The education of the chemical engineer is not complete unless he has a knowledge of the basic principles underlying the proper application of instrumentation and automatic control to industrial processes and plant, because, as has been stated already, their design and their method of operation have become (and will become increasingly) dependent for their economic success on their controllability. The universities and technical colleges have recognized the desirability of providing the chemical engineer with a knowledge of these basic principles, and the chemical engineering departments of several universities have made a generous allowance in their teaching programmes for a study of control systems. The very wide field to be covered in a chemical engineering syllabus makes this difficult to do; and it has been found possible to do it only in those schools which have appreciated the vital importance of the subject and are prepared to sacrifice something else for it. Many even of the younger chemical engineering graduates have had little opportunity, therefore, of studying the subject during their undergraduate years, and it was for these graduates and for those who graduated before instrumentation had achieved the general appreciation it now enjoys that the Conference was arranged.

As time goes on, and the inclusion of substantial courses on automatic control in graduate engineering syllabuses becomes more general, the need for joint conferences of plant and process designers and control system designers will certainly increase. Future conferences will not be primarily educative as in the case of this first conference; they will be pitched at an increasingly advanced technical level and will be concerned with the discussion of system design problems.

Chemical Engineering Data

The available chemical engineering data, although not as accurate as is sometimes desirable, are in general adequate to permit the prediction of process and plant behaviour in steady conditions and, therefore, to permit the economic design of plant to give a specified output of a given product of the required quality—as long as there are no major disturbances to the operating conditions. It is, of course, the object of a control system to eliminate such disturbances or to minimize their effect on operation but it will be clear that if they are to do so most effectively, the dynamic characteristics of the process and of the plant must be designed to make the task as easy as possible. Such design, however, demands a knowledge of the mechanism governing these characteristics, and since this mechanism has not been of immediate concern to the plant designer in his main activity of designing for a steady output he cannot be blamed for not having studied it. In future, however, he must. The essential basis for such study was presented very concisely and simply in the first two papers presented at the Conference

It is not proposed to give a summary of these and other papers presented at the Conference and the discussion upon them because they have been published in full in the *Journal of the Institution of Chemical Engineers*.

Economics

It is of interest, however, to record the very significant fact that in every paper, including the opening address by the president of the Institution and the concluding remarks by Sir Harold Hartley, past president of the Institution, and by the president of the Society of Instrument Technology, the economic aspect of control system design was emphasized. Even in the first paper dealing with fundamental principles. Mr. R. S. Medlock pointed out that the design of a control system depends on the economics of the process, and increasing emphasis was placed on the economic aspect of the problem by each succeeding paper until the last paper but one, by Mr. S. W. J. Wallis, which was devoted entirely to the economics of process control.

This emphasis on the economics of the matter reflects the growing consciousness of control engineers of their responsibility for developing, and applying to the full, the potential of automatic process control as a means of reducing production costs.

The gradual evolution of process control to its present high standard of performance has been so continuous that, to a large extent, its contribution to reduction of process operating costs has been masked. Mr. G. C. Eltenton, in opening the discussion at the afternoon session, was voicing the conviction of the process control engineers themselves, when he pointed out the value of being able to give firm facts to demonstrate the reduction in production costs which automatic control has effected in specific instances. Unfortunately, it is very rarely that it has been possible to obtain the firm figures which are unanimously agreed to be so desirable, and Mr. Eltenton's remarks presented a challenge to both control and chemical engineers which they must take up. This will result in the production of new figures on the economics of process operation, and these will be of the very greatest importance to the subject—not only as a means of extending the use of automatic control in the process industries, but also as a means of improving the design of process control systems and of process plant as a whole.

Organization

Two other very important matters were raised during the Conference; both concerned organization, in different ways. The first concerned the methods of organizing the design of processes and plant in order to bring to bear on the problem the full knowledge available to both the chemical engineer and the control engineer. In opening the discussion following the morning session, Mr. J. E. Braham directed attention to the difficulties involved in this problem, and to the necessity of giving thought to their solution at the present time. Clearly this is very necessary, because much delay will occur in the application of new design practices unless the process industries have built up design organizations of the proper nature to deal with them.

The organizational problem associated with the new conception of combined design by the chemical engineer and the control engineer had received too little previous consideration to permit any immediate discussion at the Conference, but there is no doubt that Mr. Braham's timely warning of the difficulties to be overcome will be the subject of considerable attention in the near future.

The second organizational problem arises from the necessity of building up a fund of experimental data on plant and process characteristics. These data should clearly be collected and correlated, as Mr. Oriel pointed out in his opening address, by some central body "where there can be a ready exchange of data which is so urgently needed" by both the plant designer and the control designer.

Sir Harold Hartley, in his summing up of the Conference, suggested that this might well be a function of the National Chemical Engineering Research Station, which it was recommended by the Cremer Report should be set up and sponsored jointly by the Government and industry. Some delay, however, is unavoidable before any new organization could undertake this responsibility, and it was suggested by the president of the Society of Instrument Technology that the Control Section of the Society could well undertake this important work in the meantime. By doing so, the Society could avoid the delay which might otherwise occur in organizing the collection and correlation of the data and could make a valuable contribution to accelerating progress in this field and thereby decrease the production costs of the process industries.

It is clear, however, that the success of any central organization employed for collecting and correlating technical data, or of any organization in individual companies for putting into design practice the new techniques envisaged, must depend on the close collaboration of process plant and control system designers. The most important result of this Conference has been to stimulate a joint approach to the problem and care must be taken in the future to encourage and preserve it.

AGOSTINO BASSI, 1773–1856

By Dr. G. C. AINSWORTH

Department of Botany, University of Exeter

THE concept of pathogenicity is now so familiar that it seems scarcely possible that less than a century ago the question of the reality of microbial infections could still be a living issue. The controversy which then prevailed was, however, at least for pathogenic fungi, becoming a rearguard action by the few who were unable to appreciate the significance of discoveries made between 1835 and 1846 by an Italian lawyer turned farmer, by a Hungarian medical man in Paris, and by an English country clergyman—microbiologists then, as now, being drawn from diverse disciplines.

The Rev. Miles Joseph Berkeley's classical paper of 1846[1], "Observations, botanical and physiological, on the potato murrain", in which he concluded of potato blight that "the decay is the consequence of the presence of the mould and not the mould of the decay", has long been accepted as a landmark in the history of plant pathology. David Gruby's series of six short papers[2] published between 1841 and 1843, in which he elucidated the mycotic nature of thrush and the principal types of ringworm in man, is generally recognized to have laid a firm foundation for the development of medical mycology. Agostino Bassi (Fig. 1), the centenary of whose death falls on February 15, who was the first to elucidate the etiology of a contagious microbial disease and to effect the experimental infection of one living organism by another, has, on the other hand, been neglected outside his native country. He receives a few words in most histories of biology but he has been largely forgotten, even by mycologists who have perpetuated his name in the specific epithet of one of the common entomogenous fungi.

Agostino Bassi's life was uneventful and can be quickly summarized. He was born in Lombardy on September 23, 1773, at Mairago, four miles from Lodi, where he went to school. Then he studied law at the University of Pavia and after graduating in 1798 was appointed to the post of provincial administrator and assessor at Lodi, later becoming an official under the new Napoleonic regime. Like so many men of genius, Bassi suffered from life-long ill health. Defective eyesight forced him to relinquish office and to retire to his father's farm at Mairago, and one result of this was the publication in 1812 of his first book, "Il pastore bene istruito" ("The Well-educated Shepherd"), a comprehensive work of 460 pages on sheep farming. In 1815 an improvement in his health allowed him to re-enter government service, but only for a year, after which he returned to Mairago, where he devoted himself to agricultural and scientific pursuits until his death in 1856. At first financially embarrassed, Bassi in 1838 inherited a fortune from a cousin, a poor tailor of Mairago who became a wealthy military contractor and was created Count of Sommariva by Napoleon.

Bassi's interests were wide, and, while at the university, in addition to his legal studies, he took courses on mathematics, medicine and various aspects

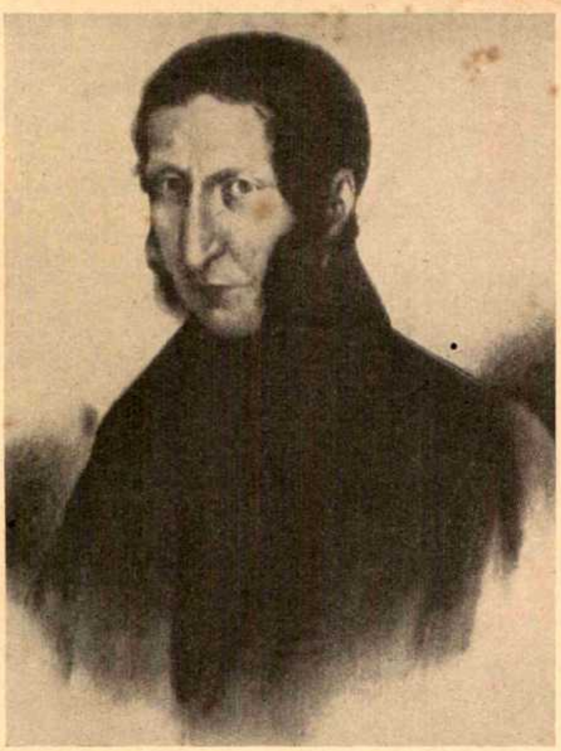
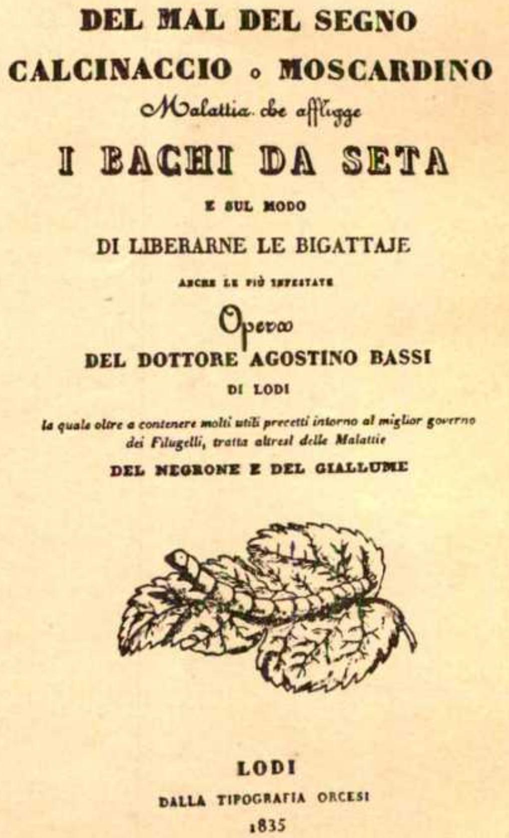


Fig. 1. Agostino Bassi (1773–1856)

of natural science, his teachers including the anatomist Scarpa, the physicist Volta, and Lazzaro Spallanzani[3] (1729–99), the versatile physiologist noted for his studies on spontaneous generation which antedated by a century those by Pasteur and Tyndall. Bassi was also of an inquiring turn of mind and in 1807 he decided to investigate the dread muscardine disease of silkworms which ravaged the silkworm industries of Italy and France. The notion prevailed that the cause of muscardine was 'environmental', that is, was due to the state of the atmosphere, the food, or the method of breeding, and it was to these aspects that Bassi first turned his attention. He "bred silkworms in all ways, subjecting them even to the most barbarous treatment ; the poor creatures died by thousands and in a thousand ways", but not a single case of muscardine disease resulted. He next tested the hypothesis that the disease was due to hyperacidity and studied the effects of phosphoric acid, but although the silkworms again died there was only putrefaction ; no hardening of the corpse and no white bloom on its surface, the characteristic post-mortem signs of muscardine disease. Bassi was able to simulate death by muscardine disease by hanging up silkworms enclosed in paper bags in a chimney over a continuous fire and then placing the hardened corpses in a cellar or keeping them moistened with water. Silkworms so treated deceived the experts, but to Bassi's chagrin they lacked the one essential character of a silkworm which has died from muscardine disease. The "contagious faculty" was missing. They did not induce the disease when placed among healthy silkworms.

Discouraged by his failure, Bassi was "humiliated in the extreme, silent and idle" and "oppressed by a terrible melancholy" for many months ; but in 1816 his spirits revived and he began work again on a new line of attack suggested by his observations on the course of natural epidemic outbreaks. It occurred to him that the disease did not originate spontaneously but was caused by an "extraneous germ". He soon discovered that the infectious material was the white efflorescence which developed on the dead silkworms, and by subjecting this material to microscopic examination (Bassi possessed a compound microscope which after his death was acquired by the town of Lodi ; Berkeley worked with doublets until 1868), he found it to be "a plant of the cryptogamic kind, a parasitic fungus". By a long series of comprehensive and often elegant experiments Bassi was able to demonstrate that this fungus was the pathogen. He showed that silkworms of all ages were susceptible and that an infected worm became infectious only after "calcination"—the sporulation of the fungus over the surface of the dead larva—and he concluded that every "spontaneous" outbreak of the disease could be traced to the introduction of infected silkworms or to the use of contaminated cages or utensils. He also developed measures by which the disease could be controlled.

By 1833 Bassi felt ready to submit his work for adjudication by the University of Pavia, and in 1834 he performed a series of the crucial experiments before a commission of nine professors from the Faculties of Medicine and Philosophy. The professors were convinced. They issued Bassi with a signed certificate which he printed in the preface of the first part of the monograph ("Del Mal del Segno, Calcinaccio o Moscardino" ; Parte Prima : "Teoria", 1835 ; Parte Seconda : "Pratica", 1836) (Fig. 2) in which he gave a detailed account of his investigations



DEL MAL DEL SEGNO
CALCINACCIO o MOSCARDINO
Malattia che affligge
I BACHI DA SETA
E SUL MODO
DI LIBERARNE LE BIGATTAJE
ANCHE LE PIÙ INFESTATE
Opera
DEL DOTTORE AGOSTINO BASSI
DI LODI
la quale oltre a contenere molti utili precetti intorno al miglior governo dei Filugelli, tratta altresì delle Malattie
DEL NEGRONE E DEL GIALLUME

LODI
DALLA TIPOGRAFIA ORCESI
1835

Fig. 2. Title-page of "Del Mal del Segno" (1835)

and his conclusions. This work aroused much interest but was given a mixed reception. Giuseppe Balsamo Crivelli, professor of natural history in the University of Milan, studied the causal fungus and named it *Botrytis bassiana* (now *Beauveria bassiana*), and confirmation of Bassi's findings was published in 1838 by the director of the Paris Natural History Museum, Victor Audouin, to whom Bassi had sent a copy of his monograph and an infected chrysalis. There were opponents, to whose opinions Bassi was perhaps unduly sensitive, but his results were well founded and convinced the unprejudiced.

The study of muscardine disease is Bassi's major achievement. In the years that followed, he issued a second edition of "Del Mal del Segno" (1837) and published additional observations on this disease. He also wrote lengthily on pellagra and cholera, on diseases of the mulberry, vine and potato, and on other topics. He received a number of honours from both Italian and foreign academies, and to commemorate the centenary of Pasteur's birth a collected edition[4] of Bassi's writings was published in Italy in 1925 under the auspices of a national committee headed by Mussolini. The collected writings are supplemented by biographical data and by a bibliography which lists more than forty articles, all in Italian, bearing on Bassi's life and work. The most important account of Bassi in English is that by Major[5].

As with many other outstanding figures in the history of science, Bassi crystallized ideas which were becoming prevalent. The influence on Bassi of Spallanzani's views on spontaneous generation has already been implied, and Bassi must have been familiar with the frequent association of fungi with decay and disease. In England an illustrated observation on salmon disease of freshwater fish had been given as early as 1748, and in 1832 the zoologist, Richard Owen, when dissecting a flamingo which had died at the London Zoo, found the lungs lined with a vegetable mould and concluded that there were Entophyta as well as Entozoa. The trail became even warmer when, as cited by Bassi, Profs. Configliachi and Brugnatelli, of Pavia, suggested that the muscardine disease had a mycotic origin because of the fungus smell associated with silkworms killed by this disease; but to Bassi must go the credit of being more perceptive and persevering than his contemporaries. Bassi's work was in its turn the stimulus that led Schoenlein to discover the mycotic nature of favus in man and it certainly influenced both Gruby and Berkeley; the latter including in his paper on potato blight the first illustration of *Beauveria bassiana* to be published in Britain.

Bassi, if given to verbosity, was a modest and at times almost diffident writer. He was generous to others but he appears not to have suffered fools gladly, for in the preface to "Del Mal del Segno", while appealing to savants and breeders for their observations, he warns them that "to save time and trouble I shall reply only to those which seem to me sufficiently founded in fact to be able to further in some way the progress of science and art". Bassi lived up to his motto: "Quando il Fatto parla Ragion tace, perchè la Ragione è figlia del Fatto, non il Fatto figlio della Ragione" ("When Fact speaks Reason is silent, because Reason is the child of Fact, not Fact the child of Reason").

I am much indebted to Prof. R. Ciferri, of the University of Pavia for a microfilm of Bassi's monograph, for a portrait of Bassi, and for taking me on a pilgrimage to Lodi, and to Mr. P. J. Yarrow, of the University of Exeter, for translations from the Italian.

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[1] Berkeley, M. J., *J. Hort. Soc.*, **1**, 9 (1846). (Reprinted in "Phytopathological Classics", No. 12, 1948).

[2] Zakon, S. J., and Benedek, T, *Bull. Hist. Med.*, **16**, 165 (1944), give English translations of Gruby's papers.

[3] Tortonese, E., *Endeavour*, **7**, 92 (1948).

[4] "Opere di Agostino Bassi" (Pavia, 1925).

[5] Major, R. H., *Bull Hist. Med.*, **16**, 97 (1944).

OBITUARIES

Dr. Arthur Felix, F.R.S.

THE sudden death of Dr. Arthur Felix on January 14 at the age of sixty-eight removes from the bacteriological world one who had made his home in Britain for nearly thirty years and who had come to occupy, in the niche he carved out for himself, a position of considerable authority. The work he had done, much of it as a young man, had earned for him an international reputation, and it was a source of great joy to himself and his friends when the value of his contributions was recognized in 1943 by his election to the Fellowship of the Royal Society. He was an excellent example of the group of investigators who, trained in the field of chemistry and physics, have turned their attention to bacteriology and added so much to our knowledge of medical science.

Dr. Felix was born of Orthodox Jewish parents on April 3, 1887, in Silesia—now part of Poland—not far from Tarnow. He was educated at a German *Gymnasium*, and then went to Vienna, where he studied chemistry and took his doctorate. After a period of two years or so learning mycology under Lafar, he was called up on the outbreak of war in 1914, and attached to a laboratory in a field ambulance posted near Cracow. There he met Weil, associate professor of bacteriology at Prague, under whom his bacteriological training was begun. The two formed an admirable pair. Between them they observed a peculiar phenomenon that they rapidly adapted to the diagnosis of typhus fever, which was then prevalent on the Eastern front. The Weil–Felix reaction, as it was called, proved of immense value in the differential diagnosis of typhus from typhoid and other fevers of unknown origin, and stimulated a great deal of research to explain why it was possible to obtain a specific agglutination reaction with an organism playing apparently no part in the causation of the disease. Intimately bound up with this reaction was a curious variation observed by Weil and Felix in the behaviour of one of the strains—*Proteus X* 1—which was under some conditions motile and under others non-motile. The association of this change with the serological behaviour of the organism was quickly appreciated, and a distinction established between the loose floccular agglutination dependent on the flagella of the motile form and the compact granular agglutination dependent on the body or somatic substance present in both motile and non-motile forms. These observations on *Proteus* were later found to fit in admirably with similar observations made several years previously by Smith and Reagh in the United States on a member of the *Salmonella* group, and provided the basis of a wide generalization on the antigenic structure of bacteria.

At the end of the First World War, Felix worked for a time at Prague and, after taking a three-months course in tropical medicine at Hamburg, moved in 1920 to Palestine, where he served as a hospital bacteriologist for some years. In spite of his attachment to Zionism, he was forced to the conclusion that Palestine could not offer him the opportunities for research that he wanted, and he gladly accepted an offer in 1927 by Prof. J. C. G. Ledingham to join the Lister Institute in London. There he settled down among congenial colleagues and added to his reputation by discovering the *Vi* antigen of the typhoid bacillus. In 1939 he was appointed to a post in the Emergency Public Health Laboratory Service, in which he built up what was later to become the Central Enteric Reference Laboratory and Bureau. His development of the *Vi*-phage typing method for 'finger-printing' typhoid bacilli, which had been introduced by Craigie and Yen in 1938, attracted world-wide interest, and in 1947 Felix's laboratory at Colindale was designated the international reference laboratory for the phage-typing of these organisms. Felix retired from the Public Health Laboratory Service in 1954, and returned to the Lister Institute where, with a research grant, he was able to tidy up some of his unfinished work.

Dr. Felix married in 1923 Leah Gluckman, of Tel-Aviv, who survives him. G. S. Wilson

Prof. James Small

Prof. James Small died on November 28 at the age of sixty-six. Born at Brechin, Forfarshire, he was educated at Brechin High School, the Pharmaceutical Society's School, and Birkbeck College (University of London). After graduation he lectured for a brief period at Armstrong (now King's) College, University of Durham, and then at the outbreak of the First World War joined the Black Watch Regiment. He was wounded and invalided out of the Army in 1916, and returned after a period of convalescence to his appointment at Armstrong College. In 1916 he became lecturer in botany at Bedford College, University of London, and in the following year was appointed also lecturer at the Pharmaceutical Society. He left London in 1920 to take the chair of botany in The Queen's University, Belfast, succeeding Prof. R. H. Yapp. He was elected to the membership of the Royal Irish Academy in 1922, and to the fellowship of the Royal Society of Edinburgh in 1926. He held the chair at Belfast until his retirement in 1954, when the Senate of the University bestowed the title of emeritus professor upon him.

Small's first major research was on the Compositae. His work on this family was published as a *New Phytologist* monograph in 1919 under the title "The Origin and Development of the Compositae", and for this research he received the degree of D.Sc. of the University of London. In 1922, Small contributed a chapter to J. C. Willis's book, "Age and Area", on the evolution of the Compositae, and this initiated a series of papers in which he joined Willis in rejecting natural selection as an explanation of the course of evolution, advocating instead the idea of a sudden origin of species. He drew evidence for this from several groups, plant and animal, but particularly from the diatoms and Foraminifera, which have fossil records suitable for quantitative analysis. Recondite in style, these studies on "quantitative evolution" have seemed to some almost perversely out of step with current evolutionary thought; yet by his intensive analysis, Small brought to light quite remarkable regularities in the evolutionary history of the groups that came under his attention, regularities which remain to be explained by any evolutionary theory claiming to have general validity.

His other main line of research concerned *p*H phenomena in plants. He devised a colorimetrical method for the determination of *p*H in plant tissues in the early nineteen-twenties, and the results of numerous observations were brought together in the *Protoplasma* monograph "Hydrogen-ion Concentration in Plant Cells and Tissues" in 1929. His book, "*p*H and Plants", was published in 1947, and another of a more general nature, entitled "Modern Aspects of *p*H", in 1953. In this year also he wrote a contribution on "The *p*H of Plant Cells" to the current series of *Protoplasmatologia* monographs, and during his final illness he completed the correction of the proofs of a contribution on the estimation of *p*H values in living tissues and saps to Paech and Tracey's "Modern Methods of Plant Analysis".

His work on *p*H led Small to an interest in stomatal mechanisms, on which he published several papers. He was also actively concerned with the problems of protoplasmic movement, and devised a technique for its study in living stems. His important observation of very high rates of cyclosis in living sieve-tube elements of marrow is often overlooked, despite its high significance in relation to solute translocation.

Small's many-sided work on evolution and plant physiology was recognized in 1951 by the award of the Makdougall–Brisbane Prize of the Royal Society of Edinburgh, for distinguished research published in the journals of the Society.

His early interest in pharmacognosy was responsible largely for the writing of Small's "Textbook of Botany" (first edition, 1921; fourth edition, 1937), which was intended principally for the use of medical and pharmaceutical students, and which in its encyclopædic nature reflected its author's own vast acquaintance with morphological botany.

For practically a quarter of a century Small was a member of the committee of the British Pharmacopœia, and he served on the council of the Pharmaceutical Society of Northern Ireland from its inception. He wrote innumerable papers on the botanical characteristics of officinal plants, and contributed a long series of beautifully illustrated articles to the journal *Food* on the structure, properties and uses of drugs and spices.

From 1920, when winning a vest-pocket camera in a newspaper competition provided an introduction, Small had an enthusiastic interest in photography, both technical and artistic. He became keenly aware of the potentialities of photography for recording the structures of botanical objects in the magnification range × 1–20, and his superb pictures taken with the Small–Watson camera have been widely published and exhibited. This activity gained him election to the fellowship of the Royal Photographic

Society in 1938—an honour which he treasured as highly as any that came to him in the more academic sphere.

A great lover of argument, Small never failed to stimulate through his perennial heterodoxy, coupled with his impressive width of botanical knowledge. To those who knew him well he was the most kindly and generous of men, full of a humour which was wont to find its expression at times in the gentle teasing of authority, more particularly authority which was itself humourless.

He is survived by his wife, two sons and daughter.

J. Heslop Harrison

Prof. D. R. Boyd

David Runciman Boyd, who died on December 28, gave forty-one years service to university education in Southampton, and was one of the ablest of a very small and steadfast band whose work has made the University of Southampton possible. Born on February 26, 1872, he was the son of the minister of the parish of Mains, near Dundee. His father died when he was only one year old, leaving a widow and three young children in straitened circumstances. The family moved to Edinburgh, and young David attended the then rather spartan John Watson Institution during 1880–86. After a short period on the classical side of George Watson's College, he moved to Glasgow and in 1888 entered the University of Glasgow. He had a distinguished undergraduate career, gaining prizes in chemistry, natural philosophy and mathematics, and in 1892 was awarded the B.Sc. degree with honours in chemistry. With the Robert Donaldson scholarship he studied in Victor Meyer's laboratory at Heidelberg, acting as Jacobson's assistant for a year, and gained the Ph.D. degree. After about two years as demonstrator in chemistry, under Frankland, at the Mason College, Birmingham, he was one of five lecturers appointed in 1896 to the Hartley Institution, Southampton, with the object of bringing the teaching up to university standard. This was so far successful that the Institution became the Hartley University College, with a small and precarious Treasury grant, in 1902. It was largely due to Boyd and his colleague, John Eustice, head of the Engineering Department during 1892–1931, that the College survived the frequent crises of the first decade of this century.

Up to 1919, Boyd never had more than one academic assistant, and the major part of a heavy teaching programme fell on him. He was an exceptionally clear and inspiring teacher: Prof. C. K. Ingold, a student at the College during 1911–13, writes: "he treated us to a most exciting exposition of the whole of Chemistry as a living, growing subject, rich in opportunity for the questing spirit. Werner's resolution of cobaltammines, and Knorr's and Kurt Meyer's work on ethyl acetoacetate came hot from the Annalen or Berichte, yet without sacrifice to the pattern of the lecture course as a whole. Everything was critically (and remarkably soundly) assessed, and some much publicized but unsound work dealt with severely". After 1920, with a somewhat larger staff, though still small by university standards, the teaching was maintained throughout at a very high level until his retirement in 1937.

Until about 1930, Boyd kept research going actively, despite very meagre resources. His name appears on some twenty papers, and another ten by his pupils are on lines initiated by him. He studied various aspects of the chemistry of aromatic compounds, and a series of papers on organic compounds of phosphorus is of particular interest. Two papers on the kinetics of reaction between sodium derivatives of phenols and ethylene oxides are still frequently quoted. He encouraged several other successful lines of research, in different branches of chemistry, in his department. He was awarded the D.Sc. degree of the University of Glasgow in 1902, and frequently examined for that University.

Boyd was invaluable in the administration of the College, in which he took a large part. He was chairman, later dean, of the Faculty of Science for many years, and vice-principal after the retirement of Prof. Eustice in 1931. He was tall, gentle and dignified, with courtly manners; he spoke and wrote clearly and persuasively, and spoke so little of himself that many of his colleagues were unaware that, over several years while holding the chair, he read for the Bar and qualified as a barrister of the Inner Temple. His unvarying maintenance of high academic standards, unselfishness and outstanding integrity earned the confidence of his colleagues; and he was much loved and respected in his own department. He married in 1909, and had two sons; but his later years were saddened by the death of both his sons in 1944 on war service, and his wife died last August. What the University of Southampton owes to him cannot be over-estimated; and he rendered notable services to chemistry both through his own researches and by the inspiration and sound training he gave to many generations of pupils, whose collective contributions to research and to teaching are an imposing monument to their teacher.

N. K. Adam

Prof. P. N. Chirvinsky

Petr Nikolaevich Chirvinsky was born on February 7, 1880, in Moscow in a family of a scientific worker. In 1902 he graduated from the University of Kiev. In 1909 he was appointed professor of applied geology in the Don Polytechnical Institute at Novocherkassk and finally in 1943 he became professor of petrology in the University of Molotov (formerly Perm). He died on June 21, 1955.

A petrologist and mineralogist by profession, Chirvinsky took all allied sciences as his province. In his fifty-three years of academic life, it is estimated that he published 380 papers and books comprising 6,760 printed pages, and covering such varied subjects as petrology, mineralogy, crystallography, meteoritics, geology, hydrogeology, astronomy, physics, chemistry and geochemistry. Of these the first four were his main preoccupation, and he has to his credit many published descriptions of igneous, metamorphic and sedimentary rocks, minerals and meteorites. He was particularly interested in the mineral composition of granites and other igneous rocks, and in this connexion he elaborated a method of "geometrical–chemical" analysis (1937) and published a book on the average composition of rock-forming minerals (1953). Another interest was the chemical composition and genesis of minerals, and one of his papers on a uranium mineral was published in English (*Miner. Mag.*, 20, 287; 1925). More than eighty papers and notes were devoted to meteorites. He was also very much alive to the wider problems of cosmology and geochemistry. He was a modest and friendly man, and an excellent and inspiring teacher.

S. I. Tomkeieff

NEWS and VIEWS

The Department of Scientific and Industrial Research :

Sir Ben Lockspeiser, K.C.B., F.R.S.

In March of this year Sir Ben Lockspeiser ceases to be secretary to the Committee of the Privy Council for Scientific and Industrial Research. He was appointed in 1949, and has, therefore, had the responsibility of guiding the largest of the Government's Research Councils through a most important phase of its development. When he took over, D.S.I.R.'s recurrent expenditure was little more than £3 million, and its capital grant about £100,000. To-day the first runs at £6·5 million, while the second stands at £1·3 million. In parallel, D.S.I.R.'s scientific staff has increased from 1,700 to 2,400. Sir Ben was ideally suited to bring about this expansion. He brought to his task considerable administrative capacity and experience, and a life-long knowledge of Government scientific establishments. From 1920 until 1939, when he became assistant director of scientific research at the Air Ministry, he was a member of the Royal Aircraft Establishment, Farnborough, and before moving to D.S.I.R., he was successively director-general of scientific research, Ministry of Aircraft Production, and chief scientist to the Ministry of Supply. During the period of his forceful reign, Sir Ben has constantly kept to the fore the conception of D.S.I.R. as an agency which is concerned not only in the cultivation of new scientific knowledge, but also in seeing that this knowledge finds its fruitful application. Under his influence the research associations have prospered, and at the same time D.S.I.R. has strengthened its connexions with industry by establishing a central Intelligence Division.

Sir Ben's influence has also been both valuable and extensive outside the domestic affairs of D.S.I.R. As an official member of the Defence Research Policy Committee (see p. 251 of this issue) he has shared the responsibility of defining the general scientific needs of the Armed Services, and, where necessary and possible, has seen that the facilities of D.S.I.R. have been available for work in this field. He has also been an official member of the Advisory Council on Scientific Policy, through which he has been directly concerned with a wide variety of topics that fall within the field of civilian science, and most particularly with the problem of scientific man-power. Since 1953 Sir Ben has, in addition, been president of the European Organization for Nuclear Research. Sir Ben's voice will be much missed in the Council rooms to whose work he has always contributed with wisdom, and with force tempered by good humour. Although he has now come to the end of his official term of service at D.S.I.R., it is to be hoped that the country will still be able to learn his opinions about the broader affairs of science, and that he will find the opportunity to make his views on science and industry, as well as on scientific education, known to increasingly wider audiences.

Prof. H. W. Melville, F.R.S.

Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham since 1948, succeeds Sir Ben Lockspeiser as secretary of D.S.I.R. Prof. Melville was educated at George Heriot's School, Edinburgh, and at the Universities of Edinburgh and Cambridge. During 1933–44 he was a Fellow of Trinity College, Cambridge, and between 1940 and 1948, before taking up his appointment in Birmingham, professor of chemistry in the University of Aberdeen. He was elected to the fellowship of the Royal Society in 1941, and was awarded the Davy Medal last year for his distinguished contributions to the chemistry of macro-molecular substances. His researches before 1939 were concerned with the mechanism of gas-phase reactions, especially in slow and explosive combustions, and with the photochemistry of polyatomic molecules and photosensitized reactions. Inquiries into gas-phase polymerization reactions, which Prof. Melville took up during this period, laid the foundation for much of his post-war researches. These were mainly directed to the study of liquid phase polymerization ; and the development and combination of a series of completely new physical methods, including highly sensitive methods of following liquid phase reactions, led to the complete eludication of the kinetics and chemistry of this process. Considerable advances were also made in the study of the breakdown of large molecules, while the use of radioactive tracers allowed Prof. Melville to extend his investigations on the chemical side. All these developments have shown how to synthesize completely new types of macro-molecules. Much of this will no doubt be reviewed by Prof. Melville in the Bakerian Lecture of the Royal Society which he is due to deliver in the near future.

Prof. Melville brings to his new responsibilities not only great achievements as an investigator, but also considerable experience of advisory work on behalf of the Government. He was a member of the Advisory Council of D.S.I.R. between 1946 and 1951, and has also served on the Advisory Council of the Ministry of Supply ; on the Research Council of the British Electricity Authority ; on the Fuel Research Board ; and on the Advisory Council of the Ministry of Fuel and Power. He was also a member of the Royal Commission on University Education in Dundee. Many new responsibilities will now fall to his lot, including not only the direction of D.S.I.R. but also the representation of its interests on the Advisory Council on Scientific Policy and on the Defence Research Policy Committee. Prof. Melville's great record of achievement and service provides every confidence that the further development of D.S.I.R. has been entrusted to a man who has all the imagination and drive necessary to fulfil his task.

Directorship of the National Physical Laboratory :

Prof. G. B. B. M. Sutherland, F.R.S.

Prof. G. B. B. M. Sutherland, professor of physics and director of the Biophysics Research Centre in the University of Michigan, has been appointed director of the National Physical Laboratory. It is expected that Prof. Sutherland will take up the appointment in September next ; Dr. R. L. Smith-Rose will continue as acting director until Prof. Sutherland takes up duty. Prof. Sutherland is a leading authority on infra-red spectrum analysis but of recent years has developed especial interests in the field of biophysics. He was educated at the Morgan Academy, Dundee, and the University of St. Andrews. From 1935 until 1949 he was a fellow of Pembroke College, Cambridge. During the early part of the Second World War, Prof. Sutherland was assistant to the Director of Scientific Research at the Ministry of Supply. In 1941 he was made head of a group carrying out research in Cambridge for that Ministry, the Ministry of Aircraft Production and the Admiralty on the structure of hydrocarbons. This work led to significant improvements in aviation fuels. In 1947 he became reader in spectroscopy at Cambridge and in 1949 was appointed to his present post in the University of Michigan. He was elected a Fellow of the Royal Society in 1949.

Zoology in University College, Swansea: Prof. E. W. Knight Jones

Dr. E. W. Knight Jones, deputy director of the Marine Biology Station at the University College of North Wales, Bangor, has been appointed to be the first occupant of the chair of zoology in the University College of Swansea. Educated at Epsom College and at the University College of North Wales, Dr. Knight Jones graduated with first-class honours in zoology in 1938 and started research on the nervous system of *Saccoglossus*, one of the Enteropneusta. He was awarded a Meyricke Scholarship of Jesus College, Oxford, in 1939 and continued his research under Dr. (now Prof.) J. Z. Young. At the outbreak of war he joined the Army, being commissioned in the Royal Artillery. He was promoted captain, mentioned in dispatches and wounded during the crossing of the Rhine in 1945. On demobilization he returned to Oxford to complete his studies on the enteropneustan nervous system, for which he was awarded the degree of D.Phil. From 1946 he was engaged on shellfish research under Dr. H. A. Cole in the Ministry of Agriculture and Fisheries, being naturalist-in-charge at the then newly formed Burnham-on-Crouch station, until he returned to Bangor in 1950 on the foundation of the Marine Biology Station. Much of Dr. Knight Jones's work has been concerned with problems of larval settlement, to which he has made contributions of fundamental importance. He has shown the importance of gregariousness during spat-fall and has directed attention to the constancy of direction of metachronal waves and its relation to the direction of beat in the ciliary tracts of both larvæ and adults. Recently he has shown that many planktonic animals are sensitive even to small changes of hydrostatic pressure, a finding that is likely to prove of great significance in relation to vertical movements.

Institution of Electrical Engineers: Awards

Sir Stanley Angwin has been elected to honorary membership of the Institution of Electrical Engineers in recognition of his outstanding life's work in the field of telecommunication, both national and international, and of his distinguished services to the Institution. Sir Stanley, who was engineer-in-chief of the Post Office during 1939–46, is a past president of the Institution and was awarded the Faraday Medal of the Institution in 1953 (see *Nature*, 171, 287; 1953).

Prof. G. W. O. Howe

The thirty-fourth award of the Faraday Medal of the Institution has been made to Prof. George William O. Howe for his pioneering work in the study and analysis of high-frequency oscillations and on the theory of radio propagation, and for his outstanding contributions to engineering education. After graduating from Armstrong College (now King's College), University of Durham, Prof. Howe gained industrial experience in electrical engineering, and then in 1905 went to the Imperial College of Science and Technology, London, as a lecturer, being appointed assistant professor of electrical engineering in 1909. For a brief spell in 1920 he was head of the Department of Electrical Standards and Measurements of the National Physical Laboratory, and in the following year he was appointed James Watt professor of electrical engineering in the University of Glasgow, a position he held until his retirement in 1946. During 1920–22 he was editor of the *Radio Review*, and in 1923 became editor of the *Wireless Engineer*, an office he still holds. Prof. Howe's association with the Institution of Electrical Engineers began in 1905 when he was elected an associate member. He took a prominent part in the formation of the Wireless (now Radio and Telecommunication) Section of the Institution in 1919, and in 1924 he gave the first of the Institution's Faraday Lectures, his subject being "World-Wide Radio Telegraphy".

New York Academy of Medicine: Awards

The Medal of the New York Academy of Medicine has been awarded to Dr. Eugene Floyd DuBois for his fundamental contributions to the science of metabolism and the understanding of disease, for his work in the development of clinical science and medical education and for his services to the United States during two World Wars in the solution of physiological problems in aviation medicine and submarine warfare. The Medal was founded twenty-seven years ago and is awarded from time to time for distinguished service in medicine, the present award being the tenth to be made. Dr. DuBois, who was formerly professor of physiology and biophysics in Cornell University Medical College, New York, is probably best known for his studies of the physical mechanism of fever, particularly his calorimetric work in skin temperature and heat radiation. The Academy has also presented a plaque to Dr. Malcolm Goodridge for his outstanding services to the Academy, particularly as president during the early years of the Second World War.

Imperial College of Science and Technology

Questions were raised in the House of Lords on January 25 regarding the expansion of the Imperial College of Science and Technology. The Secretary of State for Commonwealth Relations, replying for the Lord President of the Council, said that, in view of the urgent need to increase the output of scientists and technologists in Britain, the Government has decided to adhere to the scale of development for the Imperial College originally announced. To enable this decision to be given effect, new premises for the Imperial Institute will be provided elsewhere. He said that he does not think there is now anything to hold up the original building plan of the Imperial College; the Government is fully aware of the urgency of the problem of expanding technological education.

Manchester College of Science and Technology

Speaking at the associateship ceremony of the Manchester College of Technology on November 26, the principal, Dr. B. V. Bowden, referred to the conferment of a Royal Charter on the College, with the title of the Manchester College of Science and Technology, and paid tribute to the efforts of the past: beginning in 1824 with the building of a Mechanics Institute, which was opened in May 1827, successive developments led to a much larger Institute in 1857, to a Technical School in 1883 and then to what Mr. A. J. Balfour described, in opening it in October 1902, as "the greatest fruit of this kind of municipal enterprise in the country". Three years later, the relation with the University of Manchester was established, under which the University's Faculty of Technology has ever since been in the College of Technology and the professorial staff of the College have been members of the University Senate. Even half a century ago the building just then completed was too small to meet the demands being made upon it, and the building expected to be completed shortly is a little bigger than the one for which plans were first approved in 1914. Two years before the latter date, however, the principal, Dr. Maxwell Garnett, had pleaded for more advanced education for engineers, claiming that while the practical man was as necessary as ever, the practical man of the day was the man who could readily apply theory to practice, when practice was governed by something better than rule of thumb. At that time, the position of Britain in the vanguard of progress was already threatened by developments attributable to the growth of the technical institutions in Germany, the Netherlands and Switzerland, where by 1910 there were twelve such institutions of university rank as against two in Britain. Dr. Bowden said that nowadays the survival of Britain as a great nation depends on the production of many more scientists and technologists than are at present being trained; after referring to the value of the part-time training given by the College, he added that it is hoped to develop an institution which would derive its strength from the traditions of the past hundred and thirty years, but which would be specially adapted to meet the changing needs of to-day, contributing both the ideas and the men which industry needs.

School for Advanced Study at the Massachusetts Institute of Technology

A School for Advanced Study has been established at the Massachusetts Institute of Technology, with Dr. Martin J. Buerger, professor of mineralogy and crystallography, as director. The School will be similar in its objectives to the Institute for Advanced Studies at Princeton, but will differ in that it will be an integral part of the Institute and serve as an extension of the level pursued at the existing Undergraduate and Graduate Schools. These three Schools will thus constitute the three 'horizontal' levels of the Institute, and the staff will continue as members of the five 'vertical' organizations, namely, the Faculties of Science, Engineering, Architecture and Planning, Industrial Management, and Humanities and Social Studies. For the moment, the staff of the School for Advanced Study consists solely of the director and a secretary. Scholars will be invited by the Institute to pursue advanced study and will have the status of Fellows in the School. Up to now there have been approximately a hundred such people a year, from fifteen countries, studying at the Institute, and they have been registered as 'guests' or 'visiting Fellows'. It is hoped that ultimately the new School will provide a centre and adequate housing for Fellows and guests and, by means of special programmes and other schemes, arrange for them to meet in informal conferences among themselves and with the permanent staff of the various Faculties of the Institute. Dr. Buerger, who will assume the office of director on July 1, was a student at the Institute in 1920 and has been on the staff since 1925, becoming a full professor in the Department of Geology in 1944. A former president of the Mineralogical Society of America, he is widely known for his studies in theoretical mineralogy and for the development of new theories of crystal structure analysis.

Nuclear Weapons and Civil Defence

The first of a series of pamphlets in Vol. 1 of the "Manual of Civil Defence", prepared by the Home Office and Scottish Home Department, is one on "Nuclear Weapons" (pp. 55. London: H.M.S.O., 1956; 2*s*. 6*d*. net), and replaces "Atomic Warfare" ("Basic Training", Vol 2, Pamphlet No. 6). Freely illustrated with photographs, diagrams and maps, and lucidly written so that the intelligent layman should have no difficulty in understanding the exact nature of the hazards of nuclear explosions and what can be done to mitigate them, it is nevertheless not a popular exposition for the general public, and something much simpler and more concise would better serve to bring home to the ordinary citizen the value of those few simple precautions which they could themselves take to reduce casualties outside the immediate area of an explosion. The major part of the pamphlet is concerned with the hazards from nuclear radiation, including the immediate and delayed dangers and protection from fall-out as well as the control of exposure to radiation in contaminated areas, but there are chapters on the fire risk and on blast. It is, in fact, in these chapters that the pamphlet best indicates the contribution which common-sense and such simple measures as white-washing windows and remaining under cover can offer against thermal radiation and blast, respectively, and the pamphlet could assist in providing the basic information and stimulating simple practical measures needed. That such measures are severely limited in scope, and that the tactical and administrative measures which are not considered in the pamphlet are of the utmost importance, will not be gainsaid. Nevertheless, a campaign of public education is of the utmost urgency to enable ordinary people to take whatever precautions are in their power, some of which, such as the construction of trenches or shelters and the choice of one type of house as against another, demand a certain amount of foresight and preparation.

Preservation of the Lake District

The report and newsletter for 1955 of the Friends of the Lake District (pp. 25. Ulverston: Friends of the Lake District, 1955) comments on the growing support for the idea that national parks should be financed nationally, and the proposal that some part of the annual interest on the National Land Fund should be used for this purpose has been widely canvassed. A detailed resolution has been submitted to the Chancellor of the Exchequer by the British Travel and Holiday Association, and the Financial Secretary to the Treasury has received a deputation of members of Parliament on the matter and has agreed to raise with the Chancellor the possibility of including some suitable provision in the Finance Act accompanying the next Budget. Moreover, the Minister of Housing and Local Government, at a recent conference of park planning authorities, in suggesting that the time had come to review the working of the Act, emphasized his full support for any efforts to resist undesirable encroachment or disfigurement in the national parks. The newsletter recapitulates in some detail the events which led, in June 1955, to the decision of the North-Western Electricity Board to lay underground the whole of the much-debated line up Borrowdale, between Keswick and Resthwaite, including a loop-line along the far side of Derwentwater, without extra charge to individual consumers in the valley. This result is attributed to the intervention of the Minister of Fuel and Power, following the representations made by the National Parks Commission to that Minister and to the Minister of Housing and Local Government. Negotiations in regard to Langdale and in regard to Patterdale continue. The society, with the Council for the Preservation of Rural England, has also reached a satisfactory agreement with the Forestry Commission in regard to any land within the 300 square miles of the central Lake District which the Commission might acquire and which was not under woodland in 1936. The National Trust has also agreed in replanting its woodlands at Loweswater and above Buttermere to bring in a firm policy of introducing or carefully re-generating hardwoods wherever the ground is not too wet.

Brazilian Association for the Progress of Science

THIS year's meeting of the Brazilian Association for the Progress of Science will be held at Ouro Preto (Minas Gerais) during July 2–7, and as planned at present there will be eighteen sections, although this number is likely to be reduced later. The main themes for the meeting will include "Problems of the Atomic Age" (Physics Section), "The Problem of Petroleum in Brazil" (Geology Section) and "University Teaching of Science" (Education Section). Other topics of special interest are "The Use of Isotopes in Technology", "Ionospheric Exploration", "Metallurgy of Radio-active Metals", "Animal Movement" and, possibly, "*Rauwolfia serpentina*". The great natural resources of Minas Gerais State and the existence of a mining school in Ouro Preto give a specially geological regional interest to the meeting, which will be brought out in various papers to be read on mining for iron and gold, on petroleum and on mineralogy and geology generally. Among the British contributions to the meeting will be a showing arranged by the British Council of a number of recent scientific films, and an address on "The Teaching of Science and Technology in British Universities" by Mr. F. M. Beatty, the British Council's science officer in Brazil.

Oil and Colour Chemists' Association: Eighth Technical Exhibition

THE eighth technical exhibition of the Oil and Colour Chemists' Association, organized by the London Section of the Association, will be held during March 20–22 in the Royal Horticultural Society's New Hall, Grey Coat and Elverton Streets, London, S.W.1, at the following times: March 20, 3 p.m.–8.30 p.m.; and March 21 and 22, 11 a.m.–7.30 p.m. As before, the theme of the exhibition will be the presentation of technical advances in those industries supplying the paint, varnish, printing ink, linoleum and other allied industries. The area covered by the exhibition and the total number of companies and research associations exhibiting (eighty-two in all) are the largest yet reached. A ninety-two page catalogue of the exhibition has been prepared and is available. Admission to the exhibition is free. Further information can be obtained from the general secretary, R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

Optics Meetings in the United States

THE International Commission for Optics will meet this year in the Massachusetts Institute of Technology, Cambridge, Mass., during March 28–April 3, and will devote four days to a symposium on "Frontiers in Physical Optics", which will be open to all interested. At the symposium the following topics will be discussed: new phase-contrast and interference microscopic and measuring devices; thin films and filters; meteorological optics; and nuclear optics. The main papers for these sessions have already been invited and prepared, but time will be reserved for free discussion. In addition to these events, the regular spring meeting of the Optical Society of America will be held during April 5–7 in Philadelphia, Pennsylvania, and this also will be open to all interested. Further information about the meetings can be obtained from Dr. S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, University of California, San Diego 52, Calif.

Announcements

RAYMUND L. ZWEMER, formerly chief of the Science Division of the Library of Congress, has been appointed head of the Division of International Co-operation for Scientific Research in the Natural Science Department of the United Nations Educational, Scientific and Cultural Organization. He will be responsible for Unesco's relations with international scientific unions and other organizations concerned with scientific research on an international scale.

SIR ERIC RIDEAL is to deliver a course of three lectures on "Colloids and their Behaviour" at the Royal Institution on February 28, March 6 and 13 at 6 p.m. This is a refresher course intended primarily for school teachers. Members of the London Branches of the Science Masters' Association and the Association of Women Science Teachers will be notified by their Associations about applications for tickets; non-members should apply to a local branch secretary of one of the Associations.

THE Institution of Naval Architects is offering two scholarships in naval architecture—the I.N.A.–Elgar-Martell of £275 a year, and the Vickers-Armstrongs of £220 a year—both of which are tenable for three or four years at a university institution. They are open to British subjects, less than twenty-three years old, who have been employed in shipbuilding. Applications should be made by May 31 to the Secretary of the Institution at 10 Upper Belgrave Street, London, S.W.1.

THE Council of Europe and the High Authority of the European Coal and Steel Community will award jointly a number of fellowships this year for research into problems of European interest. The fellowships will be worth 300,000 francs each (about £300). The fields of work applicable are as follows: efforts to achieve European integration by co-ordination in the political, social, economic, scientific or educational fields; European civilization in relation to contemporary problems (philosophy, history, literature or the arts); economic, legal or social problems relating to the European Coal and Steel Community and its institutions. Candidates from Great Britain should obtain their application forms from the Education Division, British Council, 65 Davies Street, London, W.1, and return them before March 15.

THE NATURE CONSERVANCY

ANNUAL REPORT

THE Nature Conservancy has virtually completed the building up of its organization and the initial surveys of areas of scientific interest, and in the year ended September 30, 1955, covered by its sixth annual report*, it has been concerned mainly to secure the most effective use of the resources now at its disposal. During the year, the Conservancy declared sixteen new nature reserves in Britain and added to four previously declared, bringing the total acreage to 79,035 acres in thirty-five reserves. The whole programme for national nature reserves was reviewed during the year and, except for a handful of sites presenting special difficulties, it is hoped to complete the programme of declarations within the next four years. Unfortunately, some of the areas of special scientific interest which cannot be included in this programme are suffering considerable damage and losses, and the Conservancy hopes that more local authorities will use their powers to create local nature reserves under the National Parks and Access to the Countryside Act, and also that more voluntary action will be taken by both national and county trusts and societies. Of the three such local reserves noted in this report, that at Ravenglass had another successful season, at Aberlady Bay the legal validity of by-laws applicable to the foreshore made by the Nature Conservancy and appropriate local authorities was established, and by-laws for the protection of the scientific interest in the Castle Eden Denes Local Nature Reserve have been submitted to the Secretary of State for approval.

Financial stringency, as anticipated, greatly embarrassed the Conservancy, compelling postponement of fencing of reserves and long overdue woodland operations. The grant-in-aid received during the year for the general expenses account was £154,500, and expenditure was £157,992, while the grant-in-aid on capital expenditure account was £47,500, including £30,000 for purchase and equipment of the new London headquarters at Belgrave Square, and expenditure was £47,256. Fourteen new research grants, totalling £10,934, were awarded, and twenty-seven grants were continued or renewed; but the funds available for this purpose and the programme of scientific work were quite inadequate. The implications of this financial position and the comments of the Conservancy on co-operation and co-ordination and the like are discussed elsewhere in this issue (p. 245); references to the new nature reserves have already been made in these columns. The following notes are accordingly limited to the scientific work of the Conservancy, whose total staff is now 130, forty-two of whom are scientifically qualified.

The two research stations at Merlewood, More cambe Bay, and at Furzebrook, Poole Harbour, and the Field Station at Anancaun, Kinlochewe, have now completed two seasons of field-work, and the Moor House Field Station on the Westmorland Pennines three. Much of the summer of 1955 was particularly favourable for field-work. The primary work of survey continued, particularly for existing and projected nature reserves; but the emphasis is shifting to intensive specialist investigations of sites of major importance, particularly in connexion with programmes of research. A more intensive survey of distributions is also being carried out with the assistance of such bodies as the Botanical Society of the British Isles. In this work amateur botanists are providing many of the observations. Other examples are the duck counts and the comprehensive survey of inland waters being undertaken by the Wildfowl Trust. Two tentative forest maps have been prepared for Scotland, the first showing the present distribution of native birch, oak, pine, alder and ash wood, and the second attempting to reconstruct the distribution of Scottish forests in the first four centuries of the Christian era, or as it could have been to-day in the absence of man's activities.

Such surveys can be of great value in decisions on land use, and during the year at the Forestry Commission's Gisburn Forest, hardwoods and coniferous trees have been planted on a series of plots statistically designed to yield precise comparisons of productivity and changes in soil status for the different types of timber, and also for sheep-rearing. By this means it is hoped to secure fundamental data of effects of grazing and tree-growth together with practical data on the economic use of hill lands of a type very common in northern and western Britain. Nature Conservancy scientists have collaborated with the Natural Resources (Technical) Committee in a review of the relative advantages and disadvantages of forestry and agriculture on marginal land. An extensive survey of floods and soil erosion resulting from modern changes in land use was begun in Scotland.

The ecological management programme for the Yarner Wood Nature Reserve on the edge of Dartmoor was initiated, with the principal long-term aim of re-constituting a naturally regenerating wood of the type believed once to have covered much of south-western England, and a favourable start was made in the experiments on reconstitution of high-altitude woodlands at Moor House. Investigations of soil invertebrates at Merlewood Research Station indicate that certain amino-acids essential for the maintenance of animal life are more abundant in the fallen leaves of some plants than of others, and free-living nematode worms are also being investigated with the view of determining what are the nematode faunas of soils and litters beneath natural and planted woodlands of different species of trees. A survey of wood ants showed that *F. rufa* is more abundant in the limestone woodlands near Grange-over-Sands but has declined over the past half-century in the Windermere area, apparently as a result of invasion by bracken. On the Hartland Moor Nature Reserve, the distribution of all ant species has been mapped by transect over 10 hectares, and a more detailed permanent quadrat has been established over about 600 square metres.

Intensive studies of peat nutrients have been started at Merlewood Research Station, and work on moorland animals at Moor House has revealed interesting relationships between the moth *Coleophora caespititiella* and its food plant *Juncus squarrosus*

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* Report of the Nature Conservancy for the year ended 30th September, 1955. Pp. iv+56+12 plates. (London: H.M. Stationery Office, 1955.) 4s net.

(heath rush). With the co-operation of the Ministry of Transport and Civil Aviation radar station at Great Dun Fell (2,780 ft.) of the Meteorological Office, it is hoped to initiate a range of automatic recordings of meteorological data at that point, which will in future be compared with those being taken at Moor House and at Alston. Establishment of the Cairngorms Nature Reserve has made possible a partial filling of a serious gap in the snow survey of Britain, and autographic temperature-recording has now started at Loch Etchachan (3,058 ft.), where weekly readings are taken during April–October.

The present status in Britain of the hare has also been investigated, as well as the population density and feeding habits of the buzzard in sample areas throughout the country. No evidence of an extensive switch of diet by predators in directions harmful to human interests has so far been traced to the disappearance of rabbits. The measurement of long-term changes in the vegetation on grasslands, particularly where rabbit-grazing has been suddenly reduced by myxomatosis, continued, and at Bridgwater Bay measurements were made of the rate of shingle movement along the beach and its relation to the growth of the cord grass, *Spartina townsendii*. At Braunton Burrows the closing of blow-outs by brushwood and hessian fencing, together with the planting of *Ammophila arenaria*, increased the height of the coastal dune ridge by five to six feet, while the untreated central ridge was lowered by a similar amount and the inner ridge encroached landward by about 25 ft. a year. As a result of the Conservancy's continued experiments on spraying of roadside verges and hedgerows, the Ministry of Transport and Civil Aviation issued a circular on the use of selective weedkillers containing substituted phenoxyacetic acids for control of roadside vegetation to all appropriate local authorities. The Nature Conservancy also investigated during April–June 1955 complaints of killing of lambs by golden eagles in Lewis, as a result of which no amendment of the law forbidding the killing of this bird was considered necessary.

A list of scientific publications of the Conservancy is included in the report.

THE NATIONAL PARKS COMMISSION, GREAT BRITAIN

ANNUAL REPORT

WITHIN the limits set by its financial resources and the neglect to implement fully the administrative provisions of the National Parks and Access to the Countryside Act, the sixth annual report of the National Parks Commission, covering the year ended September 30, 1955*, gives a reasonably encouraging record of progress. The education of the public and of government departments, public corporations and local authorities has been patiently, tactfully and persistently pursued. Firm opposition has been maintained, so far as the Commission's powers permit, to proposals which threaten the purposes for which the parks were created, and although there is no immediate prospect of extending the list of areas designated as national parks the Commission is giving increasing attention to the designation of areas of outstanding natural beauty. Administrative arrangements for the Exmoor and Yorkshire Dales National Parks have not yet been settled, nor for the Brecon Beacons Park or the Northumberland National Park designated on September 20, 1955. At the same time, the Border National Forest Park, including Kielder Forest and the adjoining forests of Kershope in Cumberland and Newcastleton and Wauchope in Roxburghshire, was established in a joint notice issued by the Forestry Commission and the National Parks Commission.

Generally, the administration of the parks proceeded smoothly, and the Commission advocates the introduction of a system of retirement by rotation for each park planning authority, so as to secure some flexibility and continuity of membership. The Commission commends particularly the activity of the Peak Park Planning Board in securing public access to the Kinder and Bleaklow plateaux: the seven access agreements already approved by the Minister cover some 9,345 acres. Much positive action has been taken in providing car parks, the improvement of caravan sites and the removal of undesirable advertisements; and the Board's warden service has earned the gratitude of landowners and farmers for their work, especially for their help in freeing sheep during winter snowstorms. The Lake District Planning Board has likewise given much attention to camping and caravan sites, car parks, the planting of trees and removal of offensive advertisements, and its lease of a large house at Hassness, Buttermere, to the Ramblers' Association Services, Ltd., for use as a hotel is characterized as a milestone in the history of national parks in Britain. At the opening ceremony the Commission's chairman, Lord Strang, congratulated the Board also on being the first park planning authority to provide a new public right-of-way, and on opening the first camping and caravanning site to be available under the powers of the Act. The activities of the other park planning authorities have been on similar lines. The Snowdonia Joint Advisory Committee, for example, is giving increasing attention to publicity, and, like the Pembrokeshire National Park Committee, to the clearance of disfiguring structures from sites used during the War by the Services. The Dartmoor National Park Committee has been asked to deal informally with the denial of access, and the Committee has diligently pursued various methods of dealing with the litter problem. The programme of the North York Moors Park Planning Committee includes a scheme for the protection of the wild daffodils in the valley of the proposed Farndale Local Nature Reserve and publication of a guide book to the Reserve.

In referring to the question of a National Park in Cornwall which has recently been examined once more, the Commission expresses some doubt whether the long, narrow and discontinuous coastal stretches of Cornwall are in all respects suitable for designation as a national park, and whether their administration as such would be practicable. It proposes, therefore, to consider designating coastal areas in Cornwall, and also in Devon and Dorset, with as much of their hinterland as merits inclusion, as areas of outstanding beauty. The experience gained in this way should show whether the provisions of the Act in regard to such areas are adequate, or whether some further legislative measure of protection is required. The Commission has in the meantime already made proposals for designating the Gower Peninsula and the

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* National Parks and Access to the Countryside Act, 1949. Sixth Report of the National Parks Commission for the year ending 30th September, 1955. Pp. iv+60+8 plates. (London: H.M. Stationery Office, 1955.) 4*s*. net.

Quantocks as areas of outstanding natural beauty, and is in informal consultation with the county councils about the Surrey hills and the Lleyn. The effect of such designation is chiefly to apply to such areas the powers conferred by the Act for the preservation and enhancement of natural beauty, and projects for these purposes, approved by the Minister, qualify for Exchequer grants of 75 per cent.

The other area considered by the Commission during the year as a possible national park, the Broads, presents problems not encountered elsewhere. The Broads themselves are diminishing in area, and this encroachment of land on water results from a complicated natural process not yet fully understood. Neither the origin of the lagoons nor the causes of their in-filling has yet received more than superficial investigation, and the Commission considers that such a scientific survey is an essential preliminary to any decision as to whether and at what points and at what cost restoration could be undertaken with any hope of success. Arrangements for such a survey are being discussed with the Nature Conservancy and the Ministry of Housing and Local Government, and it is hoped that the task will be undertaken by the Nature Conservancy in the near future.

Disappointment is again expressed at the slow rate of progress with the 'long distance routes', and the Commission's dissatisfaction with the Minister's decision to uphold the Manchester Corporation's contention in regard to the Pennine Way and Crowden Great Brook is recorded. Little progress was made in the establishment of new rights of way for the Cornwall north and south coast sections of the South-West Peninsula coast path; but more encouraging reports are given of the Pembrokeshire coast path, the Flamborough coast route and the South Downs route; a Welsh Highland route is under consideration. The Commission has been able to increase its publicity activities and plans to make more information available about the national parks and the long-distance routes and, as already noted, the ever-present problem of litter receives increasing attention under the publicity campaign with the Country Code.

In regard to development questions, the Commission notes that the Service departments consult the Commission on their proposals for the acquisition of land and erection of buildings and associated works required for the defence programme when these fall within areas in which the planning authorities know the Commission is interested. To ensure that the Commission is made aware of such proposals at the earliest opportunity and to facilitate liaison, the Commission now proposes to supply the Service departments with copies of special maps showing the areas in which it is interested. The Commission's views on the reconciliation of the claims of amenity with the duties of area boards to supply electricity at the lowest possible cost are reiterated; as a result of a general discussion with the Central Electricity Authority in which the Commission stressed the value of early consultation on new projects in areas of special landscape value, it is hoped to build up local liaison and by its means reach acceptable compromises. Meanwhile, the Ministry of Fuel and Power announced on June 27 that the North-Western Electricity Board has agreed to lay underground the whole of the new supply lines as far as Rosthwaite, including the circuit of Derwentwater, but decision on the remaining sections of the Borrowdale line are awaited. The Board has also announced that there will be no additional charge to consumers for the Hartsop scheme or in any other area where the Board is placing lines underground to preserve the beauty of the existing scene. As regards the North Wales hydroelectric power proposals, the Commission, while not offering outright opposition to the Bill embodying the Ffestiniog and Rheidol schemes, has submitted a detailed memorandum directing attention to points requiring special consideration, and it insists that it is essential that its representations should reach the Parliamentary Committee in the form in which they are made. This procedure has now been agreed with the Minister.

In regard to the proposed road racing circuit in the Peak District National Park under discussion by the Derbyshire County Council, the Commission records the opinion that it cannot see how any such proposals could be consistent with the maintenance of the area as a national park. The Conference of Park Planning Authorities held in London on July 26 provided a valuable opportunity for discussion of problems and for the demonstration of community of view.

THE DEVELOPMENT OF THE POLAROGRAPH

THE thirtieth anniversary of the invention of the polarograph was marked by Prof. J. Heyrovský's recent visit to Great Britain at the invitation of the Polarographic Society, when he took the opportunity of delivering his presidential address to the Society, given in London at the Royal Institution on November 16. Prof. Heyrovský began by pointing out that 1925 was to some extent a nominal date for the invention of the polarograph. Like most inventions, it took a year or so to conceive and develop. The original design is still in use, and its performance is, in fact, superior to many of the commercial instruments which have been developed from it.

The exact reproducibility of the current-voltage curves obtained with the dropping-mercury electrode had made it worth-while to construct an automatic device (the polarograph) for the purpose of recording such curves. Therefore, in the original meaning of the word 'polarography' the use of an exactly reproducible electrode was of greater significance than the use of automatic recording. In recent years, however, there has been a tendency to neglect the importance of reproducibility and to apply the term 'polarography' to the automatic recording of current-voltage curves in general. Nevertheless, Prof. Heyrovský considered it desirable to restrict the use of the word to the investigation of all aspects of the dropping- or streaming-mercury electrode. These include a number of phenomena that are studied by current-time or potential-time curves. The current-voltage curves of solid electrodes, which were studied many years before the introduction of the polarograph, were not reproducible and so did not constitute polarography in the strict sense of the word, even though they might be obtained by means of the polarograph. Such considerations govern the inclusion of material in the well-known bibliography which is maintained by the Polarographic Institute of the Czechoslovak Academy of Science.

With regard to the capillary, the mercury flow-rate should not exceed 2 mgm./sec. In concentrated solutions, failure to adhere to this condition leads to unwanted maxima of the second kind, and Kryukova has attributed these to stirring of the solution in the vicinity of the drop. Kinks in the plastic tube which joins the capillary to the reservoir can be discouraged by a specially bent capillary assembly. The introduction of the horizontal capillary by Smoleř is of considerable interest, for the resultant current-voltage curves are smoother than those obtained with the vertical capillary, disturbances are absent and the oscillations due to drop formation are greatly reduced. Current-time curves of single drops show that the horizontal electrode obeys the Ilkovič equation more exactly than the vertical one. The horizontal electrode is conveniently achieved by bending the tip of a vertical capillary, so that the last 2 mm. or so is in the horizontal plane. The control of drop-time by the use of a small electromagnetic hammer is now proving useful, not only for the synchronization of the twin-electrode systems employed in subtractive or derivative polarography, but also for any circumstances in which it is desirable to reduce the drop weight from its natural value. The streaming-mercury electrode, originally introduced for oscillographic experiments, has proved useful in ordinary polarography, and an equation for its diffusion current has been introduced by Ríus, Llopis, Polo and Koryta.

Small fluctuations in the potentials of the two mercury pools as well as in the rate of flow of mercury through the twin capillaries have proved a practical hindrance to the elegant subtractive method. On the other hand, derivative curves are readily obtained by means of two synchronized electrodes immersed in one solution and differing in potential by about 10 mV. throughout the polarogram. Vogel and Říha have obtained derivative curves from a single capillary by means of a condenser-resistance circuit (their publication appeared about a year before that of Lévêque and Roth), and in this case it is necessary for the applied voltage to vary linearly with time. In yet a third method, a single capillary can be made to yield derivative curves by the use of a mirror galvanometer having a special 'two-coil' suspension. Here, the passage of electrolytic current through the first coil induces its time-derivative in the second one. The general advantage of the derivative curve is that its maximum gives information both on the half-wave potential (the quality) and on $\mathrm{d}i/\mathrm{d}E$ (the quantity) of the electroactive substance. On the other hand, the sensitivity is only about 5 per cent of that obtainable from the normal polarogram. Furthermore, apart from the method, which employs twin capillaries, the half-wave potential depends on both the rate and direction of the applied voltage. Any discussion of derivative polarography would be incomplete without reference to the square-wave polarograph developed at Harwell by Barker and Jenkins; in its sensitivity, this instrument greatly exceeds any polarograph which has so far been developed.

Attention was directed by Prof. Heyrovský to the little-known Kaloušek method for studying the reversibility of electrode processes. By means of a commutator, the electrode is subjected to alternate cathodic and anodic polarization at between 5 and 10 cycles/sec. In these circumstances, a metal such as zinc undergoes cyclic deposition and dissolution. In acid solution, the resultant single anodic–cathodic wave shows the reduction process to be reversible. On the other hand, the formation of a double wave in alkaline zinc solutions indicates an irreversible process.

During recent years, polarography has been successfully combined with the chromatographic technique of separation, a method known as 'chromatopolarography' having been devised by Kemula. Industrially, the polarograph is finding an ever-increasing application as a continuous service indicator. For such purposes, the mercury-pool anode is unsatisfactory, since the whole of the mercury is eventually converted to calomel. To meet this difficulty, the dropping-mercury electrode in halide solution has recently been introduced as a stable reference anode. The continuous determination of oxygen constitutes one of the more prominent examples of the continuous service application, and in this particular example the mercury-pool cathode has proved to be about a hundred times more sensitive than the dropping-mercury cathode.

An interesting biochemical application of polarography is to be seen in the apparatus of Šerák. Here, the oxygen uptake of tissue preparations can be accurately followed over a period of time. In the medical field, the polarographic diagnosis of cancer is based on Brdička's protein test, now almost twenty years old, in which, after precipitating the bulk of the proteins from the patient's serum, the filtrate is examined polarographically in the presence of hexamminocobaltic chloride in ammoniacal solution. When the patient is suffering from cancer or some feverish condition, an exceptionally large protein wave, due to muco-proteins, is observed. Prolonged experience of this test suggested that it is 80 per cent certain, but the modified test recently introduced by Balle-Helaers appears to be 100 per cent certain; this modification involves graded alkaline denaturation, before precipitating the proteins with sulphosalicylic acid.

In theoretical polarography, a new field has been opened up by Wiesner and Brdička's discovery of the kinetic current, which depends upon the rate at which depolarizer is being formed at the electrode surface. Kinetic currents are independent of reservoir height and possess temperature coefficients of the order of 30 per cent per deg. C. Such investigations have led to important information about rate-constants; for example, all four rate-constants of the mutarotation of α- and β-glucoses are derived in this manner. Brdička's study of the reduction waves of weak acids has also led to the consideration of the absolute rate of recombination of ions.

The cathode-ray oscillograph is finding increased uses in polarography. In this way, it is possible to follow the polarographic current-voltage curves on one mercury drop of 5–8 sec. duration. In an alternative approach, the potential-time curves are obtained.

THE GEOGRAPHICAL ASSOCIATION

ANNUAL CONFERENCE

THE annual conference of the Geographical Association, held at the London School of Economics and Political Science during January 3–6, was noteworthy this year for two main aspects, namely, the emphasis given to papers on London and the London Basin and the unusually large number of members who were present. All the lectures were very well attended and in several cases the seating accommodation in the lecture-theatre was over-full. The annual dinner, with the president, Mr. L. S. Suggate, in the chair, attracted more members than ever before, and the excursions on the last day of the conference, though more numerous than previous years, were considerably over-subscribed.

Mr. W. F. Grimes, director of the London Museum, opened the conference with an excellent summary of the present knowledge of London's prehistory. The London theme was taken up later by a series of papers ranging from Mr. A. F. Green's fascinating analysis of the problems of London's underground drainage to Prof. S. W. Wooldridge's interesting commentary on the relationship of London's railways to the relief and structure. Dr. J. H. Bird presented a critical résumé on the activities of the London docks, and Dr. M. J. Wise analysed the role of London in the industrial geography of Britain with particular reference to the recommendations of the Barlow Commission. Both these papers were followed by excursions, one to the docks and the other to industrial areas of East London. The past and present agricultural development of the London Basin was the subject of Dr. H. C. K. Henderson's paper, which was followed by a traverse by motor coach across the northern part of the London Basin to Luton. Another excursion crossed the southern part of the basin and in the afternoon visited the National Institute of Oceanography at Wormley, near Godalming.

Teaching matters were fully discussed by Mr. Suggate in his presidential address on "Some Aspects of Teaching Geography in the Grammar School". His paper was most enthusiastically received by a very large audience, conscious of the very great contribution that Mr. Suggate has made to the development of geography in school. Another very large audience heard a stimulating and provocative paper on river development by Dr. G. H. Dury, who commented, as an examiner, on mistakes commonly found in school examination scripts. Later he took a large party of members to examine a series of river meanders in Enfield. "Sample Studies" was the title given to a meeting sponsored by the Secondary Schools Committee of the Association. The subject was introduced by Mr. R. C. Honeybone, who stressed the value of the approach as one of many ways of teaching geography in a geographical manner and outlined its pitfalls. Mr. D. J. Cadman followed this introduction by a lesson to third-form boys on the Vauxhall Works at Luton as a sample of the British automobile industry.

Prof. A. E. Smailes presented an account of the Association's summer school held last August in Aix-en-Provence; Prof. P. W. Bryan showed two films on Snowdonia and Anglesey; and Prof. A. L. Banks read a paper on what is to most geographers an unusual topic, "Some Aspects of Medical Geography". This last was a combined meeting with the Institute of British Geographers and the Royal Geographical Society, and was held at the Society's house in Kensington.

In addition to the usual large and representative publishers' exhibition, the Association's Standing Committee for Visual Aids in collaboration with the National Committee for Visual Aids in Education and the Educational Foundation for Visual Aids mounted an exhibition of sample study material, projectors and recently published film-strips.

R. C. HONEYBONE

THEORETICAL PHYSICS

SYMPOSIUM AT ST. ANDREWS

THE presence of Prof. W. Heisenberg (Göttingen) as Gifford Lecturer in the University of St. Andrews was used to organize a short, rather informal, conference on theoretical physics during November 18–20. Unfortunately, Prof. Heisenberg had to return to Germany sooner than had been expected and so, regrettably, was unable to be present, but about fifty physicists, mainly from British universities and government establishments, attended. Four sessions were held, one of which was devoted to an informal discussion on the teaching of theoretical physics.

Dr. J. Hamilton (Cambridge) introduced the first session on field theory. In view of the recent confirmation of the existence of the antiproton, his talk was devoted to an account of calculations performed in Cambridge, in conjunction with Bethe, on the possible modes of annihilation to be expected for this particle. He showed that the application of general principles of conservation of angular momentum, isobaric spin and parity is sufficient to make predictions concerning this process in the presence of very light nuclei. In general, the annihilation is expected to occur with the production of π-mesons, the ratio of π^- to π^+ to be expected depending simply on the quantum numbers of the nucleon involved.

Dr. T. H. R. Skyrme (Harwell) gave an account of a relativistic variational method for calculating the properties of a real nucleon in *PS—PS* theory, and Dr. J. S. R. Chisholm (Cardiff) reported work on the *S*-matrix in neutral pseudoscalar derivative coupling theory. Dr. J. W. Leech (Queen Mary College, London) described a method for the calculation of long-range interatomic forces; an earlier treatment of this problem by Casimir and Polder led to an inverse seventh power potential, but he finds the dependence to be an inverse third power. Dr. W. K. Burton (Glasgow) described work done in conjunction with de Borde on the method of functional integration for Fermi systems. Dr. D. L. Pursey (Edinburgh) discussed the possibility of having an acceptable theory which, although not covariant in every respect, leads only to covariant observable predictions. Finally, the session on field theory was concluded by Dr. C. G. Kuper (Liverpool), who discussed roton excitation in liquid helium.

Prof. H. A. Bethe (Cambridge and Cornell) introduced the session on nuclear physics by an appreciation of the nuclear model of Brueckner and collaborators. This model uses a generalized Hartree–Fock method and attempts, with considerable success, to deduce a self-consistent nuclear potential from the force between two free nucleons. A principal aim of the theory is to show that, using only such two-body forces, one can achieve nuclear saturation. Prof. Bethe gave an account of his own independent calculations on nuclear energy and radius, in which he has succeeded in taking complete account of the Pauli principle, and he also reported success, with Goldstone (Cambridge), in dealing with the repulsive core of the two-body nuclear potential. Preliminary numerical calculations (not taking account of the repulsive core), using a minimization procedure for the energy, show fair agreement for nuclear binding energy, but a nuclear radius one-third that of the actual radius. Proper treatment of the repulsive core, now in progress, will certainly change both results in the right sense.

There followed four short papers, in the first of which Dr. H. Primakoff (Oxford) discussed the nuclear absorption of μ-mesons. Then Dr. R. Nataf (Edinburgh) spoke on the foundations of the Bohr–Mottelson nuclear model, and Dr. S. Dedijer (Edinburgh) analysed, in terms of the independent particle model, the similarity in the variation of binding energy of the last neutron for nuclei near carbon-12 and oxygen-16. In the last contribution to this session Prof. N. Kemmer (Edinburgh) proposed a classification of many-body forces in the lightest nuclei based on representations of the symmetric group.

The session on solid state theory was opened by Prof. M. H. L. Pryce (Bristol), who described the information obtained from studying the fine structure of the paramagnetic resonance absorption of ions such as cupric in crystals. He went on to describe the distortion of the hydration sphere of the ion which, by the Jahn–Teller effect, arises from the degeneracy of the electron wave function in a fully symmetrical environment. This degeneracy may or may not be fully removed by the distortion. If rotation about an axis remains free, the system becomes equivalent to a particle moving in an annular potential well. Prof. Pryce finally suggested an analogy between this situation and the Bohr–Mottelson model of the atomic nucleus.

Dr. E. H. Sondheimer (Queen Mary College, London) and Dr. J. M. Ziman (Cambridge) then discussed the transport of heat and electricity in solids. Dr. Sondheimer emphasized the general validity of the Onsager reciprocal relations and showed how in some treatments of thermo-electric processes algebraic obscurity has led to methods of approximation which violate these relations, while Dr. Ziman discussed the variational principle used in the solving of transport equations. Dr. N. H. March (Sheffield) described the results of some measurements of the absorption of high-frequency radio waves in semi-conductors. Dr. K. W. H. Stevens (Nottingham) discussed the construction of bonding orbitals for the first co-ordination shell in face-centred and body-centred cubic metals, and Dr. R. Fürth (Birkbeck College, London) spoke on long-range order in crystals. An account of the recombination of current carriers in a semi-conductor was then presented by Dr. P. T. Landsberg (Aberdeen), and in conclusion Dr. G. A. P. Wyllie (Glasgow) discussed the problem of diffusion at low temperatures.

On the afternoon of November 20 an informal discussion was held on the teaching of theoretical physics. After short introductory talks by Prof. Bethe, Dr. D. ter Haar (St. Andrews) and Prof. Pryce on the teaching of theoretical physics in the United States, Netherlands and United Kingdom, respectively, two topics were discussed at some length: the amount of mathematics to be taught at the undergraduate level to students who will be proceeding to do research in theoretical or experimental physics; the amount of formal teaching in physics (and possibly mathematics) to be given to research students in experimental or theoretical physics. There was a very considerable degree of agreement on the following points: that students proceeding to do research in physics should have a thorough training in pure and applied mathematics, but that this presents difficulties in many British universities owing to the rigid structure of courses and examinations; and that there should be one year with considerable formal instruction at the beginning of the period of research, and that this should be received by experimental as well as theoretical physicists. This latter point was very forcefully put by several speakers, and its need was considered sufficiently great to outweigh the disadvantage that it might occasionally extend the Ph.D. training beyond the normal three years.

J. F. ALLEN

CHILDREN'S FILM FOUNDATION

THE Foundation was set up in 1951 as a result of the co-operative effort of the British film industry to ensure the production, distribution and exhibition of special entertainment films for children. It began its activities in October 1951 and, during this period, has become accepted, not only in Britain but also throughout the world, as an integral part of the British film industry. It is a non-profit-making organization and is financed by grants from British Film Production Fund, Ltd.

During the four years of its existence there has been time to set a standard for the content and quality of its films and to study their reception by audiences in Great Britain as well as overseas. The steady rise in the bookings is significant of the success of Children's Film Foundation films with the audiences for whom they are made.

Since in most situations the Foundation was starting completely anew, its first films followed the conventional pattern of the 'Western'. This was necessary because children are conventional in their tastes and do not accept innovations easily. It was enough, first of all, to introduce child actors in an English background without altering the simple 'good versus bad' technique. Generally, these pictures have proved highly acceptable.

The content of the films has been gradually changed to introduce ideas of achievement above and beyond the satisfaction of catching thieves or spies. Eight achievement stories have proved as popular as the conventional adventures. The fact that the films are placed with many different companies for production helps to give the pictures vitality and variety, which add to their value in children's programmes.

Although the Foundation has not yet been able to undertake any special research project, the reception of the films is carefully recorded and studied. Besides personal observations of audiences by the officers of the Foundation, a questionnaire, returned and filled in by cinema managers, provides valuable information. There appears to be little difference in taste and response between different parts of Great Britain; but some audiences, especially in the larger cities where they are more accustomed to film-going, like the story to develop quickly; rural audiences prefer a slower pace. Individual tastes vary enormously.

What clearly emerges is the excellent natural taste of children at the cinema. They are anxious to participate in the programme and their interest is lost only by weaknesses in production, acting and, above all, in the script.

It takes time to wear down the old-fashioned idea that children go to the cinema to be excited and stimulated by violent adult action; but it is dying out in Britain. The reports of cinema managers reflect the pleasure their audiences take in films that deal with children's problems and achievements. The only general suggestion for improving the films is the use of colour, which is costly.

The British Film Production Fund, Ltd., has made grants totalling £529,883 to the Foundation. Fundamentally, an entertainment film for children cannot be a low-priced production. Receipts from the distribution of films are now sufficient to pay for the cost of release prints, and the balance is paid to the British Film Production Fund. These receipts can never be large because admission prices to children's film shows are low. The Foundation's value to the industry and the community cannot be judged in terms of money since its primary object is to promote appreciative and intelligent film-going by youthful audiences. For this reason the British film industry as a whole supports the Foundation with an annual grant from the Fund.

FRESH WATER FROM SALT WATER

The production of fresh water from salt water must be one of the oldest technical problems. It is currently receiving a degree of widespread yet concentrated attention which surpasses anything previously devoted to it. The reasons for this are substantially the same the world over; chief among them is the fact that living standards are rising generally and that fresh-water consumption per head of population is a basic and reliable index to the standard of living of a community. As the degree of industrialization increases and living standards rise, so does the demand for water; reservoir capacity becomes inadequate, the drain on artesian wells increases (see *Nature* of Dec. 17, p. 1133). The consequence of the latter effect depends on the situation. In coastal areas it may lead to infiltration of sea water, in other areas to a raised salt content as the increased pumping lowers the level of the underground reserve. The possibility of demineralization must be considered in both cases. For alternative sources of water one may turn, depending on one's location, to new wells, which may themselves be brackish; to new reservoir capacity, if this is feasible and if the rainfall justifies it; to more or less long-distance pumping of supplies from distant sources; or in extreme cases to sea water. All these possibilities are likely to be expensive; the first may, and the last certainly will, involve demineralization procedures.

Some indication of the interest in these procedures has been described by D. J. Neville-Jones (*Research*, 8, No. 11; November 1955). Since some publicity was given to the United Kingdom participation in the Organization for European Economic Co-operation discussions on the subject a year or two ago, scores of inquiries have been received in London from places ranging from Norway to Australia, from Hong Kong to the Bahamas. The United Kingdom itself is interested, despite its notorious rainfall, because the inexorably increasing demand is leading to sea water infiltration in such areas as the Thames Estuary; it is becoming increasingly difficult to find uncontaminated alternative sources which do not involve expensive long-distance pumping. Germany has similar problems in the lower reaches of the Rhine. The Netherlands is concerned because, by the nature of its low-lying territory, sea water infiltration is always a likely problem. Australia and South Africa are developing territories in which sea water or other highly saline waters have to be considered. The rapid industrial development of the United States of America is leading to water shortages in the vast interior territories where in many cases only brackish water is available.

The problem is not simple to define, or solve. This will depend on a multiplicity of factors such as the availability and cost of energy sources, the mineral content of the raw matter and the purpose for which the fresh water is required, that is, the price which can be paid for it. Each case will have to be examined according to the local circumstances.

LABORATORY TECHNICIANS

A SUB-COMMITTEE of the Science Masters' Association has been considering the place of laboratory technicians in secondary schools and has now issued a report. The number of schools with laboratory technicians is far too small, and there is urgent need for more technicians to be employed. This is particularly important since the problem of the recruitment of laboratory technicians in schools is related to that of the shortage of science teachers. The sub-committee suggests, however, that the establishment of a national scheme for the provision of laboratory assistance on an adequate scale to all schools where a significant amount of science is taught is a problem in its own right.

The teacher without a laboratory technician finds himself with less time than he should have for his normal teaching duties, the planning of his work and for the development of new apparatus and techniques. He has no time for designing and arranging practical work which can be carried out by the pupils themselves, and all too frequently lessons become "chalk and talk". Such a wasteful use of the time of science teachers must be deplored.

The sub-committee considers that the duties of a school laboratory technician call for a considerable degree of skill and a good deal of training. Much work has been done by various organizations on the formulation of courses of study for laboratory technicians. For schools the most suitable of these is that leading to the examination for the Laboratory Technician's Certificate of the City and Guilds of London Institute. The facilities for study are expanding; twenty-four centres, mostly technical colleges, now offer courses of instruction recognized by the City and Guilds of London Institute, and the number of candidates entering for the examination has increased from eighteen in 1951 to ninety-six in 1954.

The sub-committee realizes that recruitment is one of the most difficult parts of the problem, but believes that science teachers would be able to encourage suitable boys and girls in their own schools to apply for the posts if they could assure their pupils that salary, prospects and promotion, good working conditions—hours, holidays, superannuation, sick pay—facilities for study, and status were such as to compete with those obtainable in other educational institutions and industry.

Suggestions are also made as to the scale of assistance which might be given to various schools, suitable scales of remuneration and the duties which could be performed by laboratory technicians.

DISTRIBUTION OF 8-AZAGUANINE IN THE NUCLEIC ACIDS OF *BACILLUS CEREUS*

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8-AZAGUANINE can replace a proportion of the guanine residues in the ribonucleic acids of a variety of organisms, although the amounts incorporated are low, varying from less than 1 per cent to 3 per cent of the ribonucleic acid guanine[1]. We have now found that in *Bacillus cereus*, strain 569*H*, up to 40 per cent of the ribonucleic acid guanine may be replaced by 8-azaguanine when the latter compound is supplied during growth. This is comparable to the proportion of thymine which may be replaced by halogenated pyrimidines in the deoxyribonucleic acids of *Bacterium coli* and its bacteriophages[2]. This high level of incorporation has enabled us to study the distribution of 8-azaguanine in nucleic acid preparations, relative to the normal base, and to follow the course of 8-azaguanine incorporation during bacterial growth.

Aerated cultures of *B. cereus* 569*H* were grown at 36° on the following medium: vitamin-free casein hydrolysate, 10 gm.; KH_2PO_4, 3·5 gm.; $MgSO_4.7H_2O$, 0·51 gm.; $(NH_4)_2Fe(SO_4)_2.6H_2O$, 4·8 mgm.; in 1 l. water and adjusted to *p*H 7 with sodium hydroxide. 8-Azaguanine (40 μgm./ml.) was added at a suitable bacterial density and incubation continued for 2·5 hr. The cells were then chilled, washed and frozen. Ribonucleic acid was extracted with hot *M* sodium chloride after the cells had been defatted in ethanol and acetone. Some 10–20 per cent of the total polyribonucleotide content of the bacteria was extracted by this procedure. In other experiments treatment of the cells with water (3 hr. at 50° C.) yielded about 70 per cent of the total polyribonucleotide.

Preparations or fractions of ribonucleic acid were hydrolysed in *N* potassium hydroxide to mononucleotides, which were separated by paper chromatography in *iso*propanol–water–ammonia[3] followed by electrophoresis on paper at *p*H 1·7. The spots of guanylic and 8-azaguanylic acids were eluted and estimated spectrophotometrically. (On a larger scale, 8-azaguanylic acid can be separated from guanylic acid by ion-exchange chromatography on acid 'Dowex-50' resin.) Where estimates of total ribonucleic acid content of bacteria were required (for example, Table 1), alkaline digestion was carried out on whole bacteria after extraction with hot 50 per cent ethanol.

To study the relative distributions of 8-azaguanine and guanine along the polynucleotide chains, the ribonucleic acid was digested to completion with pancreatic ribonuclease. The final products of this hydrolysis are pyrimidine mononucleotides, polynucleotides consisting of chains of one or more purine residues terminated by a pyrimidine nucleotide residue, and purine nucleoside 2′ : 3′ cyclic phosphates[3]. The purine nucleoside 2′ : 3′ cyclic phosphates can only have occupied terminal positions in the ribonucleic acid chain adjacent to a pyrimidine residue[4]. The hydrolysis products were partially separated into a number of bands in paper using the *iso*propanol/water/ammonia solvent. In this solvent compounds containing 8-azaguanine move in the same position as the corresponding guanine derivatives. The bands, in order from the starting position in the chromatogram, were eluted and the fraction of guanine residues replaced by 8-azaguanine

$$\left[\text{molar ratio } \frac{(\text{8-azaguanine})}{(\text{8-azaguanine} + \text{guanine})} \times 100\right]$$

measured in each. This gave the relative distribution of the two bases in polynucleotides of decreasing size.

Table 1. REPLACEMENT OF 8-AZAGUANINE BY GUANINE IN THE RIBONUCLEIC ACID OF *B. cereus*

8-Azaguanine (50 μgm./ml.) was added to cultures 1 and 2 at zero time. After 30 min., guanine (25 μgm./ml.) was added to culture 2

Time after addition of 8-azaguanine	Molar ratio $\frac{(\text{8-azaguanine})}{(\text{8-azaguanine}+\text{guanine})} \times 100$ in bacterial ribonucleic acid		Relative amounts of ribonucleic acid in the cultures (based on D_{260} mμ of ribonucleotides after hydrolysis)	
	Culture 1	Culture 2	Culture 1	Culture 2
30 min.	13·5	13·5	2·62	2·62
60 min.	16·9	7·7	3·13	3·16
120 min.	28·2	4·0	3·76	5·66

Under conditions in which 20–23 per cent of the ribonucleic acid guanine was replaced by 8-azaguanine, enzymic hydrolysates of the bacterial deoxyribonucleic acid gave much-smaller amounts of a substance with properties of 8-azaguanine deoxyriboside (less than 1 per cent of the nucleic acid guanine). Extracts of the bacteria in hot 50 per cent ethanol contained substantial amounts of 8-azaguanosine and 8-azaxanthosine, but no free 8-azaxanthine, the principal metabolite of 8-azaguanine in mammals[5] and plants[6].

Ribonuclease digestion was carried out on ribonucleic acid preparations in which 20–23 per cent of the total guanine was replaced by 8-azaguanine. The fraction of guanine replaced by 8-azaguanine was found to increase as the average size of the polynucleotides decreased, varying from 17 per cent in the largest polynucleotides to 40 per cent in the dinucleotide region. The highest 8-azaguanine content was found in the band containing only the 2′ : 3′ cyclic phosphates of guanosine and 8-azaguanosine, where 68 per cent of the residues contained 8-azaguanine.

Some fractionation of ribonucleic acid preparations can be obtained by dialysis through 'Cellophane' in *M* sodium chloride, and by precipitation with increasing concentrations of ethanol at decreasing *p*H. Using these procedures, we found that polynucleotides of smaller average size contained a greater proportion of 8-azaguanine residues relative to guanine, and also a higher proportion of 8-azaguanine 2′ : 3′ cyclic phosphate terminal groups than the whole nucleic acid preparation.

Thus the nucleic acid preparations contained a number of shorter polynucleotide chains in which a higher proportion of the guanine residues has been replaced by 8-azaguanine. From the distribution of 8-azaguanine in ribonuclease digests, replacement appears to be least in the longer sequence of purine nucleotides in the ribonucleic acid chain and greater in the shorter sequences. The very high proportion of 8-azaguanosine 2′ : 3′ cyclic phosphate terminal residues in the nucleic acid could be explained by assuming that an 8-azaguanine residue in this position makes the further addition of nucleotide residues along the chain less likely. Alternatively, the 2′ : 3′ cyclic phosphate termination may have some special significance in ribonucleic acid turn-over.

The inhibition of bacterial growth by 8-azaguanine and the incorporation of the latter into ribonucleic acid may be annulled by supplying guanine. We have followed the disappearance of 8-azaguanine from the ribonucleic acid as the growth-rate is restored. 8-Azaguanine disappears much more rapidly than can be accounted for by dilution of existing ribonucleic acid by new ribonucleic acid without 8-azaguanine (Table 1). These results suggest either a rapid degradation and resynthesis of polynucleotides, or an exchange reaction in which bases can be replaced without breakdown of the polynucleotide chain.

We wish to thank Dr. Martin Pollock for the strain of *B. cereus* and the Medical Research Council Unit for Research in Antibiotics, Clevedon, for a large-scale preparation of this organism.

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VARIATIONS IN THE AMOUNT OF FEULGEN STAIN IN NUCLEI OF PLANTS GROWN AT DIFFERENT TEMPERATURES

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It has long been known that growth at low temperature induces a linear differentiation in the metaphase chromosomes of certain plant species[1-3]. At temperatures ranging from −1° C. to +5° C., depending on the species, specific weakly Feulgen-staining segments appear which are constant in length and position. It was shown from a study in various plant species that such segments correspond to the condensed and frequently fused heterochromatic segments observable in telophase and interphase nuclei[1,2,4].

The weak reaction of heterochromatic segments in metaphases from plants grown in the cold was attributed to 'nucleic acid starvation'. This interpretation implies that low temperature, by retarding the synthesis of deoxyribonucleic acid, leads to the chromosomes entering mitosis with eu- and heterochromatic regions competing for a depleted supply of deoxyribonucleic acid. Antagonism to this view has grown with the recent wide acceptance of the concept that the amount of deoxyribonucleic acid per haploid chromosome set is constant[5,6].

The present study is part of an attempt to reinvestigate this phenomenon quantitatively by measuring Feulgen staining photometrically by means of a scanning densitometer devised by Deeley[7]. This was used in conjunction with a cell-crushing technique which enables measurements to be made at all phases of the mitotic cycle[8]. The accuracy of the scanning instrument has been demonstrated by a series of measurements made on Feulgen-stained sperm heads and cells of the onion root meristem, which show that the readings obtained are, in fact, proportional to the amount of stain present, to an accuracy of the order of ± 3 per cent for this type of material[7].

Plant species with and without detectable heterochromatin were investigated. Roots were removed and fixed after the potted plant had been kept at the control temperature (19°–20° C.) for at least four days. The plant was then subjected to the cold conditions; other roots were removed from it and

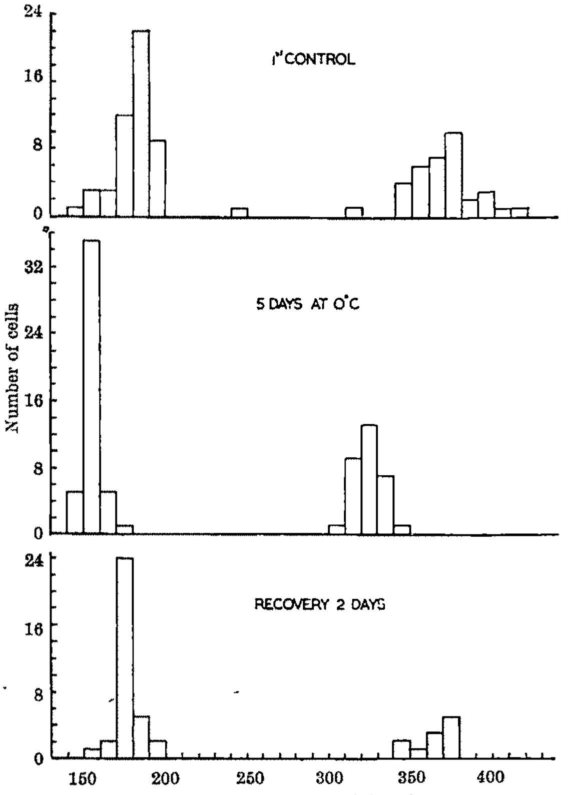

Fig. 1. Measurements of total Feulgen stain in mitotic nuclei of *Trillium grandiflorum*, showing the alteration in values obtained according to temperature conditions of plant growth. From root meristems of a plant kept at 19°–20° C. for four days, after five days at 0° C. and after return to 19°–20° C. for two days

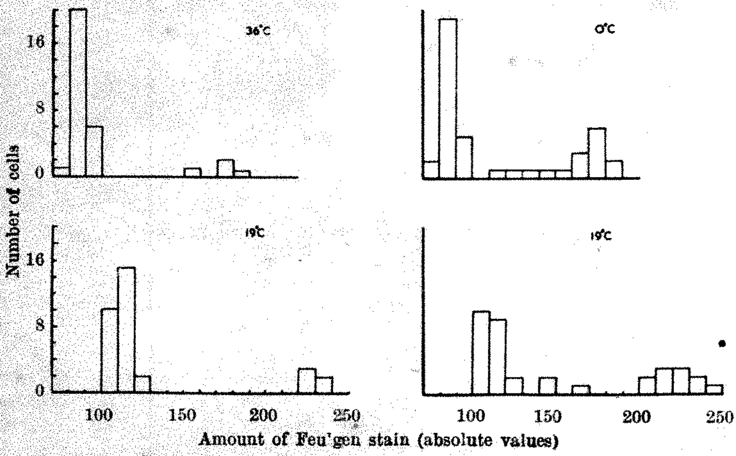

Fig. 2. Measurements of total Feulgen stain in mitotic nuclei from root meristems of *Scilla campanulata*, showing the similarity of values in two plants kept at 19° C. and the similar reduction obtained in them at two extremes of temperature

fixed at suitable intervals of time and the plant was returned to recover under the control conditions. It was thus possible to have controls from the same plant both before and after treatment.

Fixation, hydrolysis and staining were strictly the same for control and treated roots. Since all specimens from any one experiment were stained by the Feulgen reaction and measured at the same time, the first control roots had to be stored in 70 per cent alcohol in a refrigerator for a longer time than those grown in the cold. This was shown to have no effect on the final measurements, since identical results were recorded for the control roots taken before and after the cold treatment. All phases of the mitotic cycle were examined.

Six main facts have emerged from these initial observations. First, as recorded for animal tissues (cf. ref. 6), $2C$ and $4C$ values, depending on the stage of chromosome division and duplication of deoxyribonucleic acid, were obtained in nuclei from roots of plants kept at the control temperature. Thus telophase and most of the interphase nuclei had the $2C$ amount of Feulgen stain, whereas prophase, metaphase and some interphase nuclei contained twice this quantity; a few interphase nuclei had intermediate values. Secondly, smaller values of $2C$ and $4C$ were found in nuclei from plants kept for three to five days at low temperature. This reduction appeared in nuclei at all stages of mitosis irrespective of whether the species contained detectable heterochromatin or not (Table 1 and Fig. 1). Thirdly, the threshold temperature required for inducing these changed values varied with the species. This was clearly shown by the difference between *Scilla campanulata* and *S. sibirica*, where −1° and −6° C. respectively were required to reduce values for Feulgen staining (Table 1). Fourthly, comparable reductions to those in the root meristem were encountered in the resting nuclei of the differentiated zone. Fifthly, there was a return to normality in cells about to enter mitosis, and also in those of the differentiated zone, after cold-treated plants were returned to the control temperature (Fig. 1).

Finally, as shown in one experiment in which two plants of *Scilla campanulata* were used, high temperature can apparently cause a reduction of the value of C comparable to that obtained by cold (Fig. 2). It will be noted that the amounts of Feulgen stain in nuclei of roots taken from these two plants at the beginning of the experiment were identical.

We feel caution is required in interpreting these results. The simplest explanation would be that the decrease in the amount of Feulgen stain in the nuclei of roots grown at low temperature represented a true reduction of the deoxyribonucleic acid content. This would imply that the comparable loss in the resting differentiated nuclei represented the breakdown half of a deoxyribonucleic acid turnover cycle, the synthesis of the deoxyribonucleic acid being reduced. Until this interpretation can be confirmed by other means, however, it is necessary to recognize an alternative explanation, namely, that the change in temperature might alter the reactivity of the deoxyribonucleic acid to the Feulgen stain. No obvious mechanism can be suggested by which this could be effected by low temperature during growth and which would yet allow the deoxyribonucleic acid to be fully normal 48 hr. after the plant had been returned to control conditions. Furthermore, the fact that different temperatures were necessary to induce this effect in different species makes this interpretation appear somewhat unlikely.

We wish to thank Prof. J. T. Randall for his interest in the study and Dr. H. B. Fell for her helpful criticism of the manuscript. One of us (L. F. La Cour) is grateful for the provision of working facilities in the Wheatstone Physics Laboratory; E. M. Deeley and J. Chayen wish to acknowledge support from the Nuffield Foundation and the British Empire Cancer Campaign, respectively.

[Nov. 16

Table 1. EFFECT OF TEMPERATURE ON THE FEULGEN STAINING OF PLANT NUCLEI

Plants examined	Treatment	Results
Species with heterochromatin		
Paris polyphylla	5 days at zero (0° C.)	20 per cent reduction
Trillium grandiflorum	3 ,, ,, ,,	10 ,, ,,
,, ,,	3 ,, ,, ,,	15 ,, ,,
,, ,,	5 ,, ,, ,,	20 ,, ,,
Scilla sibirica	3 days at −1° C.	No reduction
,, ,,	5 ,, −6° C.	15 per cent reduction
Species with no detectable heterochromatin		
Scilla campanulata {identical	3 days at −1° C.	23 per cent reduction
control temp.	2 ,, 36° C.	23 ,, ,,
Bellevalia romana	3 ,, −1° C.	20 ,, ,,
Fritillaria pallidiflora	3 ,, −1° C.	25 ,, ,,

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

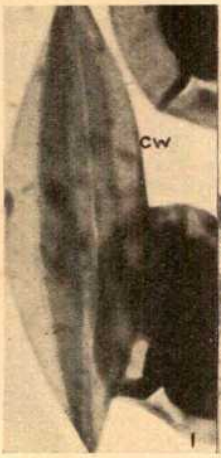
An Electron Microscopical Study of the Histochemical Localization of Alkaline Phosphatase in the Cell Wall of *Chlorella vulgaris*

In algae it is considered that the oxidative assimilation of hexose follows the same glycolytic pathway as in higher organisms, and that these substances after dephosphorylation yield hexose phosphate, which may be used in polysaccharide synthesis, or enter the metabolic pool[1]. Enzymes that may take part in these processes have been shown by biochemical methods to be present on the cell surfaces of small organisms, such as yeast[2]. However, the limitations in resolution of the light microscope have made it difficult to demonstrate such enzymes histochemically, especially as regards their exact localization relative to the cell wall.

In this work, an attempt has been made to apply histochemical methods for observation with the electron microscope, thus increasing the possibilities of a more accurate localization due to the higher resolution of this instrument[3].

The material used in these experiments, *Chlorella vulgaris*, was transferred from agar slope to a liquid mineral medium and centrifuge-washed several times in distilled water. The centrifugate was then dispersed in Gomori's mixture for alkaline phosphatase, where it was incubated for periods of time ranging from 15 min. to 2 hr. It was then centrifuged in distilled water and treated with 0·5 per cent silver nitrate solution, centrifuge-washed in distilled water, fixed in 1 per cent osmium tetroxide vapour, dehydrated in graded alcohols and embedded in methacrylate. Ultra-thin sections were cut with the Sjöstrand microtome for examination in the electron microscope.

Material treated as above, up to the alcohols, was spray-mounted on 'Formvar'-coated grids and examined directly with the electron microscope.



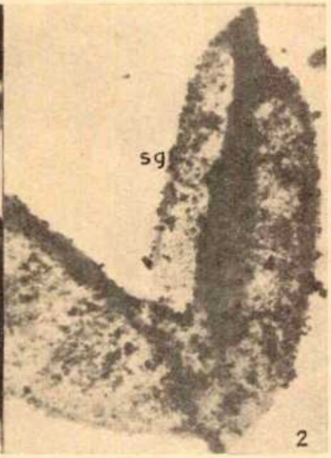
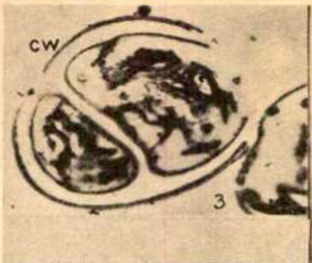
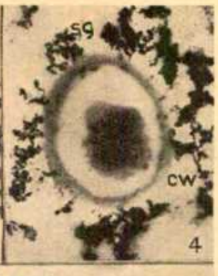


Fig. 1. Spray-mounted whole cell. × 4,000. *cw*, cell wall

Fig. 2. Spray-mounted whole cell preparation. Incubated in Gomori's substrate for alkaline phosphatase. Positive reaction shows as dense granules of various sizes deposited on the cell wall. × 4,000. *sg*, silver granules





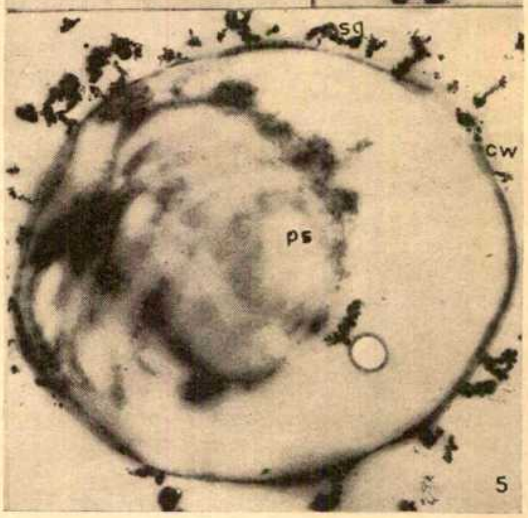


Fig. 3. Ultra-thin specimen section of control specimen. Note small number of granules on the cell wall. × 4,000. *cw*, cell wall

Fig. 4. Ultra-thin section of specimen incubated in Gomori's substrate for alkaline phosphatase. The positive reaction shows as a dense aggregate of silver granules partly attached to the cell wall. × 4,000. *cw*, cell wall; *sg*, silver granules

Fig. 5. Ultra-thin section of specimen incubated in Gomori's substrate for alkaline phosphatase. The positive reaction appears as an aggregate of dense granules of silver attached to the cell wall. × 7,000. *cw*, cell wall; *sg*, silver granules; *ps*, protoplasmic structures

Controls were run by treating the tissues in the same way except that the glycerophosphate was omitted from the incubation mixture. Sections were also made from material fixed in osmium tetroxide vapour, dehydrated in alcohols and embedded in methacrylate.

The von Kóssa method for showing up the calcium phosphate formed as a result of enzymatic action suggested the detection of silver phosphate at the sites of reaction; silver phosphate is readily visible in electron micrographs as a dense granular precipitate.

Fig. 1 shows the electron micrograph of untreated spray-mounted specimens. Fig. 2 shows the electron micrographs of spray-mounted specimens incubated in Gomori's mixture. The positive reaction is indicated by dense granules, presumably of silver phosphate, unevenly distributed on the cell wall. The cell wall appears as a denser band at the edges. However, this picture does not show the relationship between the silver precipitate and the cell structures.

Fig. 3 shows an ultra-thin section of the cell of the control material. Very few granules, of whatever origin, are present. This might be due to the unspecific deposit of the silver present in the control incubation medium. Figs. 4 and 5 are electron micrographs of ultra-thin sections of cells incubated in Gomori's medium. Here the positive reaction is marked by dense granules attached to the outer surface of the cell wall. These granules appear as particles of various sizes and in different degrees of aggregation. There also appears to be some reaction in relation to the structures present in the cell interior.

The histochemical demonstration of alkaline phosphatase has been subjected to critical experimental analysis by Danielli[4]. The rather short period of incubation and the fact that the incubation was carried out prior to fixation provide the optimum conditions for minimizing artefacts. The present results tend to confirm previous biochemical determinations which have indicated the presence of enzymes on the cell surface in other organisms[2].

In our preparations the apparent lack of contact, in many places, between the silver precipitate and the cell surface, can perhaps be explained by the fact that the material was centrifuged with forces up to 7,000 *g* at least eight times after the precipitate had been formed. The heavy metal particles, under these conditions, would be expected to separate somewhat from the cell wall. As can be seen in the preparations of spray-mounted, unsectioned specimens, the particles of silver seem to be more closely associated with the cell wall. This may be accounted for by the fact that no centrifugal force was applied after the silver precipitate was formed. In considering the weak reaction observed inside the cell, it is necessary to bear in mind that the cells have been incubated intact in the Gomori substrate, and that the possibility exists that the substrate might not have been able to penetrate the cell membrane into the protoplast structures.

The pure culture of *Chlorella vulgaris* used was obtained through the courtesy of Dr. G. E. Fogg, Botany Department, University College, London.

This work was carried out at the Anatomiska Institutionen, Karolinska Institutet, Stockholm, while we were guests of F. S. Sjöstrand, to whom our thanks are due.

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Dec. 8.

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Analysis of Crystalline Hæmoglobin Derivatives by Paramagnetic Resonance

The investigation of single crystals of hæmoglobin derivatives by paramagnetic resonance can give two distinct types of information. First, the actual resonance conditions and the resultant *g* values associated with the electronic transitions will yield details on the orbitals involved in the chemical binding of the central iron atom. Secondly, the angular variation of the *g* values enables an accurate determination to be made of the orientation of the hæm and porphyrin planes with respect to the external crystalline axes. Although the structure of the rest of the molecule cannot be analysed directly in this way, detailed information on the orientation of the hæm planes can be combined with X-ray measurements[1] to calculate the polypeptide chain directions and similar factors. It would appear that the determination of the hæm plane orientations by paramagnetic resonance is much more accurate than that by any other method so far applied.

The main experimental limitation in such an investigation is the relatively small size of the crystals available, and for this reason all the measurements are made at 20° K. with a low-temperature resonator[2] and at frequencies of 25,000 Mc./s. or 36,000 Mc./s. When studying angular variation the electromagnet is rotated around the resonator, and the field positions of the absorption line plotted against angle of rotation. The first derivative studied in detail was whale acid-met myoglobin, as this was available in the form of large single crystals. The results obtained from this are a good illustration of the two types of information that can be obtained by paramagnetic resonance.

First the magnitude of the *g* value associated with the single electronic transition was found to vary from a $g_{\perp} = 5\cdot95 \pm 0\cdot05$ to a $g_{\parallel} = 2\cdot00 \pm 0\cdot01$. As previously noted[3], the occurrence of such a wide *g* value variation can be explained by assuming that $S = \pm \frac{5}{2}$ and that the lowest doublet is $S_Z = \pm \frac{1}{2}$ with a zero-field splitting to the other spin doublets much greater than that of the microwave quanta (> 2 cm.$^{-1}$). This splitting is far larger than that encountered in other ferric salts, and shows that the charge distribution on the surrounding atoms has a much greater effect than in normal ionic binding.

Secondly, the angular variation of the *g* value can be used for locating the axis through the iron atom perpendicular to the hæm plane, since this direction corresponds to the $g_{\parallel}$ of 2·0. This determination is based on the fact that, with axial symmetry, the *g* value at any angle θ from the axis is given by $g^2 = g_{\parallel}^2 \cos^2\theta + g_{\perp}^2 \sin^2\theta$, or, in the case of these derivatives, $\sin^2\theta = \frac{1}{8}\left(\frac{g^2}{4} - 1\right)$. By rotation in the *ab*, *bc* and *ac* crystallographic planes, the direction of the minimum *g* value in these planes can be located, and from its magnitude the angle which the parallel axis makes with the particular crystallographic plane can be calculated. Sperm-whale myoglobin crystallizes in two different types *A* and *B* [1,4], and the results of measurements on both types are given in Table 1, in the form of the direction cosines for the axis through the iron atom perpendicular to the hæm plane.

Table 1

Crystal type	Crystal symmetry	Direction cosines of axis *L*	*M*	*N*
A	$P2_1$	0·89	0·36	0·28
B	$P2_12_12_1$	0·13	0·95	0·29

The acid-met derivative is only one of many that can be investigated in this way, and these large loosely packed organic crystals have the advantage that individual crystals can be directly converted to other derivatives without loss of form. Thus an acid-met crystal can be immersed in a solution of sodium azide for a controlled time and then removed with half the crystal as an azide derivative and half still as an acid-met derivative. This technique is very useful since the previously analysed spectrum of the latter can then be used as a check on the orientation and g-value symmetry of the new derivative. In this way it can be shown that the g value of the azide derivative varies from a maximum $g_\perp$ of $2{\cdot}8 \pm 0{\cdot}05$ to a $g_\parallel$ of $1{\cdot}70 \pm 0{\cdot}05$, with considerable distortion of axial symmetry. The occurrence of a single electronic transition with g values spread across the free-spin value indicates that the binding is of the d^2sp^3 type, leaving one unpaired spin with some orbital admixture, similar to the case of potassium ferricyanide[5].

Further measurements are in progress on other derivatives and with hæmoglobin and myoglobin of different species, to obtain as much detailed information as possible on the binding of the iron atom and the orientation of the hæm planes. We would like to thank Dr. J. C. Kendrew for supplying the single crystals.

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Spectrophotometric Method for the Estimation of Vitamin K_3

Reddy and Srinivasan[1] have described a method for the estimation of vitamin K and vitamin K_3 which is slightly different from that of Novelli[2]. During the course of our investigation on the biosynthesis of vitamin K in moulds, we found that the method of Reddy and Srinivasan was not suitable for determining microquantities of vitamin K. It was observed that, on standing, the intensity of the colour at the junction of the two layers increases, with the result that the intensity of colour is not uniform throughout the layer. In the present communication, we wish to describe a modified method which can be used to estimate vitamin K in the range 2–30 μgm.

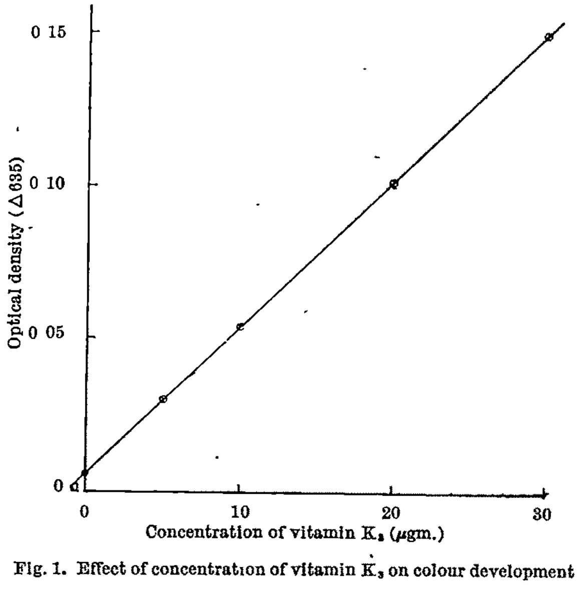

Fig. 1. Effect of concentration of vitamin K_3 on colour development

Vitamin K_3 solution (2–30 μgm.; 2-methyl-1,4-naphthoquinone) was shaken with 0·5 ml. of ethyl alcohol and to this was added 0·1 ml. of a saturated solution of 2 : 4-dinitrophenyl hydrazine in 2 *N* hydrochloric acid. After 10 min., 0·25 ml. of 20 per cent sodium carbonate was added and shaken well until the green colour appeared. 3 ml. of amyl alcohol, 1 ml. of ethyl alcohol and 1 ml. of water were added, shaken thoroughly and kept for 5 min. for the salts to go down. The amyl alcohol layer was taken and the density read at 635 mμ in a Beckman model *DU* spectrophotometer (1 cm. light-path). The colour obtained in this method is stable for 10 hr. Distilled ethyl and amyl alcohol were used throughout this investigation. Fig. 1 gives the relation between the optical density (Δ 635 and the concentration of vitamin K_3).

Details of the application of this method to estimate microquantities of vitamin K in moulds will be described elsewhere.

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The 'Queen-Substance' of Honeybees and the Ovary-inhibiting Hormone of Crustaceans

In the course of work on the social organization of honeybee communities[1], it has been found that worker honeybees obtain a substance ('queen-substance') from their queens which, if obtained in sufficient quantity, inhibits development of their ovaries and the production of further queens. It will also, under experimental conditions, inhibit ovary development in worker ants (*Formica fusca*) (unpublished work, C. G. B.). A similar hormone has been shown to inhibit ovary development in decapod crustaceans[2]. These substances appear to be similar in several respects. Thus both are stable to heat and to acids but less so to alkalis, soluble in acetone and alcohol, both are active, at least under certain conditions, when taken orally, and both serve to inhibit development of the ovary and related phenomena.

We decided, therefore, that it might prove of interest to administer honeybee queen-substance to prawns and also the ovary-inhibiting hormone of prawns to bees. The results of preliminary experiments are now available.

The queen-substance from a single mated queen honeybee (*Apis mellifera* L.) was extracted in alcohol. This extract was mixed with water, a little palmitic acid added, the *p*H adjusted to 6·2 and the alcohol and excess water distilled off. A control emulsion was prepared in the same way starting with alcohol alone.

Three groups, each consisting of twelve female prawns, were used. The prawns in group I remained intact and received no injections. The eye-stalks of the prawns in group II were severed, thus removing

Table 1

Condition and treatment of animals	Mean weight of ovaries (mgm.)	Histological condition of ovaries
(I) Intact; received no injection	4·90±0·65	All fully regressed; no commencement of vitellogenesis
(II) Eyestalks removed; control emulsion injected	17·67±3·39	All with well-developed yolk-droplets. One ovary full of yolk and showing dark green, ripe colour
(III) Eyestalks removed; honey-bee queen-substance injected	6·56±0·72	Some yolk-droplets present in a few cells in each ovary

the ovary-inhibiting hormone, and on the following day each of these prawns received an injection of 0·08 ml. of the control (alcohol) emulsion. The prawns belonging to group III had their eyestalks removed, and on the following day 0·08 ml. of the experimental (alcohol + honeybee queen-substance) emulsion was injected into each. This experiment was carried out at the time of year when most ovary-inhibiting hormone is present in the eyestalks of prawns and their ovaries are fully regressed. In such circumstances, removal of eyestalks normally leads to rapid ovary development.

One week after injection the surviving prawns—nine in each group—were killed and their ovaries weighed and examined histologically (Table 1).

The results show that removal of the eyestalks of the prawns forming the controls (group II) resulted in development of their ovaries and that, since there is a significant difference ($P < 0·001$) between the degree of ovary development in the prawns in group II and III, a single injection of honeybee queen-substance has produced a strong but incomplete inhibition of ovary development.

In the reciprocal experiment, twenty sinus glands—the organ in the eyestalks of crustaceans in which the ovary-inhibiting hormone is stored[2]—were removed from female prawns (*Leander serratus*) and their contents were dispersed by means of a Potter homogenizer in 67 per cent sucrose syrup. This syrup was then incorporated in a pollen-candy mixture and fed continuously to newly emerged bees kept in a cage at 31° C. and supplied with drinking water. Another group of newly emerged bees, the controls, were kept similarly but fed on a pollen-candy mixture without the addition of sinus-gland contents.

After nineteen days it was determined whether the ovaries of each bee had developed or had remained undeveloped as they would have done in the presence of a queen (Table 2).

It is clear that there is a highly significant difference ($P < 0·001$) in the degree of development of the ovaries of the bees of these two groups, and it appears that the sinus-gland extract of prawns has inhibited ovary development in worker honeybees.

Table 2

	Treatment	No. of bees with ovaries developed	No. of bees with ovaries undeveloped
Control group	Fed pollen-candy mixture	30	4
Experimental group	Fed pollen-candy mixture + prawn sinus-gland contents	15	17

To the similarities which we have observed between the queen-substance of honeybees and the ovary-inhibiting hormone of prawns may now be added a reciprocity of action. It seems probable that these two substances are the same or related compounds, possibly steroids, and occur in a number of arthropods.

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An Erythrocyte Sphering Factor in Rat and Mouse Plasma

When suspensions of many types of mammalian red cells in saline media are examined between a glass slide and coverslip, the cells change their shape from biconcave disks, through a stage of crenation, to spheres[1]. This change is associated with the removal or inactivation of an anti-sphering factor normally present in plasma albumin[2].

Recently, Trotter[3] in this laboratory has demonstrated the great importance of contamination of glassware by some substance, possibly a fatty acid, present on human skin. A single handling of a clean cloth used for wiping slides or coverslips contaminates both the cloth and the glassware and causes sphering. If the contaminated glassware is flamed, however, red cells retain their disk-like form. This finding makes it possible to observe the action of sphering agents without the presence of plasma or albumin. We have found that the plasma of several common varieties of laboratory rats appear to contain a substance which will cause sphering of saline suspensions of human cells between flamed slides and coverslips. This is in marked contrast to the behaviour of the plasma of the ox, pig, sheep and man as well as purified bovine or human plasma albumin, which not only have no sphering action but on the contrary prevent sphering on unflamed slides and protect the cells against substances such as sodium oleate, which cause sphering. In fact, the spheres observed in rat plasma can be changed back into disks by the addition of sufficient human plasma. The sphering activity of rat plasma is quite high; one part of rat plasma diluted with four parts of 2 per cent human albumin causes complete sphering and one part in twenty causes crenation of all cells and some sphering.

Rat plasma causes sphering of the cells of several other species including the rabbit and cat. There is no sphering action on rat cells, or on mouse cells, though the latter may become cupped. Human plasma does not cause crenation or sphering of rat cells, though cupping may occur (in our experience cupping seems to be a common reaction of the red cells of one species to the plasma of another; but we found no reference to this in the literature). Plasma from common laboratory mice behaved similarly to that from the rat, though the activity was rather less. Plasma from the vole, wild Orkney mouse, hamster and rabbit all caused crenation, but not complete sphering, while guinea pig plasma seemed to be quite inactive. The effect is thus not universal among rodents. We have sometimes observed that the sphering activity appears to increase if the plasma is left to stand for some hours at room temperature. Sphering activity has not been observed in the plasma of other common animals though the number investigated is comparatively small.

Indirect evidence suggests that the sphering agent may be a fatty acid. It is possibly significant that Robinson *et al.*[4] have found that rat plasma contains an active lipolytic system which brings about the dissolution of chylomicrons with the release of free fatty acids. No explanation can yet be offered of why the rat cells do not become spherical in their own plasma.

We wish to thank Dr. D. S. Robinson for useful discussions and the Rockefeller Foundation for financial assistance. This work was aided by a personal grant (F. M. G.) from the Medical Research Council.

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A Method for determining the Duration of Action of the Cardiac Glycosides

The determination of the duration of action of the cardiac glycosides has depended mainly on toxicity experiments which require large numbers of animals. The Hatcher method[1] depends on the difference between the usual lethal dose of a suitable cardiac glycoside and the actual dose required to kill at various times after the administration of the cardiac glycoside under test. Another method developed by Hauptstein[2] makes use of the relationship between the rate of infusion and the toxic dose of a cardiac glycoside; the decrease in toxicity with slow rates of infusion indicates the degree of elimination (detoxification and excretion). Data on the duration of action are also available from clinical records, where the criterion for the persistence of cardiac activity after the administration of a cardiac glycoside can be electrocardiographic changes such as alteration of the *T*-wave or decrease in heart-rate, or the therapeutic effect, although this is difficult to evaluate precisely.

A property of the cardiac glycosides has recently been described by Rand, Stafford and Thorp[3], which can be adapted for the study of the duration of action of cardiac glycosides and related compounds, particularly short-term changes seen with certain rapidly metabolized drugs of this group. The action of injected adenosine on the guinea pig heart (a transient period of partial heart-block) is markedly potentiated by doses of cardiac glycoside which alone are too small to have any observable effect on the electrocardiograph. The degree of potentiation appears to depend on the amount of digitalis drug available to the heart.

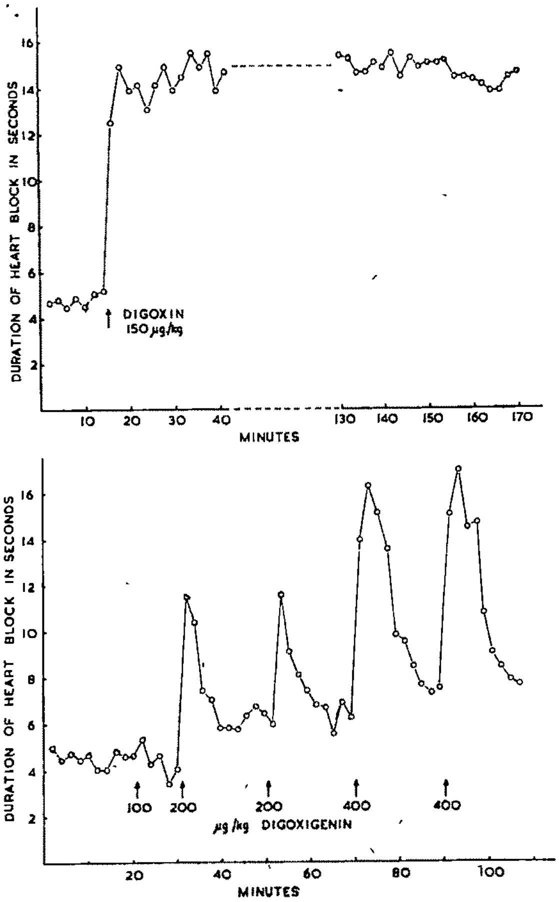

Fig. 1

Injections of adenosine are made at regular intervals, and then a dose of the cardiac glycoside under test is given. The change in duration of the period of heart-block produced by adenosine injections gives an indication of the activity of the cardiac glycoside. (The technical details have been described by Rand *et al.*[3]). With a single injection of digoxin, the potentiation of the adenosine effect persists for longer than three hours with no indication of any decrease, whereas a single injection of digoxigenin produces only a transient increase in the duration of the adenosine heart-block. Typical experiments are shown graphically in Fig. 1. It can be seen that a higher dose of digoxigenin is required to produce the same degree of potentiation as digoxin, reflecting the lower toxicity of this compound in the guinea pig. The rate of dissipation of digoxigenin can be calculated as the time for the response to adenosine to return to its previous level after giving the digoxigenin. From the results given in Fig. 1 the rate of elimination of digoxigenin is approximately 1·5 mgm./kgm./hr. for the high dose and 1·0 mgm./kgm./hr. for the lower dose. Hoffman and Lendle[4] found a value of 1·0–2·0 mgm./kgm./hr. for the elimination of digitoxigenin in the guinea pig using a slow infusion method.

A study of the rate of elimination of a number of other cardiac glycosides and genins and their synthetic derivatives is in progress, together with experiments on the role of hepatic and renal mechanisms in their elimination.

We are indebted to Prof. R. H. Thorp for his interest and encouragement during the course of this work, and to Mr. S. E. Wright, of the Pharmacy

Section, for supplying a chromatographically pure sample of digoxigenin.

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Biosynthesis of Fatty Acids by Seeds of *Ricinus communis*

So far, the biosynthesis of fatty acids in plant material seems to have received little attention; in this connexion we notice especially the communications of Newcomb and Stumpf[1]. We have now taken up similar researches on seeds of *Ricinus communis* var. *sanguineus*. The seeds were germinated in moist sand at 30° C. in darkness, the cotyledons sliced with a thin razor blade by freehand into sections ± 0·5 mm. thick, and aliquots incubated in water and substrate in a Warburg apparatus for 6 hr. at 30° C. After incubation the slices were rinsed and extracted with a mixture of ethanol–ether (3 : 1); evaporation *in vacuo* leads to pure castor oil. After saponification, the non-saponifiable material was extracted with petroleum-ether. The fatty-acid fraction was acidified, extracted several times and the combined ether-fractions dried and evaporated.

An aliquot of the fatty acids was subjected to chromatographic fractionation by the method of Howard and Martin[2]; ricinoleic acid, because of its alcoholic function, had a different solubility and passed the column as a $C_8 - C_{10}$ fatty acid (see also J. Boldingh[3]). With acetate as substrate, the respiratory quotient was ± 0·85; with propionate it was a little higher; without substrate, it was lower than 0·85. The latter fact is due to a higher oxygen consumption. The concentration of the substrates was 0·01 *N*.

Although incubation of the slices with ^{14}C-1 acetate (± 0·15 mgm.) reveals an important conversion of the ^{14}C-1 acetate to carbon dioxide, a considerable part was metabolized and incorporated into fatty acids. This fact confirms again that acetate is an important precursor of the fatty acids in seeds.

Separation of the acids by urea complexes[4] showed that the ricinoleic acid fraction, containing 70 per cent of the total fatty acid content, possessed practically no radioactivity; the remaining fraction, containing the saturated and unsaturated fatty acids, was highly active. Fractionation of radioactive castor oil by the method of Howard and Martin confirmed these results and proved that the ^{14}C-1 acetate was incorporated mainly into the C_{18} fatty acid (Table 1).

Table 1. FRACTIONATION OF CASTOR OIL (^{14}C-1 ACETATE AS SUBSTRATE)

Fatty acid	Specific activity (counts/min.)	Total activity	Acetate incorporated × 100
Ricinoleic acid (72·2%)	0·6	180·4	0·39
C_{12} acid (3·0%)	10·8	136·1	0·30
C_{14} acid (2·6%)	41·8	451·4	0·98
C_{16} acid (4·5%)	48·7	920·4	2·0
C_{18} acid (17·7%)	126·8	9,357·9	20·4
Non-saponifiable material	550·0	715·0	1·5

Table 2. FRACTIONATION OF CASTOR OIL (^{14}C-1 ACETATE AND GLUCOSE AS SUBSTRATE)

Fatty acid	Specific activity (counts/min.)	Total activity	Acetate incorporated × 100
Ricinoleic acid (64·9%)	0·7	203·8	0·44
C_{12} acid (2·3%)	15·0	157·6	0·34
C_{14} acid (5·1%)	59·7	1,380·4	3·01
C_{16} acid (12·9%)	250·1	13,668·5	29·83
C_{18} acid (14·3%)	79·4	5,257·3	11·47
Non-saponifiable material	818·0	1,554·2	3·4

Addition of glucose (conc. 0·01 *N*) to the ^{14}C-1 acetate substrate reduced respiratory quotient during several hours of the experiment, by diminution of the exhaled carbon dioxide, but it stimulated the incorporation of acetate into the fatty acids at a considerable rate. Fractionation of castor oil carried out in this way shows that: (1) the percentage of stearic acids and ricinoleic acid is lowered in favour of the C_{14} and C_{16} acids. (2) The radioactivity is transported to the C_{16} fraction (see Table 2).

The non-saponifiable material possessed, contrary to the results of Newcomb and Stumpf, considerable radioactivity. This indicates that acetate might play a part in the biosynthesis of phytosterols.

Our results on the influence of glucose may be explained by assuming that glucose acts as an acetate 'sparer'. The question remains open whether glucose is an active precursor of glycerol, and whether the removal of the fatty acids, as triglycerides, from the metabolic pool, is limited by the amount of glycerol available.

These experiments illustrate also the possibility of free metabolites influencing the lipid metabolism of germinating seeds.

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A Synthetic Growth Medium for the Trypanosomid Flagellate *Strigomonas (Herpetomonas) oncopelti*

BIOCHEMICAL studies of the Trypanosomidae have been delayed by the difficulties encountered in cultivation and maintenance of many species. Up to the present time, only one member of this family (*Herpetomonas culicidarum*) has been cultivated in a defined medium[1], and this was of a degree of complexity comparable to that required by the most exacting bacteria. The present communication describes a simple synthetic medium which will support the growth of the parasitic flagellate *Strigomonas oncopelti*; this trypanosomid, first isolated in bacteria-free culture by Noguchi and

Table 1. A SYNTHETIC GROWTH MEDIUM FOR THE PARASITIC FLAGELLATE *Strigomonas oncopelti*

	(mgm.)		(gm.)
Methionine	200·0	Glucose	5·0
Adenine	10·0	NH_4Cl	5·0
Thiamine	1·0	$Na_2HPO_4.2H_2O$	0·25
Nicotinamide	1·0	KH_2PO_4	0·08
Ca pantothenate	1·0	NaCl	9·0
Pyridoxine hydrochloride	1·0	KCl	0·42
p-Aminobenzoic acid	1·0		
Biotin	0·01		
Trace metal solution*	10 ml.		

Glass-distilled water to 1 litre

Initial *p*H value, 7·2. Medium sterilized by autoclaving at 10 lb pressure for 10 min.

* Trace metal solution: $MgSO_4.7H_2O$, 20·0 gm.; $FeSO_4$, 0·5 gm.; $ZnSO_4.7H_2O$, 0·5 gm.; $MnSO_4.3H_2O$, 0·5 gm.; $CuSO_4.5H_2O$, 0·5 gm., made up to 1 litre in *N*/10 sulphuric acid.

Tilden[2] in 1926, is parasitic in the digestive tract of Hemiptera and in latex plants. Lwoff[3] reported that *Strigomonas oncopelti* could be cultivated in alkaline hydrolysates of silk or in certain peptones if these were supplemented with thiamine; in contrast to other trypanosomids, it does not require hæmatin as a growth factor.

The nutritional requirements of *Strigomonas oncopelti* have been determined in a synthetic medium according to the general method of Gladstone[4]. A complete medium which would support the growth of the flagellate was prepared containing twenty-one amino-acids, eight growth-factors, purines, pyrimidines, glucose, ammonium chloride, sodium and potassium phosphates and trace metals. Further batches of media were prepared to test the effect of omission of the above components either singly or in groups. Cells to be used as inocula in growth tests were grown in the complete medium for 24 hr. at 25° C. and were washed three times in the medium to be tested; a standard inoculum of 2 × 10^5 cells/ml. growth-medium was used in all cases.

Results showed that the amino-acid requirement of this organism could be satisfied by methionine alone; adenine was also required for growth in addition to the growth factors thiamine and nicotinamide. In a glucose – salts medium containing these additions, growth was slow, the organisms having a mean generation-time of more than 24 hr.; the further addition of biotin, pyridoxin, pantothenic acid and *p*-aminobenzoic acid more than doubled the growth-rate, and cells reached a final density of about 4 × 10^7/ml. (≡ 0·4 mgm. dry weight cells/ml.). *Strigomonas oncopelti* has now been maintained on this medium for more than six months, being subcultured at intervals of three to four days; the detailed composition of the medium is given in Table 1. This is the simplest medium yet recorded for the growth of a parasitic flagellate, and it is interesting to note that *Strigomonas oncopelti*, although a parasite of Hemiptera and latex plants, is considerably less exacting nutritionally than the free-living ciliate *Tetrahymena pyriformis*[5].

So far as I am aware, there is no account in the literature of the cultivation of any member of the Trypanosomidae on solid media, Protozoa of this group usually being cultivated on complex diphasic media. *Strigomonas oncopelti* grows readily on a solid medium prepared by adding 0·7 per cent (w/v) agar to the synthetic medium described; discrete colonies are visible after four days incubation at 25° C. and cultures can be kept for three to four weeks without loss of viability.

The development of a synthetic medium for *Strigomonas oncopelti* permits for the first time a detailed study of the biosynthetic capabilities of an actively growing trypanosomid. Experiments using the synthetic medium described, supplemented with tracer amounts of acetate labelled with carbon-14, have shown that 50 per cent of the acetate carbon is fixed in the lipid fraction of logarithmically growing cells, 35 per cent is located in the cell protein (the use of methyl- and carboxyl-labelled acetate indicates that both carbons are utilized for the synthesis of glutamic and aspartic acids, alanine, threonine, tyrosine, lysine, arginine, valine, proline, phenylalanine and the leucines), and the remaining 15 per cent is distributed equally between the acid-soluble cell constituents and the nucleic acid fraction. These and other results, which will be reported in detail elsewhere, are similar to those obtained by McQuillen and Roberts[6], who studied the utilization of acetate for synthesis in *Escherichia coli*, and may be interpreted in terms of the Krebs tricarboxylic-acid cycle functioning in actively growing *Strigomonas oncopelti*.

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Resolution by means of a Micro-organism of Racemic Diaminosuccinic Acid and Determination of its Configuration

THE chemical structure of diaminosuccinic acid is analogous to aspartic acid, asparagine, C_4-dicarboxylic acids and the other biologically important substances. The acid, however, has not yet been found in Nature, and so has never been fully investigated. In 1925, racemic acid was resolved into its antipodes by Kuhn[1], through the morphine salt of N,N′-dibenzoyl diaminosuccinic acid; $[\alpha]^{20}_{D} = -18·9°$ (10 per cent hydrochloric acid). Suzuki and Suzuki[2] found, during the course of an investigation on the behaviour of micro-organisms towards the acid, that *Micrococcus ureae* was capable of growing on a medium containing the racemic acid as the sole source of nitrogen, and that about half the amount of racemic acid always remained even after full growth. From these observations the authors considered that the micro-organism preferentially assimilated one of the two optical isomers, and that a non-utilizable antipode could perhaps be isolated from the medium.

(1) *Synthesis of Racemic Diaminosuccinic Acid.* The acid was prepared by the reduction of dioxytartaric acid phenylosazone in the following manner, which was a modification of Farchy's method[3], since, in our hands, it gave more satisfactory results. A powder of 100 gm. of the osazone was resolved in 1 litre of 2 per cent sodium hydroxide with 1 kgm. of cracked ice, and 4 kgm. of sodium amalgam (2·5 per cent) was added to the solution; the mixture was stirred for 1 hr. At the end of the reaction, 167 gm. of 30 per cent sulphuric acid was slowly added (the temperature rising to 40° C.), and after stirring for

an additional hour, the mixture was filtered. The filtrate was decolorized with the continuous extraction of ether, and when it was acidified with sulphuric acid to *p*H 2, the meso-isomer precipitated. After the precipitate was filtered off, the filtrate was adjusted to *p*H 5 with sodium carbonate. It was necessary for the complete precipitation of the racemic acid to keep the solution for a week at 0° C. The crude preparation was purified by recrystallizations from aqueous hydrochloric acid as well as Farchy's method, and dried over phosphorus pentoxide *in vacuo*; the yield was 13 gm. The racemic acid contained one mole of water.

Analysis. Calc. for $C_4H_8O_4N_2.H_2O$: N, 16·86; found: N, 16·90 per cent. Melting point of N,N′-dibenzoyl-diaminosuccinic acid, 162° C. R_F values by paper chromatography (ascending method): *n*-BuOH/AcOH/H_2O (4 : 1 : 1), 0·04; phenol saturated with water, 0·11.

(2) *Culture and Extraction.* *Micrococcus ureae* was incubated at 30° C. with shaking in the following medium: distilled water, 1 litre; glucose, 10 gm.; sodium citrate, 2 gm.; dipotassium hydrogen phosphate, 1 gm.; ammonium chloride, 0·5 gm.; DL-diaminosuccinic acid, 0·5 gm.; crys. magnesium sulphate, 0·1 gm.; sodium chloride, 0·1 gm.; potassium dihydrogen phosphate, 0·1 gm.; *p*H adjusted to 7·0 with sodium hydroxide. After 24 hr., the culture solution was added with trichloracetic acid, and deproteinized by centrifuging. The supernatant was adjusted to *p*H 5 and concentrated to one-twentieth of the first volume by vacuum distillation. Diaminosuccinic acid was obtained as crude crystals by keeping the concentrated solution in an ice-box for one week. It was purified by recrystallizations from aqueous hydrochloric acid and dried over phosphorus pentoxide *in vacuo*; the yield was 40 per cent of racemic acid. Its nitrogen content, melting point of dibenzoyl derivative and R_F values were identical with those of the racemic acid.

(3) *pH-Change of the Specific Rotation.* The rotatory power of this preparation of diaminosuccinic acid was measured in solutions of sodium hydroxide and hydrochloric acid of various concentrations. Table 1 shows that the specific rotation was at a maximum in neutral solution, and successive additions of acid or alkali to it resulted in a lævorotatory shift. It is well known that the specific rotation of amino-acids varies decidedly with the *p*H of the solution, and that unnatural amino-acids (D-configuration) show maximum dextrorotatory power in neutral solutions, whereas natural amino-acids (L-configuration) show maximum lævorotatory power in these solutions[4]. Therefore it is concluded that the configuration of this antipode belongs to the *D*-series.

Table 1. SPECIFIC ROTATION OF D-DIAMINOSUCCINIC ACID AT VARIOUS SODIUM HYDROXIDE OR HYDROCHLORIC ACID CONCENTRATIONS

Moles of sodium hydroxide or hydrochloric acid per mole diaminosuccinic acid in the solution		Specific rotation* $[\alpha]_D^{20}$
NaOH	65·1 38·9 19·4 10·8 1·1	− 2·84 − 4·96 − 9·04 − 13·40 + 5·47
HCl	4·7 9·8 20·1 47·0 250·0	+ 32·20 + 16·70 − 0·65 − 4·36 − 16·80

* Measured by a Landolt-type polarimeter (0·01°) with 1-decimetre tube.

(4) *Racemization of D-Diaminosuccinic Acid by Benzoylation.* In order to measure the specific rotation of N,N′-dibenzoyl-D-diaminosuccinic acid, it was benzoylated by Kuhn's method using benzoyl chloride and sodium bicarbonate; the reaction was run at 25° C. for 2 hr. The specific rotation of the benzoyl derivative thus prepared (melting point,

$$162° \text{ C.) was } [\alpha]_D^{20} = +0\cdot019\,\frac{100}{1\cdot004 \times 1\cdot693} = +1\cdot12°.$$

Since the specific rotation of the same substance obtained by chemical resolution[1] was + 106·5°, it is evident that our preparation had been racemized through this procedure.

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Separation of Unstable Oxidation Intermediates of Cysteine

THE recent emergence of new bio-functional thiol compounds (coenzyme-A, lipoic acid) has revived interest in the series of compounds which represent oxidation-levels intermediate between —SH and —SO_3H.

We therefore wish to record an observation made some time ago in connexion with paper chromato-

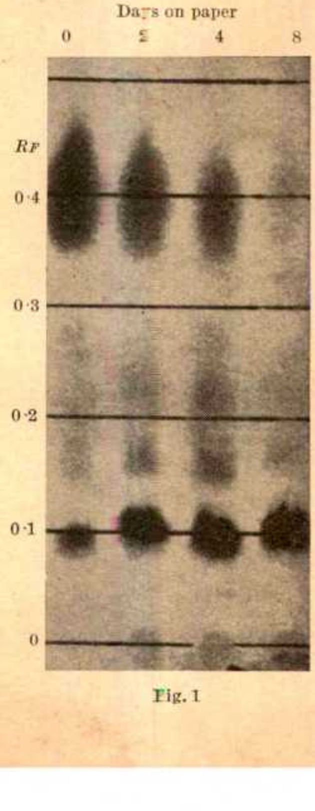

Fig. 1

graphic experiments[1], which suggests a simple technique for visualization and separation of unstable oxidation products. In order to evaluate the stability of cysteine in paper chromatography, we applied, on different days, to *S. & S. 589 GR* paper four spots of 10λ, each of which contained 80μ of cysteine hydrochloride in $3\,N$ hydrochloric acid in 50 per cent formic acid. When the last spot had dried, the paper was developed with phenol/*iso*propanol/water[1] and treated with ninhydrin. Fig. 1 shows the results. From left to right, the spots have been 'ageing' on the paper for 0, 2, 4 and 8 days before development. This is accompanied by a steady decrease of cysteine (R_F 0·4) and a steady increase of cystine (R_F 0·1, and probably in non-ionized form at R_F 0). In addition, intermediates, that is, compounds which pass through a time-maximum, are seen at R_F 0·16 and 0·23, and perhaps at 0·27. Discreteness of the spots and absence of tailing indicate that they represent a record of oxidative events occurring on the fibre surface in the 'dry' spots, and that little, if any, changes occur during the solvent-run. The possibilities of detecting and isolating unstable oxidation intermediates by these means are obvious.

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Insect Mobility and Design of Field Experiments

Recent papers have stressed two of the problems that arise in the design of field trials when insecticides are employed. McKinlay[1] noted that the protection of a crop afforded by the use of insecticide may be partially vitiated by re-invasion of insects from adjacent unsprayed plots. The converse of this situation was mentioned by Joyce[2], who pointed out that in the Sudan Gezira "the insect regime on unsprayed cotton may have been [so] affected by the wide-scale application of insecticide upon surrounding cotton".

A population of a mobile species is conceived to be in dynamic balance, numbers lost by emigration being replaced by immigration. When the distribution of a population has been affected by the application of insecticides, these two processes operate side by side to modify the environment in which sprayed and unsprayed crops grow. An important consequence of this modification can be the diminution of differences of yield expected between sprayed and unsprayed plots. By recolonization, the yield of a sprayed plot may be diminished; but following the action suggested by Joyce[3], the yield of a control plot may secondarily be increased by a drain of insects from the control to the sprayed plots.

Entomological opinion in the Sudan Gezira leans to the view that areas sprayed with DDT act as traps into which the nymphs and adults of *Empoasca libyca* de Berg migrate and die. In this way, populations upon control plots are reduced. By local usage, this postulated movement of jassids from unsprayed areas is termed an 'interplot effect' and connotes the ability of a plot to modify the character of the insect population upon an adjacent cropping area.

Recolonization by jassids of a previously sprayed area at Tokar as an example of interplot effect has been examined by Goodman (unpublished results). The inward movements of *Empoasca* nymphs from unsprayed cotton could be detected two weeks after spraying, though it is probable that continuous invasion occurred at all times after this date. The invasion was noticed first at the periphery of the sprayed plot, and the subsequent rates of build-up of nymphal populations were significantly correlated (P = 2 per cent) with the distance of the sampling station from the sprayed/unsprayed interface.

The influence of sprayed areas in reducing populations of jassids infesting adjacent unsprayed cotton was elucidated recently. The experimental unit consisted of two observation rows of *X*1730*A* cotton surrounded on each side by five rows of the same variety. These outer ten rows were sprayed on a number of occasions, but the jassid counts were made only upon the unsprayed central observation rows, which were protected during spraying by temporary hessian screens. There were ten replicated subplots for each treatment, each subplot having an area of 350 sq. metres.

In Table 1 are shown the total numbers of jassid nymphs counted from fifty leaves per subplot on eight occasions between October 13 and November 27, 1954. Using the log n transformation, analysis of variance of the total nymphs counted per plot showed that significant differences of population existed between the numbers of nymphs on the control subplots (that is, observation rows surrounded by unsprayed cotton), and the numbers counted on observation rows surrounded by cotton sprayed one or more times.

Table 1. TOTAL RECORDED POPULATION OF NYMPHS ON 50 LEAVES PER SUBPLOT FOR 8 OCCASIONS

Surrounds sprayed	Total population on observation rows per subplot (log means)
Control	2·3299
1×	2·0975, 2·1830
2× : 3×	1·9229, 1·9762 : 1·9354, 1·8786
4×	1·7095, 1·7764, 1·7855

Least sig. diff. P = 5 per cent (as log) 0·1358.

That is to say, the presence of plots sprayed with DDT adjacent to unsprayed areas of cotton significantly reduced the infestation of cotton jassid upon these untreated plots. Four applications of DDT produced a greater effect upon populations on nearby unsprayed areas than did fewer applications.

This evidence is important because, where large areas of cotton are sprayed each year, as in the Sudan Gezira, the apparent benefit from DDT spraying may be considerably less than expected; indeed, may fail to reach significance level, owing to the operation of interplot effects, although other tests may show that the destruction of the cotton jassid significantly improves yields.

The interplot effect demonstrated in the case of the cotton jassid has wide implications; indeed, the concept appears in different guises and has many applications in applied entomology. Thus Pearson[4] notes both the beneficial and disadvantageous aspects of this effect in respect of the protection against *Heliothis armigera* Hb. afforded by well- or ill-timed successions of maize and leguminous crops. De Bach and Bartlett[5], in North America, showed that sprayed citrus trees trap and poison immigrant *Vedalia*

104 reflexions should be sensitive to changes in the c/a ratio, since one reflexion depends on the values of the a-axes and the other mainly on the value of the c-parameter. These measurements show that the c/a ratio is larger at 95° K. than at room temperature.

As a more quantitative check, the curves shown in Fig. 1 were extrapolated to 95° K. The values so obtained for a and c, 4·944 A. and 13·599 A., respectively, agree very well with the results for the 226 and 21·10 reflexions from the diffractometer measurements at that temperature.

I thank Dr. Donald A. Edwards for making the low-temperature measurements, and Dr. J. Samuel Smart for helpful discussions.

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[1] Greenwald, S., *Nature*, **168**, 379 (1951).

Colour Centres in Metaphosphate Glass

IN a recent communication[1], Basu states that we have attributed the coloration of metaphosphate glasses, induced by X-rays, to the activating influence of the metal (aluminium, barium, silver, etc.) in the glass, and that his results with sodium metaphosphate glasses show that '*F*-centres' can be produced without these activators. In the references to our work cited by Basu[2,3], the point is made that radiophotoluminescent centres having certain specific properties are connected with the presence of silver in potassium–barium–aluminium metaphosphate glass. It is clearly shown, we believe, in the publications from this Laboratory[3-5] that a visible coloration is produced upon X-irradiation of the above silver-free base glass, two broad bands appearing with peaks at about 420 mμ and 530 mμ. These colour centres were not attributed to any 'activating' influence of the aluminium, barium or other metallic constituents of the glass.

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[1] Basu, *Nature*, **176**, 265 (1955).

[2] Schulman *et al.*, *J. App. Phys.*, **22**, 1479 (1951)

[3] Schulman, *NRL* Memo Report 266 (1954).

[4] Schulman, *J. Phys. Chem.*, **57**, 749 (1953).

[5] Schulman *et al.*, *Nucleonics*, **13**, 30 (1955).

WHEN writing my communication published in *Nature* of August 5, I had to rely on abstracts of Mr. Schulman's papers; this was responsible for my misrepresentation of Mr. Schulman's point of view. The information now supplied by Mr. Schulman is very interesting, for it appears that none of the bands observed in my system is present in the silver-free base studied by Schulman, and his 420-mμ band is completely absent in my system. This shows that a more critical study of this system is necessary before these bands can be assigned definitely to various trapping centres, although I have made some tentative assignment from the study of glass systems of different composition.

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Reproduction of Potato Root Eelworm during the Winter in a Potato Clamp

IN early March 1955, a freshly opened clamp of King Edward potatoes was inspected at Little Downham, Isle of Ely. It was observed that cysts of potato root eelworm (*Heterodera rostochiensis*) had already formed on the roots of many tubers which had sprouted and grown in the clamp. The cysts were in various stages of development. Some were white and others had turned yellow and contained fully embryonated eggs. It was estimated that there were more than a hundred cysts on some root systems. The wet autumn of 1954 had made lifting conditions very difficult and much damp soil had been clamped with the potatoes. Under these conditions root growth had been induced, and it is certain that the larvæ must have invaded the roots within the clamp and completed their development during the winter.

The field, on the black fen, was sampled to determine the level of infestation. The infestation was severe—5·24 viable cysts per gm. and 1,072 eggs per gm. of air-dried soil.

When a field is lightly infested with potato root eelworm, the clamp site will quickly become contaminated, as some soil will be deposited there from all parts of the field during harvesting operations. In addition, a clamp site often supports a high population of volunteer potatoes which will help to build up the eelworm numbers. If reproduction occurs within the clamp, the level of infestation may be increased still further, even though it is possible that many larvæ do not reach maturity under these conditions.

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Oct. 3.

Migration of Nematodes

THE relationship between hydrostatic pressure-deficiency and the migration of larvæ of the beet eelworm, *Heterodera schachtii* Schmidt, has been described previously[1]. It was shown that larval mobility was low in sand in which water was confined to the points of contact of sand particles. It was suggested that more critical experiments would be needed to determine whether there was an optimum pressure-deficiency for eelworm migration.

Accordingly, an apparatus (Fig. 1) was devised for examining this problem further, using the stem eelworm *Ditylenchus dipsaci*. *a*–*b* is polythene tubing,

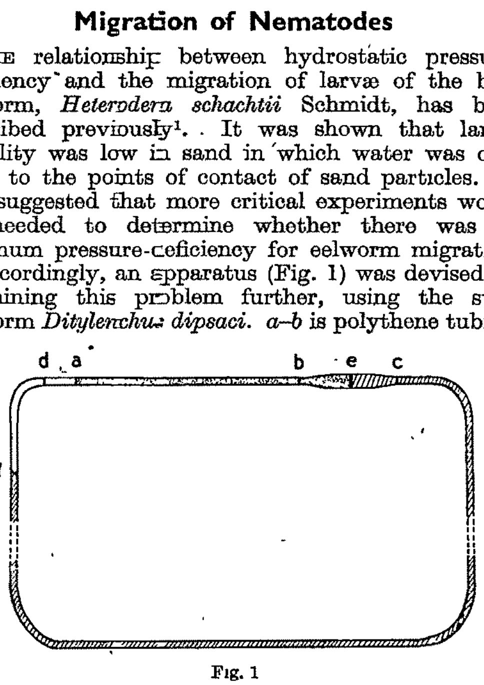

Fig. 1

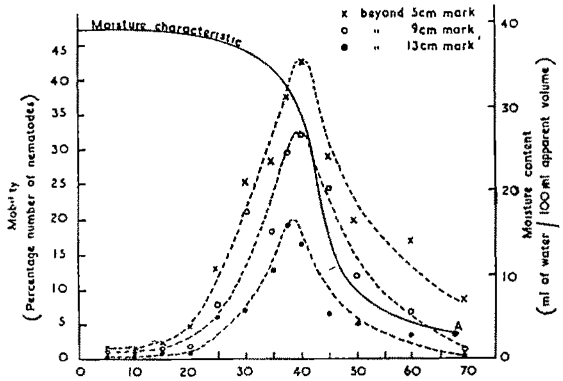

Fig. 2

18 cm. long and of 0·5-cm. bore ; *b–c* is a glass tube containing a sintered-glass plate *e* ; *c–d* is a loop of polythene tubing of the same bore as *a–b*, and *d–a* is a glass connecting tube. Sand of particle-size 200–400μ extends from *a* to *e*, and water extends from *e* to *f*. By varying the distance of the water meniscus *f* below the tube *a–b*, the hydrostatic pressure-deficiency in the sand can be regulated. A series of tubes was set up in this manner giving a range of pressure-deficiencies. About 10,000 eelworms in a drop of water were introduced into the sand at *a*. Previous experiments showed that the eelworms were carried from the end of the tube as the drop of water became distributed in the sand. However, no eelworms were carried more than 1 cm. in this way. After 16 hr., each polythene tube was cut into 1-cm. lengths and the number of eelworms in each section counted. The distribution of eelworms along each tube was thus obtained.

The results (Fig. 2) have been expressed graphically to show the percentage number of eelworms which were recovered beyond the 5, 9 and 13 cm. marks from the inoculation site (*a*, Fig. 1), at each pressure-deficiency. The moisture characteristic of the sand is also shown. As pressure-deficiency increases from 5 to 40 cm. of water, there is a corresponding rise in migration of eelworms. For pressure-deficiencies greater than 40 cm. of water, there is a decline in migration. The pressure-deficiency for maximum mobility of *D. dipsaci* in sand of particle size 200–400μ is thus 40 cm. of water, the point at which about 25 per cent of the pore space is occupied by air.

Observations suggest that *D. dipsaci* moves farther in a thin water film than when it is in a thick layer of water. Further investigation of this problem is needed ; but if this statement is accepted as a hypothesis, then it is possible to account for the relationship between eelworm mobility in sand and deficiency of hydrostatic pressure as follows. At low pressure-deficiencies the pore spaces are filled with water, air–water interfaces will be absent and mobility will consequently be low. Under these conditions, aeration will also be at a minimum and this may also inhibit active migration. As pressure-deficiency increases, air appears in the pore spaces, and movement in the resulting water films is consequently increased. In addition, increased aeration may also contribute to the general effect of increased mobility. With further increases in pressure-deficiency a point is reached when the continuity of the water film is broken. At this stage (point *A* on the moisture characteristic, Fig. 2), the nematodes are probably confined to water at the points of contact of sand particles. Progression through the sand will then entail a bridging of the air gap between water droplets, and this would inhibit migration in spite of high aeration.

Experiments with *Heterodera schachtii* indicate that there is a similar relationship between the distribution of water in sand and migration. Work is at present in progress on the factors influencing the migration of this species in soil.

I am indebted to the Sugar Beet Research and Education Committee for providing facilities for carrying out this work.

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[1] Wallace, H. R., *Ann. App. Biol.*, **43**, 477 (1955).

Prevention of Toxæmia of Late Pregnancy in Sheep

DISABILITY and death in ewes during late pregnancy and the puerperium due to toxæmia of pregnancy (twin-lamb disease) are an important cause of loss to the sheep industry in most of the principal sheep-raising countries of the world[1].

Although many observers have stressed the importance of a change in the nutrition of polytocous ewes during late pregnancy in the etiology of the disease[2], my recent observations in Britain suggested that excessive gain of weight in early pregnancy might render ewes particularly prone to develop toxæmia if they were subjected to changes in nutrition or other stresses in late pregnancy[3]. This hypothesis has been used empirically as the basis for a system of antenatal care designed to control the occurrence of the disease, which is meeting with considerable success. As the annual loss from the disease has been estimated to be £1–£2 million in Britain and £10 million in the Commonwealth[4], it seemed desirable to make some preliminary results available now.

The relevant details of consecutive lambings in some fifty lowland flocks in England and Scotland are set out in Table 1. The striking reduction in the number of cases of toxæmia and in the number of deaths in groups 1 and 2 is immediately apparent. The results in group 3 in 1955 would have been much better but for one large flock which had a mortality-rate of 12·6 per cent caused by failure to follow instructions and make adequate adjustments in the feeding during a spell of severe weather. If this flock is excluded, the figures, shown in brackets in the table, are excellent. These results are most encouraging, particularly in view of the maintenance of the average litter-size and indeed its increase in 1955 in two of the three groups to more than 1½ lambs per ewe. As it has proved impracticable to obtain results from unsupervised flocks which might serve as a control, this study should obviously be continued for a longer period to take into account the well-known natural fluctuations in the occurrence of the disease from year to year ; but the fact that such a low rate of attack was attained in 1955 when the disease in many neighbouring flocks was more prevalent than usual (Parker, W. H., personal communication) suggests that the general hypothesis may be substantially correct.

Table 1. DATA RELATING TO THE OCCURRENCE OF TOXÆMIA OF LATE PREGNANCY IN CERTAIN BRITISH LOWLAND SHEEP FLOCKS, 1953–55

Group	Year of supervision		No of flocks	No. of ewes at risk*	Average litter size†	Pregnancy toxæmia			Attack-rate per 1,000 ewes at risk*	
						Total cases	Died	No. of flocks affected	Morbidity	Mortality
1 (Pedigree Suffolk folded flocks in England and Scotland)	1st	1953	28	4,138	1·39	66	62	7	16·0	15·0
	2nd	1954	27	4,055	1·29	31	13	8	7·6	3·2
	3rd	1955	31	4,463	1·54	13	11	9	3·0	2·5
2 (Commercial flocks on grass in North-West England)	1st	1953	21	1,909	1·60	41	27	9	21·5	14·3
	2nd	1954	24	2,171	1·48	8	6	4	3·7	2·8
	3rd	1955	20	2,023	1·36	3	3	1	1·7	1·7
3 (Commercial flocks folded and on grass in Southern England)	1st	1954	5	1,987	1·45	46	42	4	32·5	30·0
	2nd	1955	5	2,211	1·63	61	54	5	27·6	24·4
			4‡	1,781	1·62	7	3	4	3·9	1·7

* Ewes at risk is the number of ewes put to ram less those barren, those aborting (before 135 days of gestation) and those lost by accident and death, excepting those dying of pregnancy toxæmia.

† Average litter size is the ratio of the total number of lambs carried by the ewes at risk, that is, the total number of live and dead born lambs plus the lambs carried by ewes dying of pregnancy toxæmia, divided by the number of ewes at risk.

‡ Excluding one flock (see text).

The system of ante-natal care, which has been used with individual modifications in all the flocks, has aimed at restricting the gain of weight of the ewes during early pregnancy, while ensuring good gains during late pregnancy. As soon as the ewes are known to be pregnant, their nutriture has been maintained unchanged as far as possible by control of the food intake, either by varying the size of the fold or the amount of grazing allowed. About six to eight weeks before lambing is due (depending on the weather), the food intake has been increased, either by allowing access to improved grazing or more usually by feeding supplements of corn, hay, etc. A common method has been to give a concentrate feed containing about 10 per cent of good-quality protein, commencing with ¼ lb. a head a day and increasing to 2 lb. a day for the last fortnight before parturition; during periods of severe weather, these amounts may be increased. At the same time, provision has been made for plenty of exercise, and any cases of the common ailments such as contagious foot-rot treated at once. Further details of these measures have been given elsewhere[5].

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Aug. 18.

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[1] Groenewald, J. W., Graf, H., and Clark, L., *Onderstep. J. Vet. Sci.*, 1941, **17**, 225 and 241 (1944).

[2] Franklin, M. C., Johnstone, I. L., and Parry, H. B. (1942); see Parry, H. B., "Toxæmias of Pregnancy: Human and Veterinary", 85. A Ciba Foundation Symposium, edit. by J. Hammond, F. J. Browne and G. E. W. Wolstenholme (Churchill, London, 1950).

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A Bathynellid from the New World

THE species of the syncarid family Bathynellidae are typical representatives of the subterranean freshwater fauna. There are three known genera, *Bathynella* from Europe, *Parabathynella* from Europe, Madagascar, Malaya and Japan, and *Thermobathynella* with the species *adami* Capart from the Belgian Congo and *leleupi* Delamare Deboutteville and Chappuis from Lake Tanganyika[1,2].

A locality on the American continent can now be added. In 1954 S. Gerlach undertook a voyage to Brazil, assisted by a fellowship of São Paulo University and the Deutsche Forschungsgemeinschaft. On January 13, 1955, he discovered a bathynellid species at Icoaraci, about 17 km. north of Belém (Parà), by the bank of the River Parà about 80 km. upstream from the ocean. The beach of Icoaraci consists of pebbles, gravel and clay. A little pit had been dug at a distance of about 1 m. from the shore. The subsoil water appeared 10–15 cm. below the beach surface. The water did not smell brackish, but Dr. H. Sioli states that at least in the dry season of the year the water at Icoaraci and up to Belém used to be brackish.

The sample contained three specimens of Bathynellids, some oligochaetes, polychaetes and acari, one harpacticoid copepod and numerous nematodes. Most of the nematodes belong to the species *Onchulus longicaudatus* Cobb. This species has been described "from soil about the roots of living plants imported from Brazil into the United States"[3], so the actual habitat of the type specimen is unknown. But it is an interesting fact that *Onchulus nolli* Goffart, the only other representative of the genus, may be considered a truly stygobiont European species, found exclusively in subsoil freshwater biotops and sometimes even together with *Bathynella natans* Vejdovsky[4].

The new bathynellid species from Brazil is a representative of the genus *Thermobathynella* Capart, the second antenna consisting of five joints and extremities lacking on the eighth thoracic segment. It can be distinguished from *Th. adami*[5] and from *Th. leleupi*[2] by the first antenna, which consists of five joints instead of six, and by the fact that epipodites are lacking on the first two pairs of thoracopods. In the arrangement of the setæ on uropods and furca the new species is similar to *Th. leleupi.*

A comprehensive description will be published in *Kieler Meeresforschungen*.

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ROLF SIEWING

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[1] Delamare Deboutteville, C. Y., and Chappuis, P.-A., *Arch. Zool. Exp. et Gén.*, 91 (1954).

[2] Delamare Deboutteville, C. Y., and Chappuis, P.-A., *Notes biospéolog.*, **10** (1955).

[3] Cobb, N. A., *Contrib. Sci. Nematology*, **9** (1920).

[4] Noll, W., and Stammer, H. J., *Mitteilg. Naturwiss. Museum Aschaffenburg*, N.F., **6** (1953).

[5] Capart, A., *Bull. Inst. Roy. Sci. Nat. Belgique*, **27** (1951).

Corrosion and Shell Composition in Barnacles

It was originally suggested by Darwin[1] that the susceptibility to disintegration of the shell of the common littoral barnacle, *Chthamalus stellatus* (Poli), was a consequence of its high content of organic matter. This suggestion has been accepted by many authors; but there appears to be no analysis to support the contention.

The organic matter and calcium content of the shells of several common barnacles, namely, *C. stellatus*, *Balanus balanoides* (L.), *B. crenatus* Brug. and *B. balanus* (L.) Da Costa, have been determined. In each case, fifty well-formed individuals of about 10 mm. rostro-carinal diameter were used. *Chthamalus stellatus* was taken from the upper level of the shore, *Balanus balanoides* and *B. crenatus* from mussel shells near low-tide level and *B. balanus* from material dredged at 20 m. The soft parts were removed, and the shells thoroughly cleaned by brushing; in the case of *Chthamalus stellatus* it was not possible to remove all the adherent unicellular green algae. The shells were then dried at 105° C., the inorganic material dissolved in dilute hydrochloric acid and the residual organic matter separated, washed and dried. Calcium was determined in the solution by a double precipitation as oxalate followed by titration with standard potassium permanganate solution. The results are shown in Table 1.

Table 1
(All values as percentage oven dry material)

Species	% Organic fraction	% Calcium as $CaCO_3$ of inorganic fraction
C. stellatus	2·1	91·1
B. balanoides	1·1	91·8
B. crenatus	0·6	90·7
B. balanus	0·8	93·4

It is evident that while the calcium content remains very uniform, *C. stellatus* contains a relatively larger organic content. However, when the difficulty of removing the unicellular green algae from this species is remembered it may be doubted whether the larger organic content at such a low value of the total is, *per se*, responsible for the increased susceptibility to corrosion. It is suggested that this is rather a function of the structure of the compartments than the quantity of organic material. Although the walls of *C. stellatus* have no parietal tubes they are permeated by numerous fine tubules. The latter are also present in the compartments of *Balanus balanus* (which undergoes corrosion) together with a number of small irregular pores. The presence of these tubules near the surface of the outer lamella could weaken the wall and allow corrosion to take place. In less-corrodible species quite large parietal tubes may be present, but these are flanked by solid calcareous wall. In support of this suggestion, it may be pointed out that in some species of *Tetraclita* notable for their extreme corrosion, although tubules are absent, the walls are permeated by several rows of thin-walled parietal tubes so that in section the compartments have a honeycomb appearance; the solid character of the wall and its resistance to corrosion are thereby destroyed.

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Oct. 8.

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[1] Darwin, C. R., "A Monograph of the Sub-Class Cirripedia" (Ray Society, London, 1854).

Dimorphism in the Portuguese Man-of-War

The Portuguese man-of-war (*Physalia*) occurs in two forms which are mirror images of one another but otherwise identical. Under the influence of the wind, one form (left-handed) moves to the right of the downward direction, the other (right-handed) to the left.

Woodcock[1] was the first to attempt to relate these facts to wind and water movements. He observed that a large majority of specimens from the North Atlantic and Gulf of Mexico were right-handed, and sailed to the left of the downwind direction. To explain this, Woodcock formed a hypothesis which required in part that southern hemisphere forms be mirror images of northern hemisphere forms, and sail to the right of the downwind direction. An examination of museum specimens seemed to show that there was, in fact, a preponderance of right-handers from the southern hemisphere (19 out of 22). Fontaine[2] observed, however, that the forms driven ashore on the southern coast of Jamaica were always left-handers. The prevailing wind was from the east.

In the Canary Islands this year we observed that forms driven into the harbour at Arrecife, which lies on the eastern coast of Lanzarote, were always left-handers when the wind came from the east or north-east. On one occasion when the wind came from the south-west, right-handers were driven in.

It seems probable from Fontaine's and our own observations that the proportion in which the two forms are found varies in particular localities not according to the hemisphere but according to the position of adjacent land and the direction of the wind.

We tentatively put forward the view that in each brood of *Physalia* the two forms are produced in rough equality, and that this has survival value in that it obviates the stranding of the whole brood in any one set of circumstances. The early development of *Physalia* is little known so it is impossible to say whether or not the two forms are genetically different.

Crude experiments were made by one of us to ascertain the speed and angle of drift of *Physalia*. In light-to-moderate breezes the following results were obtained with the aid of a spherical glass float, a chart and landmarks inside the mole at Arrecife. Towards the end of flood-tide on April 15 the speed of drift over the tide was 20 m./min. On April 16 at slack-water the courses taken by a number of animals moving across the wind varied from 34° to 42° to the right of the downwind direction. A boat sailing into the wind makes more forward than lateral way, but *Physalia*, though pointing up to the wind, makes much lateral and slight stern way.

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Sept. 28.

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[1] Woodcock, A. H., *J. Mar. Res.*, **5**, 196 (1944).

[2] Fontaine, A., *Notes Nat. Hist. Soc. Jamaica*, **64**, 61 (1954).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 13

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Lord Halsbury: "The Semantics of Determinism".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Power Supplies to Electrical Laboratories". Opening Speaker: Dr. P. F. Soper.

Tuesday, February 14

University College, London (in the Anatomy Theatre, Gower Street, London, W.C 1), at 1.15 p.m.—Mr. R. T. Green: "Psychology and the Search for a Model".*

Zoological Society of London (in the Mappin Refreshment Pavilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p m.—Scientific Papers.

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—H.E. Mrs. Vijaya Lakshmi Pandit, High Commissioner for India in London: "The New India" (Sir George Birdwood Memorial Lecture).

Imperial College (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W 7), at 5.30 p.m.—Prof. D. G. Christopherson: "Reflections on the Education of Engineers in a University" (Inaugural Lecture).

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. F. Coales and Mr. A. R. M. Noton: "An On-Off Servomechanism with Predicted Change-Over".

Royal Society of Medicine, Experimental Medicine Section (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Clinical and Experimental Studies with Radioactive Iron". Opening Speakers: Dr. L. F. Lamerton, Dr. Mary Smith and Dr. M. S R Hutt.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. B. Shepherd: "Manufacture of Phosphorus".

Society for Analytical Chemistry, Physical Methods Group (in the meeting room of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Polarography"

Wednesday, February 15

Royal Society of Arts (at John Adam Street, Adelphi, London W.C.2), at 2 30 p m.—Mr. L. H. Bedford: "The Arithmetic of the Musical Scale".

Eugenics Society (at Manson House, 26 Portland Place, London, W.1), at 5 p m —Mr. Frederick Osborn: "Galton and Mid-Century Eugenics" (The Galton Lecture).*

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p.m —Mr. D. H. Sadler: "The Abridged Nautical Almanac"; Mr. P. Beeham: "Navigating Without Instruments", Dr. J. G Porter: "The Earth Satellite Project".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion meeting on "Measurement of Water Vapour in the Stratosphere".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. E. Hart and Dr. S. J. Prais: "The Analysis of Business Concentration—a Statistical Approach".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S W.1), at 5 30 p.m.—Prof. J. Ivon Graham (Dunedin): "Fuel Conditions in New Zealand with special reference to the Coal Industry".*

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. D. Lacy: "Cell Inclusions in Vertebrate and Invertebrate Cells by Light and Electron Microscopy".

Aslib (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. D. McKie: "Sources of Information in the History of Science".

Institution of Electrical Engineers (at the Central Hall, Westminster, London, S.W 1), at 6 p.m.—Mr. B. L Metcalf: "Coal Mining Electrically" (Faraday Lecture).

British Psychological Society (joint meeting of the Education and Industrial Sections, in Room 173/4, Institute of Education, Malet Street, London, W.C.1), at 6.30 p.m.—Prof. L. J. Cronbach: "Technical Recommendations of the United States Committee on Test Standards".

Royal Institute of Chemistry, London Section (at the Institute of Metals, 4 Grosvenor Gardens, London, S.W.1), at 6.30 p m.—Dr. B. C. Saunders: "Some Properties and Reactions of the Enzyme Peroxidase".

Thursday, February 16

Physical Society, Low Temperature Group (at the Royal School of Mines, London, S W.7), at 4 p.m.—Dr. H. Ziebland: "Transport Properties of Liquefied Gases".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 4 30 p.m.—Dr. W. A. Sledge: "Observations on the Fern Flora of Ceylon"; Dr. P. Van Royen: "The Netherlands Botanical Expedition 1954–55 in New Guinea".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m —Mr. A. H. Cook, Mr. H. Meyer and Mr. W. P. Wolf: "A New Method of Correlating the Magnetic Temperature Scales of Paramagnetic Salts below 1° K.", Mr. C. D. Clark, Mr. R. W. Ditchburn and Mr. H. B. Dyer: "The Absorption Spectra of Natural and Irradiated Diamonds".

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P. F. Whelan and Dr. D. J. Brown: "Particle-bubble Attachment in Froth Flotation"; Mr. P. A. Williams: "The Identification and Valuation of Decomposed Columbite-bearing Granites of the Jos-Bukuru Younger Granite Complex, Nigeria".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. W. Whitehead: "Suspension Theorems".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. L. J. Kastner: "Some Engineering Problems" (Inaugural Lecture).*

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Technical Authorship and Illustration".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Discussion on "Sicklæmia". Opening Speaker: Dr. A. C. Allison.

Friday, February 17

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Scientific Papers.

Saturday, February 18

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Structure of Nucleic Acids and their Role in Protein Synthesis".

British Psychological Society (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. M. L. Johnson: "Exploring in Group Discussions the Factors Affecting Scientific Judgment".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist, Basic grade (with a B.Sc. degree with honours in biochemistry or chemistry or equivalent qualification)—The House Governor, The General Hospital, Birmingham 4 (February 18).

Lecturers (2) in Statistics—The Secretary, The University, Aberdeen (February 18).

Entomologist (under 30, with a degree with entomology as a special subject) in the Department of Research and Specialist Services, Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which will include laboratory and field research on insects and their near relatives, extension and advisory work mainly on agricultural entomology, but including some medical and veterinary entomology—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (February 24).

Assistant Astronomer in the Government Observatory, Perth, Western Australia, for duties mainly relating to research work in positional astronomy and photographic astronomy—Public Service Commissioner, 60 Barrack Street, Perth, Western Australia (February 29).

Organic Chemist (Scientific Officer grade) at the Long Ashton Research Station—The Registrar and Secretary, The University, Bristol 8 (February 29).

Assistant Agricultural Economist (graduate in economics and/or agriculture-horticulture) at Newton Abbot—The Registrar, The University, Bristol (March 1).

Assistant Experimental Officer (preferably with a degree in botany or agricultural botany) for work on cereal diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 1).

Assistant Lecturer or Demonstrator in Pathology, and an Assistant Lecturer (with special qualifications in applied mathematics) in Mathematics—The Registrar, The University, Manchester 13 (March 3).

Assistant Lecturers (2) in Zoology—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (March 3).

Deputy Librarian—The Registrar, The University, Sheffield (March 3).

Morphologist (with a university honours degree in botany and research experience) in the Division of Forest Products, Section of Wood and Fibre Structure, Commonwealth Scientific and Industrial Research Organization, South Melbourne, Victoria, Australia, to carry out investigations on cell differentiation and fibre structure with special reference to lignification—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C.2, quoting 290/437 (March 3).

Research Officer (with a university honours degree in science or agricultural science, and preferably with postgraduate research experience) in the Division of Soils, Commonwealth Scientific and Industrial Research Organization, Australia, to undertake surveys and field pedological studies of Australian soils—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (March 3).

Lecturer in Physics—The Registrar, King's College, Strand, London, W.C.2 (March 9).

Lecturer (with a research degree in nutrition, biochemistry or chemistry, followed by specialization in nutrition or biochemistry) in Biochemistry and Nutrition at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 15).

Tutor (with a good honours degree in natural or physical sciences, and preferably with experience in extra-mural work) in Science—The Director of Extra-Mural Studies (University of Glasgow), 91 Oakfield Avenue, Glasgow, W.2 (March 15).

Chair of Nuclear Power, and Reader in Nuclear Power, at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 16).

Lecturer (with an honours degree in geography and special qualifications in physical and economic geography and geomorphology) in Geography in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (March 17).

Chair of Geology—The Registrar, University College, Singleton Park, Swansea (March 20).

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics and subjects allied to chemistry or physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Demonstrators in Physics, and Demonstrators in Organic Chemistry—The Registrar, The University, Nottingham.

Deputy Director (with a good scientific background and able to formulate research projects which meet from time to time the needs of the industry, and also able to lead a research group successfully)—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22.

Lecturer (with high academic qualifications and some experience in the practical applications of electronics) in Electronic Engineering, with particular reference to electronics for purposes other than communications—The Registrar, The University, Bristol.

Master to teach Mathematics up to advanced level standard—The Director of Studies, Nautical College, Pangbourne, Berkshire.

Microbiologist (with a first- or second-class honours degree or equivalent qualification, and preferably with research experience), to assist in the study of fungi, moulds, etc., in their research aspects and in respect to their part in producing deterioration of materials, especially woods and textiles, under a variety of tropical environments (Ref. G.34/6A/AA); and Chemists (with a first- or second-class honours degree or equivalent qualification, and preferably with research experience) for work on general chemical problems (with opportunities for research) associated with the scientific study of the behaviour of a wide variety of materials (plastics, rubber, metals, fibres, etc.) in tropical environments (Ref. F51/6A/AA), at the Tropical Testing Establishment, Port Harcourt, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Physical Chemists or Physicists (with a first- or second-class honours degree or equivalent in chemistry or physics and an interest in the study of high-speed phenomena) at a Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to study detonation and deflagration phenomena in explosive systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.35/6A/AA.

Physicist or Engineer (with a first- or second-class honours degree or equivalent and preferably with experience of servo-mechanisms, analogue computers or applied electronics) at the Royal Aircraft Establishment, Farnborough, Hants, for work on instruments for flight control and navigation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.13/6A/AA.

Physicist (with a first- or second-class honours degree or equivalent in physics, and preferably with experience in one or more of the following: transducers, electrical recording apparatus, permanent magnetism and pyrometry) at a Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, for experimental investigations including study of transient mechanical phenomena—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 29/6A/AA.

Physicists and Electrical Engineers, Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in physics or electrical engineering), at the Ministry of Supply Fighting Vehicles Research and Development Establishment, near Chertsey, Surrey, to study problems of crossing rough and soft ground by tracked and wheeled vehicles and to develop electronic recording techniques for evaluation of soil stresses and associated automotive problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.489/5A/AA.

Physiologist (with a good honours degree in botany, and some postgraduate experience in plant physiology), at the Cotton Research Station, Namulonge, Uganda, to study the growth of the cotton plant with particular reference to the physiology of crop development and lint quality—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

Principal (under 45, with a university degree in forestry, mature experience and an aptitude for instructing in all spheres of forestry subjects) of the Forest Training School, Londiani, Kenya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, Westminster, London, S.W.1, quoting BCD.61/7/06.

Research Assistant (Biochemist or Biologist) to work on problems of nutrition and fertility, involving chiefly experiments with laboratory animals—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8.

Research Physicists; Electrical, Electronic and Mechanical Engineers, with the European Organization for Nuclear Research, Geneva, to assist in the design and construction of high energy accelerating machines and to carry out nuclear research—The Ministry of Labour and National Service, Almack House, 26 King Street, London, S W.1, quoting A.12/SW.1/18/CERN.

Theoretical Nuclear Physicist (with a first-class honours degree in mathematics or physics, together with several years postgraduate research experience in nuclear physics), to carry out fundamental research in nuclear physics, particularly on the theory of nuclear structure—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. No. A.799/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Objects and Method in Geographical Studies. (An inaugural lecture delivered at University College, Leicester, 2 June, 1955.) By Prof. Norman Pye. Pp. i+19. (Leicester: University College of Leicester, 1955.) 1*s*. [612

Ministry of Agriculture, Fisheries and Food. Bulletin No. 165: Weather and the Land. Prepared by the Agricultural Branch of the Meteorological Office (Air Ministry). Pp. iv+35+4 plates. (London: H.M. Stationery Office, 1955.) 3*s*. net. [612

Coal Tar Research Association. Review of Coal Tar Technology. January–June, 1955. (Vol. 7, Part 1.) Pp. 91. (Gomersal, Nr. Leeds: Coal Tar Research Association, 1955.) 7*s*. 6*d*. [612

The Projection of England. By Sir Stephen Tallents. (Originally published in 1932.) Pp. 46. (London: Olen Press, 1955. Published for Film Centre Limited.) 5*s*. [612

Laboratory Animals Bureau. Collected Papers, 1955. Vol. 3: The Breeding of Laboratory Animals. Pp. 92. (London: Laboratory Animals Bureau, 1955.) 7*s*. 6*d*. [612

Titration in Non-Aqueous Solvents. By A. H. Beckett and E. H. Tinley. Pp. ii+35. (Poole: British Drug Houses, Ltd., 1955.) [612

British Drug Houses, Ltd. Technical Information: 4-Dimethylaminobenzaldehyde. Pp. 21. (Poole: British Drug Houses, Ltd., 1955.) [612

Imperial College of Science and Technology (University of London). Report on Research Work in the City and Guilds College 1952–55. Pp. ii+61. (London: Imperial College of Science and Technology, 1955.) [612

Other Countries

Institut Royal Météorologique de Belgique. Contributions. No. 22: Éléments de Météorologie. Chapitre 2. Mesures en Altitude. Par L. Malet. Pp. 49–80. Publications, Série B. No. 18: La mesure de la conductibilité par radiosonde. Par Dr. L. Koenigsfeld. Pp. 8 (Uccle, Bruxelles: Institut Royal Météorologique de Belgique, 1955.) [612

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 36, No. 10: The American Wife. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [612

United States Department of Agriculture. Technical Bulletin No. 1118: The Biology and Ecology of the Red-Headed Pine Sawfly. By Daniel M. Benjamin. Pp. 57. (Washington, D.C.: Government Printing Office, 1955.) 20 cents. [612

Agricultura Tecnica en Mexico. Ano 1, No. 1 (Julio, 1955). Pp. 40. (Mexico, D.F.: Agricultura Tecnica en Mexico, 1955.) [612

Wattle Research Institute (South African Wattle Growers' Union—University of Natal—Union Department of Forestry). Report for 1954–1955 (Eighth Year). Pp. 37. (Pietermaritzburg: Wattle Research Institute, University of Natal, 1955.) [612

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert. Mission d'Études Vulcanologiques. Fascicule 1: Apercu Historique de l'Exploration et de l'Étude des Régions Volcaniques du Kivu. Par André Meyer. Pp 31+5 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1955.) [612

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. Reports, Series D: Meteorology. Vol. 5: Heard and Macquarie Islands, 1952. Prepared by the Bureau of Meteorology, Melbourne. Pp. i+173. Vol. 6: Heard and Macquarie Islands, 1953. Prepared by the Bureau of Meteorology, Melbourne. Pp. i+169. (Melbourne: Antarctic Division, Department of External Affairs, 1955.) [612

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Details from the Warden, Dillington House, College for Adult Education, Ilminster, Somerset.

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

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Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1. The closing date for the receipt of applications, in London and South Africa, is March 26, 1956.

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Applications are invited for the following vacancies: (i) Two Assistant Professorships, Nuclear or Solid State Physics or Spectroscopy (ii) One Instructorship (iii) Two Post-doctorate Research Fellowships First inquiries should be accompanied by brief particulars regarding training and experience.

Full information regarding these vacancies may be obtained from G. M Shrum, Department of Physics, University of British Columbia, Vancouver, 8 B C., Canada.

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UNIVERSITY OF LONDON KING'S College will require in April if possible and in any case not later than October 1956 a Lecturer in Physics. Salary: £700 by £50 to £1,000: £1,050 by £50 to £1,400 with family allowances and superannuation benefits with starting point according to qualifications and experience. Applicants should preferably have a higher degree. —They should write for conditions of appointment and application forms to the Registrar, King's College, Strand, W.C 2, whom completed applications must reach by March 9

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Application forms and particulars may be obtained from the above-named.

R. OPENSHAW,
Chief Education Officer

Education Department,
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The Coconut Research Board of Ceylon invites applications for appointment as Director of the Coconut Research Institute of Ceylon. 1. Salary: Local candidates, Rs 18,000 by Rs.800 to Rs.30,000 per annum; Overseas candidates, £2,000 by £100 to £3,500 per annum at current exchange rates. A dearness allowance of 15 per cent of basic salary, a rent-free two-storey house with heavy furniture is provided. A successfu applicant will be required to contribute to a provident fund at the rate of 15 per cent of his basic salary and an equivalent amount will be paid by the Board A higher salary would be accorded *ad personam* to a successful applicant with eminent qualifications. The appointmen will be in the first instance for a period of four years, inclusive of six months end of contrac leave. It is terminable with three months' notice on either side A first-class sea passage to Ceylon will be provided for an overseas candidate his wife and children under the age of 18 years Similarly, return passages will be provided to the country of domicile at the end of the period o service. Leave and travelling allowances in Ceylon will be in accordance with the regulations of the Institute. 2. Qualifications: The post calls for proved high scientific attainments, preferably in fields related to soils or crops combined with administrative experience either as head or deputy in the organization and running of a research institute or university department Experience o tropical conditions would be an advantage, but is not an essential qualification 3. Functions: The Director's primary responsibilities to the Coconu Research Board will be the administration of the Institute and the direction of the research activities of the Institute for the improvement of the yield and quality of the products of the palm. He will also be responsible to the board for the administration of replanting, rehabilitation and new planting schemes for the Island and for public relations General: The laboratories of the Institute are situated in the main coconut growing area of the Island, 32 miles north of Colombo. There is a scientific staff engaged in technological chemistry, soil chemistry, agronomy, plant breeding, and crop protection 4. Applications: Particulars should be furnished by applicants of their age marital status, academic qualifications, and research and administrative experience. They should also provide a list of publications, copie of testimonials, and the names and addresses o the referees to whom confidential inquiries can be addressed. A medical certificate and a recen photograph should also be annexed to the application.

Further particulars, if required, may be obtained from the undersigned. Applications should reach the Chairman, Coconut Research Board, Department of Agriculture, Peradeniya, Ceylon, on o before March 31, 1956

Chairman
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UNIVERSITY OF DURHAM

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A graduate Technical Assistant is required to assist in biochemical research into certain aspect of diabetes The post would be suitable for a graduate of pass degree or equivalent standard in chemistry, biochemistry or physiology. I might be possible for a suitable candidate to stud for a higher degree Experience in steroid hormone analysis, while not essential, would be an advantage

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G R HANSON,
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Applications, naming two referees, to Grou Secretary, War Memorial Hospital, Scunthorpe beetles which prey on various immobile scales on citrus. In the Sudan Gezira, numbers of cotton whitefly are reduced by the activities of several species of parasites and predators. The latter are mobile whereas the immature stages of their host on which they feed are immobile. It is possible that numbers of whitefly in unsprayed fields adjacent to sprayed ones may be increased by the loss of parasites and predators moving into sprayed fields. This aspect of interplot effect has also received attention because, if shown to be real, it would result in a general lowering of level of yields on sprayed and unsprayed fields alike, and give rise to differences in yields between sprayed and unsprayed fields which are spurious even were such differences statistically significant.

These, and other aspects of interplot effect, are being investigated by workers in this department, and it is hoped shortly to publish more extensive results on this important aspect of the biology of pests of cotton. I thank the Chief of the Research Division, Sudan Government, for permission to publish this preliminary communication.

R. J. V. Joyce

Entomology Section,
Gezira Research Farm,
Research Division, Ministry of Agriculture,
Sudan Government.
Sept. 19.

[1] McKinlay, K. S., *Nature*, **171**, 658 (1953).

[2] Joyce, R. J. V., *F.A.O. Plant Prot. Bull.*, 3 (6), 86 (1955).

[3] Joyce, R. J. V., Ann. Rep. of Res. Div., Min. of Agric., Sudan Govt., 1949–50, p. 92.

[4] Pearson, E. O., Proc. 6th Symp. Colston Res. Soc., Univ. Bristol Pub. (Butterworth, London, 1954).

[5] De Bach, P., and Bartlett, B., *J. Econ. Ent.*, **44**, 373 (1951).

A Combinatorial Design for Experiments with Alternative Responses

Often an easily recognizable symptom of disorder, for example, chlorosis, appears in plants. If the reason is not obvious and a nutritional origin is suspected, nutrient elements are applied in one way or another to find which is deficient, results being judged on the qualitative response of a 'yes' or 'no' type. Usually, every suspected element is applied in a separate treatment, say, as an injection (if trees are concerned) or a spray. At least as many solutions (or more generally, kinds of treatment) are then needed as there are elements to try. The same is obviously true if each treatment supplies all but one of the elements considered. The number of treatments, the many solutions, and the cleaning of injection or spray apparatus with the care necessary in trace-element work, make the operations tedious and cumbersome. If the area under study is remote and inaccessible, difficulties become serious.

There exists, however, at least in the exploratory stage of inquiry, a theoretical possibility of obtaining the same amount of information from a number of treatments substantially smaller than the number of elements used. To demonstrate the principle with the simplest possible example, let us take two solutions: solution I contains iron and zinc; solution II, iron and magnesium. If only solution I brings about improvement, we conclude that zinc is deficient; if only solution II works, it is magnesium; if both I and II work, it is iron. Here with only two solutions we obtain information about three elements. Of course, the gain is small in this case.

Quite generally, an element can be distributed among n different solutions (treatments) in 2^n different ways. This number includes a 'distribution' consisting of absence from all n solutions. Actually, then, only $2^n - 1$ elements can be arranged between n solutions in such a way that each element will be present in a different combination of solutions. The combination of solutions that bring about the disappearance of the abnormal symptom defines the element responsible, because elements and combinations are in a biunique correspondence.

It follows that in an experiment with three solutions, seven elements can be used. One element will be present in all three solutions; of three elements, each will be in one of the three possible pairs of solutions: I and II, I and III, II and III; and three elements will each be in one only of the three solutions: I, II or III. Metals must be used as salts, so the element forming the common anion, for example, sulphur, will usually occupy the combination of all solutions. Similarly, four solutions provide for fifteen elements, which is about the maximum needed in the present state of our knowledge about plant nutrition.

Controls or plants not treated with any of the elements will, as a rule, be an essential part of the experimental scheme. Thus, strictly speaking, with $n + 1$ variants of treatment, we obtain information about $2^n - 1$ elements.

For conclusions from an experiment of this kind to be valid, the following conditions seem especially important: (*a*) the deficiency is simple: the deficiency of only one element is the cause of the visible abnormal symptom; (*b*) the remedy is unique: only the application of the deficient element improves the condition, no other element does; (*c*) there are no interactions: each element acts in the same way whether any other element is present in the treatment or not.

In practice, condition (*a*) will be satisfied in most cases, condition (*b*) nearly so. Condition (*c*), on which knowledge is scarcest, arouses most doubt.

In spite of these limitations, the idea seems to merit submission for discussion and trial by students of this branch of plant physiology and, indeed, by all those who work with experimental arrangements where the conditions of alternative response ('yes' or 'no'), simplicity, uniqueness and independence (*c*) can be assumed to prevail.

K. Strzemieński

Soil Bureau,
Wellington,
New Zealand.
July 29.

Relationship between Photosynthesis and a Homogeneous Protein Component of Plant Cytoplasm

Ultracentrifuged analyses by Wildman and co-workers[1,2] of cytoplasmic protein of leaf cells of a number of higher plants, extracted by mechanical disruption of cells into buffer, have revealed two major fractions: the first a homogeneous component of sedimentation constant (S_{20}) 16–18 Svedberg units (fraction I) and the second a polydisperse component with mean S_{20} of 3–4 units (fraction II).

These observations have recently been extended to a number of pasture plants[3], and the presence of similar components confirmed in the leaves of monocotyledons as well as dicotyledons. Fraction II displays a number of enzymic activities[4], whereas the biochemical function of fraction I has not been elucidated.

To determine further the distribution of these two components, a brief series of experiments was carried out. The soluble proteins derived from tissues of seedlings of monocotyledons were analysed in the ultracentrifuge. In the first group, seeds of wheat and Italian rye-grass were germinated and suspended over trays of nutrient solution, where they grew in normal daylight until the first leaf was fully formed. The proteins were extracted from both leaves and roots, as well as from the leaves of albino mutants which are produced by about 1 per cent of the seed. The albino character is believed to be controlled by a single recessive gene.

In the second group, wheat seedlings were grown in the dark on moist cloth until the etiolated leaf was just emerging from the elongated coleoptile. A number of shoots were dissected into leaf and coleoptile tissue, and the remainder exposed to 4,000 ft.-candles at 60° F., further shoots being removed and dissected after various periods.

In the third group, the growth of etiolated wheat seedlings was prolonged by supplying adequate mineral nutrients and sucrose as energy source until the leaf, still in etiolated form, had completely emerged from the coleoptile and could be readily harvested. In a similar fashion the growth of seedlings, in which the first leaf had completely emerged in light, was prolonged in the dark for a further ten days, and the first leaves harvested.

The amount of fraction I calculated per 100 parts of fraction II in the extracts from these various tissues is summarized in Table 1. This method of presentation is adopted because of the difficulty of finding a suitable criterion for tissues of such widely different type and composition. The results suggest that fraction I is found only in photosynthesizing tissue or in tissue which is capable of photosynthesis after it is exposed to light. In the experiments with etiolated plants, the rapidity of leaf development after exposure to light partly obscures the formation of fraction I in existing tissue; but the low level in relatively mature etiolated leaves, and the disappearance from normal leaf on transfer to the dark indicate that the fraction reaches full development only when active photosynthesis is taking place.

Table 1

Tissue	Conditions of growth	Amount of fraction I per 100 parts fraction II
1. Wheat leaf	Full light, 7 days	66
2. Wheat root	,, ,, ,, ,,	Nil
3. Rye-grass leaf	,, ,, ,, ,,	61
4. Rye-grass root	,, ,, ,, ,,	Nil
5. Albino rye-grass leaf	,, ,, ,, ,,	Nil
6. Wheat seedling leaf	Dark, 5 days	18
7. ,, ,, ,,	,, ,, ,, + 5 hours light	23
8. ,, ,, ,,	,, ,, ,, + 12 ,, ,,	29
9. ,, ,, ,,	,, ,, ,, + 20 ,, ,,	52
10. Wheat seedling coleoptile	,, ,, ,, + 20 ,, ,,	Nil
11. Wheat seedling leaf	Dark, 10 days	32
12. ,, ,, ,,	Full light, 7 days; dark, 10 days*	16

* During growth in dark, second leaf developed in etiolated form, but only first leaf, which had matured during growth in light, was analysed.

This association of fraction I with photosynthesis may prove to be merely coincidental; but as the part it plays in cell metabolism is not yet known, its connexion with photosynthesis is worth further study.

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---

[1] Singer, S. J., Eggman, L., Campbell, J. M., and Wildman, S. G., *J. Biol. Chem.*, **197**, 244 (1952).

[2] Eggman, L., Singer, S. J., and Wildman, S. G., *J. Biol. Chem.*, **205**, 969 (1953).

[3] Lyttleton, J., *Biochem. J.* (in the press).

[4] Wildman, S. G., and Jagendorf, A., *Ann. Rev. Plant Physiol.*, **3**, 131 (1952).

A Simple Method of assessing the Moisture exuded through the Skin of Cattle

To assess the moisture, use is made of the Assman psychrometer with the addition of a simple and easily made adaptation, which consists of a square polished metal box 4 in. × 4 in. × 2½ in., open at one end. Two holes, sufficiently large to hold the box against the air tubes by means of the threaded ends of the psychrometer cups, are punched in the closed end of the box, equidistant from the sides. In the middle of the bottom edge of each side a ½-in. square cut is made, and when the box is fitted over the psychrometer cups, the instrument is ready for use on livestock.

It is recommended that the wick of the wet-bulb thermometer of the psychrometer be examined frequently during a period of experiment to guard against its becoming dry. The wick should be discarded after thirty animal readings as dust particles from the skin of the animals are likely to cling to the moist surface, thereby impairing the efficiency of the instrument.

Air humidity is measured at a distance of 3 ft. from each animal and level with its back. The skin humidity is then taken from a site on the left side of the animal, over the last rib and as close to the vertebral column as possible, ensuring that the box is flat against the skin. The hair on the site chosen is clipped close to the skin, and the readings are taken at exactly 90 sec., both for atmospheric and animal measurements. In an initial experiment (see Table 1),

Table 1

Animal	Mile	Atmospheric dew point	Animal dew point	Ratio of animal dew point to atmospheric dew point	Skin temperature	Atmospheric temperature
261	0	57	60	1·05	86·4	65·3
296	0	57	58	1·02	87·6	66·0
300	0	57	57	1·00	83·5	67·1
261	1	59	60	1·02	86·2	85·8
296	1	57	59	1·04	90·9	86·9
300	1	58	58	1·00	85·8	79·7
261	2	56	58	1·04	93·0	83·3
296	2	57	61	1·07	92·3	81·5
300	2	57	58	1·02	94·5	86·9
261	4	54	55	1·02	96·1	87·8
296	4	54	57	1·06	94·8	79·7
300	4	53	61	1·15	97·3	88·7
261	7	50	58	1·16	99·3	82·4
296	7	50	58	1·16	98·8	88·7
300	7	52	57	1·10	100·6	89·6

skin temperatures on the same site were taken using a thermistor thermometer (kindly supplied by Dr. Findlay of the Hannah Dairy Research Institute, Kirkhill, Scotland). Unshaded atmospheric temperatures were also recorded at each time of measurement.

All wet- and dry-bulb readings were expressed as 'dew point', and it is suggested that a convenient method of expressing the difference between atmospheric humidity and the humidity of the air passing close to the skin of the animal would be the ratio of the animal dew point to the atmospheric dew point. Figures calculated on this basis are included in Table 1, which shows the results of readings taken on three mature Tanganyika zebu bulls which were walked a measured distance around an open paddock. Readings were taken before walking commenced and at 1 mile, 2 miles, 4 miles and 7 miles. Walking commenced at 08.00 hr., and approximately four minutes elapsed between measurements relating to each animal at the various distances.

The animals were not allowed to graze until after the seventh mile. The results in Table 1 show that the instrument is capable of demonstrating minor fluctuations in moisture exuded from the skin of cattle under relatively dry conditions, and the high readings obtained after the seventh mile suggest that prolonged exercise causes 'sweating' in the Tanganyika zebu.

The work is continuing, and a more complete report will be given elsewhere. I am grateful to the Director of Veterinary Services, Tanganyika Territory, for permission to publish this communication.

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Sept. 10.

Thermionic Constants of Semi-Conductors

In some recent papers[1], we have described a convenient method of determining the thermionic constants of metals. The method consists essentially in determining, at different known temperatures, the rate of effusion of electrons through a small hole in a thin wall of a chamber made of the metal, instead of determining the direct emission from the surface. The advantage of the effusion method over the emission method is this. The expression for emission involves the transmission coefficient of the surface for electrons having the requisite momentum to cross the surface. This coefficient is very sensitive to adsorption of gases at the surface, and may differ considerably from unity. This coefficient, however, is eliminated in the expression for effusion, in the same manner in which the emissivity of the surface for electromagnetic radiations is eliminated when we take the electromagnetic radiations from a cavity through a small hole, instead of directly from the radiating surface. When the transmission coefficient is eliminated, any observed deviation of the A-coefficient in Richardson's equation from its theoretical value may be attributed to a small linear variation of the work function with temperature. Thus one is enabled by this method to determine not only the work function correctly, but also its temperature coefficient.

The thermionic constants of several metals have been determined by this method, using for this purpose a graphite chamber the walls of which were coated completely with the metal under study, by thermal or electrolytic deposition.

The main purpose of this communication is to direct attention to a new application of this method, namely, for the determination of the thermionic constants of semi-conductors, and to report some preliminary results obtained with nickel ribbons coated with the triple carbonates of barium, strontium and calcium in the molar percentages 47·5, 46·0 and 6·5 respectively. The ribbons were kindly supplied by Dr. D. A. Wright, of the Research Laboratories of the General Electric Co., Ltd., at Wembley. The ribbons were cut into pieces about 2 cm. in length, and a sheaf of them, held together at one end by a platinum foil, was fixed to the back of the graphite chamber, so that the ribbons did not come directly into contact with the graphite surface. The total surface area of these ribbons was more than twenty-five times the area of the effusion hole in our earlier measurements, and about fifty times in our later ones. The coated filaments were activated in the usual manner, and the effusion currents, corresponding to the saturation electronic vapour pressure of the oxide coat, in the temperature range 950°–1,160° K., were measured in the same manner as in our measurements on metals. (The electronic vapour pressure due to graphite, or platinum, is negligible at these temperatures.)

The currents corresponding to zero field were found to fit well with Richardson's equation, with $\varphi = 1{\cdot}55$ eV., and $A = 48$ amp. cm.$^{-2}$ deg.$^{-2}$. The latter value corresponds to a temperature coefficient of the work function $d\varphi/dT = 8 \times 10^{-5}$ eV. per deg., which is of the same order as in many metals. At 1,000° K. the current corresponding to effusion over the whole of the 2π-solid angle would be about 0·75 amp. per sq. cm. The corresponding current obtained by Elizabeth Grey[2] for maximum space-charge-limited pulsed emission directly from the surface of the oxide coat is 8 amp. per sq. cm., which is about eleven times as great. This ratio is of the order to be expected.

We thank Dr. Wright for supplying the coated ribbons, and for helpful discussions.

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S. C. Jain
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Nov. 27.

[1] Jain, S. C., and Krishnan, Sir K. S., *Proc. Roy. Soc.*, A, **213**, 143, and **215**, 431 (1952).

[2] Grey, Elizabeth, *Nature*, **167**, 522 (1951).

Use of Krypton-85 in measuring Gas Clean-up Rates

The intensity of gas discharges in switching devices for radar duplexers is such that clean-up of the rare-gas filling is an important factor, and may determine the life of such valves. Radioactive krypton, Kr-85 [1], has been used for measuring the rate of rare-gas clean-up in pre-T.R. valves, with promising results. Krypton-85 has a half-life of ten years and emits mainly beta radiation (680 keV.) and some gamma radiation (500 keV.). Thus it is a most convenient isotope to use, the radiation being readily detected by Geiger-counter or photographic techniques.

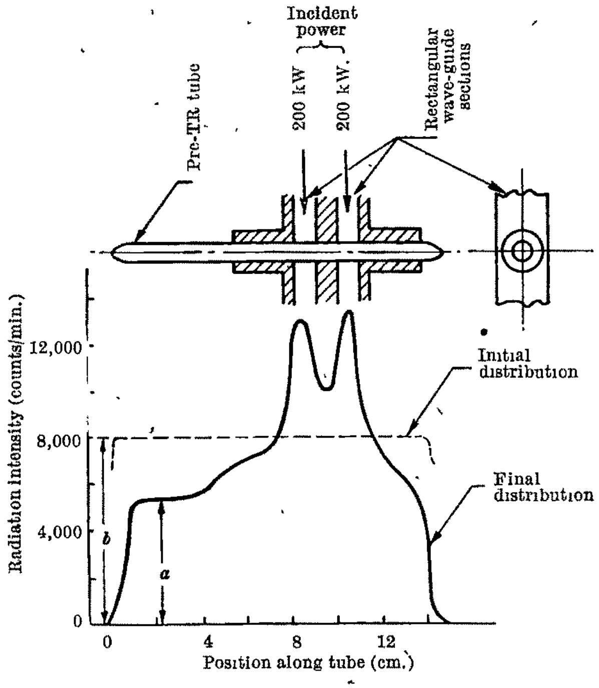

Fig. 1

Measurements using radioactive krypton can give information regarding the clean-up rate of this particular gas under certain conditions, and also enable a comparison to be made of the ability of different discharge conditions to clean-up rare gases.

Two techniques have been used to monitor the clean-up rate in pre-T.R. valves having walls of silica 0·020 in. thick: (*a*) The collimated beta radiation from a section of the valve remote from the discharge and gas clean-up region is monitored during the life of the valve, by Geiger counter. The activity then measured is due to free gas in the valve only, and hence the count-rate is proportional to the free gas density. (*b*) For low clean-up rates, a break-open test is most convenient. After a known period of life, the total activity of the valve is measured before and after breaking it open to the atmosphere. The residual activity of the valve after the free gas has escaped then corresponds to the quantity of gas cleaned-up into the walls of the valve.

A typical example of technique (*a*) is shown in Fig. 1. A silica tube pre-T.R. crosses two wave-guides, with 200 kW. of 3 cm. microwave power incident on each section of the tube. The tube contained 7 mm. mercury pressure of krypton. The lower diagram shows the distribution of the radiation emitted in a radial direction as a function of position along the tube-length, before and after a period of 250 hr. on life test. The ratio of final to initial gas pressure is given by a/b, and the area over which clean-up occurs is also indicated.

Radioactive argon and xenon are also available, but their usefulness is restricted by the low penetration from argon-37 and the short half-life (5 days) from xenon-133.

It would appear that the above techniques might be available in any experiments where clean-up of rare gases is being investigated.

The radioactive rare gases can be obtained from the Atomic Energy Research Establishment (Isotope Division), Harwell, whose helpful co-operation is acknowledged. We wish to thank the Admiralty for permission to publish this communication.

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---

[1] Radioisotope Conference, vol 2 (1954)

Changes in Lattice Constant of Cr_2O_3 near the Curie Temperature

In 1951, a communication by me under this title was published in *Nature*[1]. It showed that as Cr_2O_3 was cooled through the antiferromagnetic transition region, the *c*-axis (hexagonal setting) contracted sharply, whereas the *a* axes decreased almost linearly. Recently, R. J. Davis and W. E. Armstrong (private communication), in a study of a system involving Cr_2O_3, found that the lattice parameters at room temperature of their Cr_2O_3 sample did not agree with those given by me. They also suggested that the cause of the disagreement was my indexing the $42\bar{2}$, 664 rhombohedral reflexion pair as the $42\bar{2}$, 652 pair. Re-examination of the data and a few additional measurements have shown that this is indeed the case.

Davis and Armstrong's values at 23° C. are plotted on Fig. 1 for comparison with the values obtained by re-indexing my results. It is apparent that a slight discrepancy in the *c*-values still exists. Fig. 1 also shows that the *c*-axis lengthens rather than contracts as the material is cooled through the antiferromagnetic transition region, whereas the *a*-axes decrease in a non-linear fashion in the same temperature-range.

The c/a ratio for Cr_2O_3 is observed to increase as the temperature is lowered through the transition. The rhombohedral angle α decreases sharply in the transition region, and the rhombohedral *a*-axes decrease linearly within the experimental error.

New observations have been made at room temperature and at approximately 95° K. with a 'Norelco' high-angle goniometer diffractometer. In the front reflexion region, there is no ambiguity in indexing, and the changes in position of the 110 and

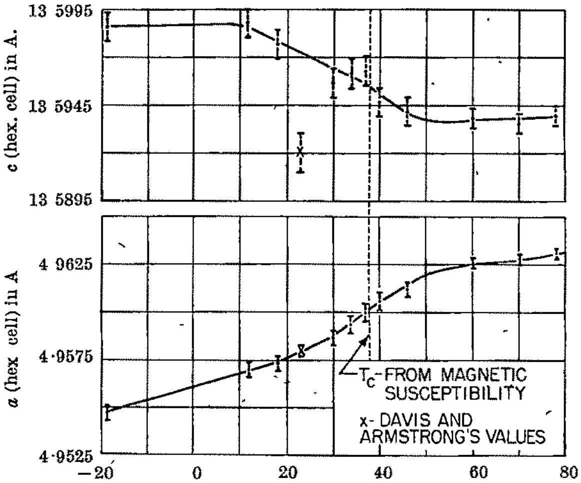

Fig. 1. Lattice parameters (hexagonal setting) of Cr_2O_3 as a function of temperature

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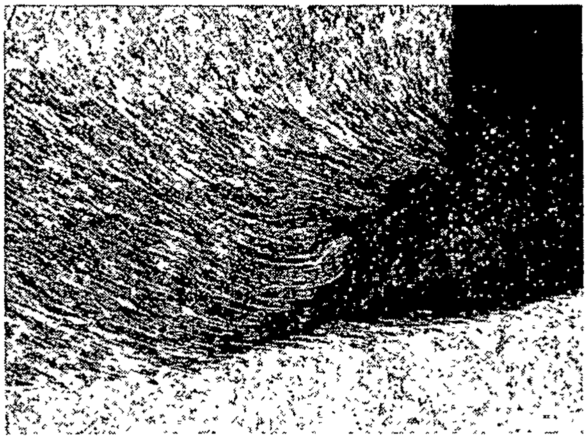

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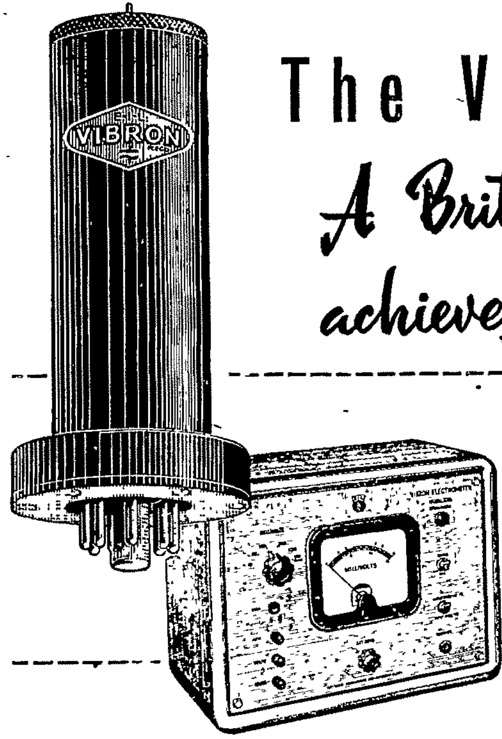

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LEADERSHIP IN A MODERN DEMOCRACY

IN his autobiographical volume "Power and Influence", Lord Beveridge says he used to impress on his students at the London School of Economics and Political Science that science and practical reform call ultimately for different qualities and cannot always be served together; and he does not think that the exploration of new fields of thought and administrative work go well together. He commented that the Civil Service can be impartial, but Members of Parliament can be neither impartial nor scientific.

One may indeed challenge Lord Beveridge's view that those who spend their whole lives in scientific work tend to become unpractical or indecisive, whereas those who devote their whole energies to advocating particular measures of practical reform tend to become unscientific; at the same time we can maintain with Smuts (in his Sidgwick Memorial Lecture on "Democracy") that we need to find more effective means of making use of impartial expert opinion, so that decisions are taken with regard to the facts of the situation rather than to prejudice or passion. It remains true, however, that the statesman and politician must have regard to what is politically practicable as well as to what is technically feasible. Expediency is a principle which no one with claims to statesmanship can ignore, whether or not we concede that expediency, and expediency alone, is the basis of all government as the first Earl of Lytton maintained.

For that reason alone the relations between theory and practice in politics are infinitely more complex than Mr. W. Esslinger has suggested in his recent book[*]. That the university can make an important contribution to the study of politics is not in dispute. It has been urged, for example, by such authorities as Sir Ernest Barker and by his successor in the chair of political science at Cambridge, Prof. D. W. Brogan, as well as by Prof. K. C. Wheare at Oxford. Prof. Brogan sees the study of politics as the study of the means whereby liberty and authority may be best combined, and the dignity of the free man is made compatible with the highest and richest forms of co-operation. Nevertheless, he doubts whether politics can be, in any but the most special sense, a science; and it may be suspected that neither he nor Prof. Wheare would dissent from Lord Beveridge's view as to the impracticability of combining the service of social and political science and the practice of the arts of democratic government in one person.

What Prof. Brogan claimed in his inaugural lecture was that by its study of politics the university could, as Sir Ernest Barker urged in another connexion, "enlist the effective thought of the whole community in the operation of discussion". The ten years since this lecture was delivered have increased our need for strengthening the power of discussion, for broadening civic intelligence and for extending civic knowledge; nor are we using the new means and opportunities of doing so even to the extent necessary to counterbalance the decay of former means of public discussion. We are indeed increasingly better equipped to understand society and mankind, and better able to study society and man and the institutions, traditions and historical conditions that limit and constrain purely political activity than any earlier age; and Prof. Brogan frankly claimed then that the teacher and student of politics in the university has the duty in his teaching and writing of imparting in this double activity as much as possible of the standards of university teaching and research. When, moreover, he continued that the university contribution to politics must often take the form of developing new and deeper understanding of old truths, he came very close to the thesis which Mr. Esslinger expounds.

Arguing for the necessity and possibility of a practical science of politics, Mr. Esslinger suggests that our predicament to-day arises primarily from our lack of rapid adaptation to the swift advances of science and technology and to the loss of our belief in the certainty of progress: we need, he suggests, a practical science of politics from which a political technology can be derived; but the difference between the two is never explained. Though he recognizes that education must cultivate the scientific spirit and that what matters is the scientific attitude, his argument is not made clearer when he gives fresh currency to the term 'sciencing' which L. A. White coined before the War. The term is never defined, nor does Mr. Esslinger ever appear to attach any meaning to it that would justify such a monstrosity.

Mr. Esslinger contributes, in fact, very little to the discussion as to how best we can improve the prospects of obtaining political actions determined more by the facts of the situation than by the prejudices of particular parties or groups, or by traditions which are no longer relevant. Nevertheless, when his counsel is not clouded by jargon, his views do not appear to be widely different from those of Barker, of Wheare or of Brogan, for example. The task of the scientist, as he sees it, is to reconsider the old points of difference and by creative and imaginative thinking indicate new solutions. He admits that there can never be the same accuracy as in the physical sciences; we cannot artificially create and reproduce the conditions of a social or economic process, nor can we even be sure that what works in a small community will work also in the whole State. A knowledge of interrelations and facts provides, none the less, the basis of good judgment, and the power of judgment can be trained in politics as in other fields.

Mr. Esslinger's plea, in fact, seems to amount in essence to one that the universities should broaden the field of studies devoted to practical problems, and in discussing schools of politics he seems to be advocating essentially what Prof. Brogan did in his inaugural lecture at Cambridge; it is to the spread of the scientific outlook and the scientific approach to the problems of government that he looks for the preservation of mankind in this age of nuclear power. The inherent difficulties in any approach to world government lie outside the scope of his book, though his final chapter is an analysis of the reasons for the failure of the League of Nations; he insists that the continuance of civilization depends on our concentrating on and finding solutions for the great political problems of peace, employment, the improvement of the standard of living in backward countries and the rejuvenation of democracy.

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[*] Politics and Science. By William Esslinger. Pp. xi+167. (New York: Philosophical Library, 1955,) 3 dollars.

It is in this connexion that he has a penetrating chapter on publication facilities, in which he emphasizes the importance of public discussion in testing the validity of new ideas and that this is even more important in respect of constructive thinking than of fact finding. This plea for better facilities for the publication and discussion of ideas is not to be dismissed lightly. It finds some support in the discussion on research in the social sciences arranged by the Parliamentary and Scientific Committee on December 13, 1955, and in passages in the paper, "The Intellectual Individual in Contemporary Society", which Mr. N. G. Fisher, formerly chief education officer for Manchester, read before the Manchester Literary and Philosophical Society last April and which has now been published in the Society's *Memoirs*.

Mr. Fisher, while agreeing that systematic training in orderly methods of thought is indispensable for administration, points out that the practical man must learn the limits of order and system when applied to human affairs, and that illusions accumulate around the intellectual approach to administration. Society works by processes largely spontaneous, seldom predictable and always untidy, and there is a law of compensation in human affairs which determines that nothing is ever as radically good or bad as it is intended and ought to be. On the whole, intellectuals make bad politicians, and politicians make bad intellectuals.

Mr. Fisher would have intellectuals critical of their society; but his lecture offers cold comfort to those who look for the spread of reason or science into public administration and world government. Nor is optimism encouraged by the passage by Keynes on his contemporaries in "Two Memoirs" which he quotes: "We were not aware that civilization was a thin and precarious crust created by the personality and will of a very few and only maintained by rules and conventions skilfully put across and guilefully preserved. We had no respect for the traditional wisdom or the restraints of custom. . . . It did not occur to us to respect the extraordinary achievements of our predecessors in the ordering of life (as it now seems to me to have been) or the elaborate framework which they had devised to protect this order".

Mr. Fisher is no more encouraging as to the value of improved means of communication, though here he is somewhat contradictory. Criticism he admits as a form of leadership, if free of personal animus and divorced from emotional compensations. Clearly he distrusts the intellectual generally in this respect, for he refers in conclusion to the danger that the masses may take the intellectual too seriously.

Where then shall we look for leadership, and how can we hope for public policy to pay the regard to technical advance that is essential if mankind is to continue? There is more hope to be found in the approach indicated by those who took part in a discussion before the Parliamentary and Scientific Committee. Prof. James Drever, who introduced the discussion, was confident that the various social sciences can contribute to the solution of problems set by race relations and international tensions, as well as by school and family and industry. Prof. R. W. Russell maintained that information about the behaviour of man as an individual and as a member of a social group is to-day put to more uses than ever before. Developments in psychological knowledge and technique have enabled the psychologist, with other biological and social scientists, to contribute increasingly, both as scientist and technologist, to the satisfaction of the growing demand for such information. As a scientist the psychologist is concerned with developing a coherent body of knowledge, consisting of general principles underlying behaviour; as a technologist he is concerned with solving problems arising mainly in the public services and in industry.

Prof. Russell thought that solutions to problems of human relations will increasingly be achieved on the basis of knowledge rather than of chance. Prof. T. S. Simey, who spoke as a sociologist, was concerned solely with problems of organization, and emphasized the importance of research in this field being independent politically, free from ideological strings and entirely above suspicion. A university department has an inherent advantage accordingly in organizing such research, so that the integrity of the research worker is established. It is also essential that the objectives of the work should be generally accepted as practical and desirable, and that there should be freedom to make mistakes.

This discussion before the Parliamentary and Scientific Committee went some way to promote the public understanding which is essential if effective work is to be done in the political or social sciences. Such understanding is indispensable for adequate finance to be forthcoming and research maintained on an adequate scale over a term of years, and it can assist also the recruitment of the right type of staff on which Prof. Simey laid stress. Our best hope of advance and of the increasing penetration of the scientific outlook and method into public affairs lies in education—in scientists themselves making the fullest and most effective use of whatever opportunities discussions such as this may offer, or meetings of the British Association, or the Press or radio. It depends, too, on the way in which we tackle the problem of general education not merely of the scientist himself but also of the arts graduate, and at the technical college and in the schools as well as at the university. It is linked up with the problem of adult and further education in general. Spectacular advance is not to be expected; but the patient, determined and sustained pursuit of public education by all such means offers the surest hope of bringing the grave issues of public policy to-day to a level of public understanding in which they can be handled with reason rather than with passion and prejudice.

THE ROYAL DUBLIN SOCIETY

The Story of the Royal Dublin Society

By Terence de Vere White. Pp. vii+228+13 plates. (Tralee: The Kerryman Limited, 1955.) 21*s*.

THE eighteenth century in Ireland was a period of contrasts. While the existence of wealth and culture was evident in Dublin and the larger towns, poverty and ignorance were widespread. Such was the situation when a small band of enthusiasts met together in 1731 and founded "The Dublin Society for improving Husbandry, Manufactures and other Useful Arts and Sciences". As the author of this book, Mr. Terence de Vere White, points out, each of the founders of the Society was expected by the rules to make a study of some special subject and to report to the Society any relevant information he could obtain by reading, conversation or his own experiments.

The Society, later known as the Royal Dublin Society, has had a chequered history, and many of those who know only of the way it has developed during recent years will be grateful to Mr. White for the interesting account he has produced. The story he tells is largely that of the various men who have played a part in building up the Society during the past two hundred years. Such a treatment makes easy reading, but some of the more irrelevant biographical details might well have been replaced by a fuller account of the work which was done. Scientific activities, especially, receive less attention than they deserve. Throughout its career the Society has given direct support to scientific projects likely to be of benefit to the country, one of the most notable of which was the Radium Institute it established at the instigation of the late Prof. John Joly. In addition, it has helped in the advancement of science in Ireland by holding regular meetings which bring together scientific workers from the universities and other institutions, the papers read at these meetings being afterwards published by the Society. In earlier days it appears that this form of activity was thought to overlap that of the Royal Irish Academy, and an interesting account is given of the brief and indecisive struggle for supremacy which occurred between these two learned bodies some seventy years ago. Mention is also made of the controversy aroused by the proposal, strongly supported by the physicist, G. F. FitzGerald, that the Society should grant fellowships.

However, the promotion of scientific research is but a part of the activity of the Royal Dublin Society and is probably of little direct interest to the majority of its members. The increasing popularity of the Spring Show, and especially of the annual Horse Show, has brought unwonted prosperity. This has enabled the Society to improve its amenities and attract a record membership. It has also served to emphasize the advantages available to an organization which can pull up on the swings what it loses on the roundabouts. One is tempted to speculate what would have happened if men with large ideas had not come forward when they did to found the Dublin Society. The growing tendency to specialization would most likely have led to the founding of smaller bodies, and while some of these would have been successful, others might have wilted through lack of support. As it was, the widely extending roots of the Dublin Society enabled it to expand freely in various directions. Branches such as museums, a botanic garden, an art school and a veterinary college grew out and later became separated from the main stem. The remaining branches continued to give each other nourishment and support. Such an organization has needed a long time for its development, and the story Mr. White recounts was worth telling.

N. G. BALL

ADVANCES IN PROTEIN CHEMISTRY

Advances in Protein Chemistry

Edited by M. L. Anson, Kenneth Bailey and John T. Edsall. Vol. 9. Pp. viii+542. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 10.50 dollars.

THIS volume maintains the high standard of its predecessors, and like them is so varied as to contain something of interest to most students of proteins. The biochemists will enjoy the article by H. R. V. Arnstein on the metabolism of glycine. As the simplest amino-acid, it enters into many synthetic and degradative reactions, besides its role in protein synthesis, and Dr. Arnstein's article contains a wealth of information on all aspects. M. I. Chalmers and R. L. M. Synge discuss the digestion of proteins and nitrogenous compounds in ruminants—a not unimportant subject, as much of our protein reaches us from the plant via the rumen. The article recalls war-time attempts to utilize the synthetic powers of the ruminant by feeding urea; but the authors conclude that there has been little evolutionary pressure towards an economical use of protein under generous feeding conditions.

The article on the formation, composition and properties of the keratins, by W. H. Ward and H. P. Lundgren, will be of interest both to protein chemists, because their fibre-like nature and great stability make them excellent materials for physical studies, and to technologists, because of the great importance of the wool and leather industries. The basic knowledge of these materials is fully reviewed. S. I. Mizushima reviews the molecular structure of some dipeptides and synthetic polypeptides mainly from the point of view of structure and physical properties. M. Laskowski and M. Laskowski, jun., discuss trypsin inhibitors, and J. P. Greenstein the resolution of racemic α-amino-acids. The remaining articles are more physico-chemical in character. D. F. Waugh's discussion of protein–protein interactions is extremely wide, and includes much information on protein structure and on the changes which particular proteins undergo when treated with various reagents; it also discusses a number of specific types of interactions, for example, antigen–antibody and enzyme–substrate.

Finally, D. F. Cheeseman and J. T. Davies discuss physico-chemical and biological aspects of proteins at interfaces. On the whole, the study of proteins spread as films at interfaces has been disappointing since, as these authors point out, the specific properties are lost when unfolding takes place. The method on the whole has thrown little light on protein specificity or size, but the authors are able to deduce some interesting reactions of drugs and growth regulators.

J. A. V. BUTLER

THE ORIGINS OF EDUCATION

Ancient Education

By Prof. William A. Smith. Pp. xii+309. (New York: Philosophical Library, 1955.) 3.75 dollars.

PROF. WILLIAM A. SMITH might well have lost would-be readers by his turgid preface. "Since education is a broad concept," he says, "a concept the connotation of which ranges all the way from the total socialisation process operative in a society to formally organised institutional programs, its scope for historical treatment must of necessity be delimited." There are twelve abstracts in those lines. But his book is, in fact, altogether stimulating. The enormous field he has to cover, in surveying the great civilizations of the ancient world, makes for speed and directness and thereby saves him willy-nilly from overmuch technical jargon. Furthermore, his pages read all the more smoothly for being very systematic. One knows precisely where one is the whole time.

A book on ancient education was long overdue, for the treatment in the standard histories of education at large has rarely yet been more than merely tantalizing. Nor have all these standard histories been quite clear as to how far 'education' means the same when they are looking at Ancient Sumer as when they are on the main highroad with Plato's Academy or Medieval Scholasticism or the Charity Schools. Here Prof. Smith speaks from strength. By education he means something both wider and deeper than "the formal school tradition" of a civilization: deeper, because in fact more than half his study of each great age is devoted to its cultural pattern, rooted in its religion, writing-system and habitat; and wider, because his focus is as follows: "Formal education arose initially to supply *training for specialists*—scribes, priests, accountants. These functionaries arose with the *urban revolution*, and were indispensable in connection with the administration of the *economic surplus*" (p. 129; italics mine). This general thesis he sustains in his first chapter, on the "Grand Divisions of Cultural History", which is certainly a fascinating build-up from the Lower Palæolithic families by way of the "Neolithic revolution" into urban centres needing specialization of function and therefore formal education (the whole transition illustrated archæologically in Mesopotamia).

The great peoples then surveyed are those of Mesopotamia, Ancient Egypt, Ancient India, Ancient China, Greece, Rome and the Hebrews—with a concluding chapter on 'anthropologically primitive societies to-day as living witnesses of the 'nonliterate' stage. The pace is fast, and the narrative a deft outline. One is not sure whether the book is primarily for the reader knowing nothing of the matter until he comes to it, or the student needing revision and a refresher. Certainly both will find in it plenty of great value. At times there is masterly summarization; as, for example, that on Aristotle: "The forms as such do not change, but matter is constantly taking on new forms; hence the sensible world is perpetually changing, and as it does so new forms are realising their potentialities or purposes". But there is equally too much sheer repetition, and too much of "as *X* states", or (oftener) "stresses", or (most of all) "aptly puts it". These quirks are the more irritating since the author can be really profound and graceful when he takes the trouble: for example, in explaining how and why the educational contribution of the Greeks towers above that of contemporary teachers in India and China. "The Indians (Aryas), initially a jolly and extroverted people, early fell under the sway of a sacred literature and a tyrannical priesthood. The Chinese escaped the sacred and the priestly, but succumbed to the past. . . . By way of contrast, the Greeks had no sacred book, no priestly hierarchy, and no authoritarian tradition to keep them from speculating about the nature of man and the world. Their geniuses were, therefore, relatively free. . . ."

That is good writing; and in this book by the former professor of education in the University of California, which makes no claim to great originality and is based on a massive bibliography of already-published studies, there is much like it.

A. C. F. BEALES

DEVELOPMENTS IN TECHNICAL EDUCATION

Technical Education

Its Aims, Organisation and Future Development. By Dr. P. F. R. Venables, with five chapters by Specialist Authors. Pp. xii+645. (London: G. Bell and Sons, Ltd., 1955.) 42*s*. net.

"THOUGH technical education is but a small sector of the whole field of education, it nevertheless has a lasting significance in meeting the economic needs of the country through industry and commerce, and in the importance that work and education for work must always have in the individual lives of innumerable people." In these words, Dr. P. F. R. Venables in his preface succinctly states the case for a wider understanding, on the part of both the public and experts, of this field of education.

It is surprising that during the past twenty-five years only one other major volume has been published on the work of technical colleges; although innumerable reports, journals and conferences have dealt with special aspects of technical education. It is therefore most timely that this very comprehensive and authoritative work should appear in print in the same year as Parliament has sanctioned the creation of a diploma in technology and a national council to control the award of that degree-level qualification.

The whole volume comprises twenty chapters: introduction; the colleges; the courses; co-operative partnerships; liaison with industry; selection and placement; seven specialist chapters on selected industries or studies; higher technological education; finance and administration; students' problems; staffing; buildings; and prospect. There are also copious statistical appendixes, a subject index and a name index. Each chapter is very fully annotated by references to a bibliography, and there are many diagrams and graphs illustrating the text.

Any critical appreciation of the volume must depend upon the type of reader for whom the work is intended. It is doubtful whether anyone outside the boundaries of technical education, including the youth employment service and industrial training officers, would have either the understanding or the patience to comb through the mass of information and statistics presented to ascertain just how or why a technical education should be beneficial to his son or daughter. In that respect, the present work differs markedly from a similar volume on technical education recently published abroad in that it includes no photographic illustrations to stimulate imagination or to lighten the heavy going of text and tables.

For those who are directly concerned with technical education, however, this publication is invaluable: as a summary of the present state of technical education; as a mine of statistical information; and as a fairly stated point of view on present problems and on proposed future development. On this last-named point, however, it is noteworthy that although five specialist co-authors were called in, these and the main author are all without exception principals of colleges. The outlook of the class-teacher, the governor and councillor, the education officer, the regional council secretary, the youth employment officer, and of the industrial training executive are thus perforce excluded, or stated at second hand. At first sight, it may seem regrettable that the idea of "partnerships in technical education" so eloquently extolled in Chapter 5—"Running through all are three essentials, administrative, industrial and academic, and all must be preserved in balance if satisfactory harmonious progress is to be made"—could not have been given practical expression in the compilation of this most comprehensive work. No reader of this book, however, more especially Dr. Venables's colleagues in technical education, will fail to be impressed by the immense task of authorship undertaken by him; nor to be grateful that, for a very reasonable price, a handbook of present-day technical education can be placed upon one's desk for day-to-day reference—for the first time since the War.

This treatise can therefore be warmly recommended to teacher, administrator and industrial training officer alike. It should also, by the synthesis it alone provides, do a great deal to place technical education in the forefront of progress.

HUGH A. WARREN

EMULSION POLYMERIZATION

Emulsion Polymerization

By Frank A. Bovey, I. M. Kolthoff, A. I. Medalia and E. J. Meehan. (High Polymers: a Series of Monographs on the Chemistry, Physics and Technology of High Polymeric Substances—Vol. 9.) Pp. xii+445. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1955.) 12.50 dollars.

SINCE emulsion polymerization was first described some thirty years ago, it has attracted a great deal of attention, and it has been found that emulsion polymers may differ very significantly in properties from their counterparts made in other ways. Much of our present understanding of this process arose from the massive effort devoted in the United States during the Second World War to the development of a synthetic rubber industry. The authors of the book under review were intimately involved in the fundamental research programmes associated with that effort, and write from a broad background of knowledge of the polymer field.

The specific problems of emulsion polymerization cannot even be formulated without an understanding of the process of polymerization in simpler systems. The authors might well have assumed their readers to possess such knowledge, or left them to acquire it from other available sources. Instead, they have chosen to make the book essentially self-contained. Following an introductory chapter, the next three chapters outline a treatment of free-radical polymerization which for the most part is not restricted in its application to emulsions. Chapter 5 gives an account of the properties of soap solutions and their ability to solubilize organic liquids, and thus leads up to Chapter 6, which discusses in detail the kinetics of emulsion polymerization. Following a general chapter on inhibitors, the authors turn to copolymerization, and show how normal copolymerization may be modified when the reaction is carried out in emulsion. A chapter on experimental methods includes a brief review of molecular weight procedures, while the final two chapters give a rather full account of the various systems used for the production of the American synthetic rubber *GR—S*.

This is a most interesting and very well-written book, and will be widely welcomed for its connected account of the problems of emulsion polymerization. Because of the plan adopted, the title scarcely does the book justice: it could fairly be described as a general text-book of polymerization, with special reference to the problems of emulsion polymerization. The general sections of the book are of the same high standard as the more specific, and can be confidently recommended as an excellent introduction to the subject. The book is indeed one which might well be put into the hands of students were it not for its unfortunately high price.

G. GEE

ELECTRICAL SUPPLY SYSTEMS IN THE UNITED STATES

Electrical Transmission and Distribution

Edited by Bernhardt G. A. Skrotzki. (Electric Utility Library.) Pp. ix+448. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 56*s.* 6*d.*

MANY good books have been written on the subjects of the generation and mains transmission of electrical energy, but the equally important one of distribution is possibly less well covered. In this volume it is pleasing to find the subject dealt with fully and in considerable detail. Written in an informal style, the book deals exclusively with practice in the United States, but British engineers will find much to interest them therein on this account. The treatment is more descriptive and practical than purely theoretical, and is written for those on the supply side rather than from the point of view of the designer of equipment. An introductory chapter deals with elementary electrical theory so far as is needed for the subsequent treatment.

The major part of the work is devoted to distribution systems, starting with a chapter on mechanical aspects, including formulæ and calculations for poles and conductors, and concluding with some useful information on cables. Electrical characteristics are next treated, including voltage-drop calculations and descriptions of system arrangements and voltage-regulation methods and apparatus. In this connexion it is interesting to note the wide use made in the United States of single-phase three-wire supply, a system practically unknown in Britain. The use of capacitors for the improvement of the power factor is given most of a chapter to itself, while another one is devoted to protection, including examples of short-circuit calculations. Another chapter is devoted to load characteristics. Diversity and coincidence, problems of varying load, and planning for possible future load-expansion are all dealt with adequately.

Apart from the distribution aspect, there is a short section on transmission, in which overhead lines and cables are described with some useful figures and much practical information. Included also are accounts, mainly descriptive, of transmission switchgear and miscellaneous apparatus—rectifiers, frequency changers, etc.—together with a section on street lighting which makes interesting reading on account of the wide use of the series system in the United States.

The book can be recommended to those interested in the supply industry on the distribution side, and for general reading to university engineering and advanced technical students. G. H. PLATT

CINEMATOGRAPHY IN SCIENTIFIC RESEARCH

Research Films in Biology, Anthropology, Psychology and Medicine

By Anthony R. Michaelis. Pp. xvi+490. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 10 dollars.

CINEMATOGRAPHY has been, and is, used by scientists for a number of different purposes. First, a film may be used as a method of illustration in teaching; secondly, it may be used for recording and demonstrating methods and techniques used in research; and thirdly, cinematography can be used as a research method in its own right. Obviously, such a classification cannot be hard and fast, for a fact discovered by cinematography often finds its way into a teaching film; indeed, it would be strange if it did not. But it is primarily with the last of the three categories of film just mentioned that Dr. Michaelis treats.

In this most comprehensive book are reviewed the origin and development of cinematographic methods used in the study of the sciences listed in its title. In this wide field it is not surprising that the number of techniques is large and that the descriptions of them are widely scattered, both in journals devoted to scientific photography and in the journals of the various specialities. Dr. Michaelis, himself a scientific cinematographer of distinction, has set out to review this field and to provide those who are interested in the subject with an authoritative survey.

The large amount of information which Dr. Michaelis has gathered presents its own problems when it comes to be marshalled for the instruction of the reader. The author's method has been to give a general introduction dealing with definitions of cinematography and research films, with the early history of research films, and then to deal with those points which may be considered as general to all the sciences under review. These sciences are then considered in turn, being divided into biological, human and medical science. In each section Dr. Michaelis explains how cinematography can best be used in that subject and goes on to describe the relevant special methods and concludes with a review of the use to which the research film has been put. In some instances he makes suggestions as to further research by such methods.

This book, therefore, is of value not only as presenting a summary of the methods of cinematography in research, but also as a history of research films.

It is possible to suggest that perhaps these two aspects of history and method have not been sufficiently separated to enable the reader primarily interested in methods to refer to them without having to read a rather too large amount of history also. To this it might well be replied that the development of methods is a matter of history and also that, in order to judge whether any one method is likely to be useful, it is as well to know the kind of result that has already been obtained by its use. However, the reader who wishes to use this book mainly as a source of methods is well catered for with an adequate subject index and also an author and reference index which includes some 1,490 entries.

Dr. Michaelis is to be congratulated on having produced a book which is a significant contribution to the history of cinematography and which also can be confidently recommended for the library of any laboratory in which studies using cinematographic methods are likely to be undertaken. It is well produced, and the misprints which seem inevitable in first editions are few. G. E. H. FOXON

THE FUTURE OF MANKIND

Two Ears of Corn, Two Blades of Grass

By D. H. Killeffer. Pp. x+139+36 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 30*s.* net.

ABOUT a hundred and fifty years ago Malthus saw, in his own village, that the limit to the increase in population was determined by the quantity of food available. He suggested that life would be easier if man could adjust his rate of increase to the amount of food available. But the industrial revolution, with improvements in agriculture and transport by land and sea, made it so much easier to obtain food that during the next hundred years the population of Britain increased fourfold and there seemed to be no limit to our food supply. The difficulties of obtaining food during world wars have, however, made us think again about this problem of population and food supply.

Sir Charles Darwin in "The Next Million Years" (1953) concluded that "In the very long run of a million years the general course of future history is, most of the time, likely to be what it has been for most of past time, a continual pressure of population on its means of subsistence—with a margin of the population unable to survive".

Mr. Killeffer's book contains an account of the scientific and technical developments of the chemical and associated industries in the United States during the past thirty years. He writes with a good inside knowledge of his subject, and every paragraph reflects the optimism which is behind the growth of industries in his country. He reviews the industries producing drugs, antibiotics, chemicals from petroleum, synthetic rubber, vitamins, chemicals for the protection of crops from insects, weeds and fungi, atomic energy and radioactive isotopes, plastics and metals.

Then he considers the problems of the future. He has no fear that the growth of population in the world will ever lead to famine because "American Technologies are going to other countries for nationals there to develop and utilize". He explains that we shall never be short of metals, sources of energy to work our factories, or food. First there will be great advances in agriculture by improving both the intensity and extent of cultivation and fertilization of our fields. But eventually we shall produce our protein foods in factories by growing yeasts and moulds. But we may have to grow our sugars and carbohydrates on farm land where we can utilize the energy of the sun. He considers that "We already know how to live well even when fields and farms shrink. Centuries before we will need them for that purpose, our industry is already operating processes that will free us from the necessity of farming fields for food. We can properly put our fears in a deep freezer".

Mr. Killeffer believes that the social and political effects will be that "Universal peace can be easily and surely realized by applying technology and science through human co-operation and collaboration to solve the basic human problems of nutrition, health and resources. We already know how to produce plenty of food and how to free people from the fear of hunger and from the load that sickness, disease and misery lay upon them. We can overcome these terrors if we apply throughout the world the techniques that we already know".

R. E. Slade

NEW METHODS IN ASTRONOMY

Radio Astronomy

By Dr. J. L. Pawsey and Dr. R. N. Bracewell. (International Monographs on Radio.) Pp. x+361+23 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 55*s*. net.

THE invention of methods of producing and detecting electromagnetic waves of long wave-length which could signal information invisibly over long distances with no material medium was a remarkable outcome of the classical electrodynamics of the nineteenth century. Although radio has since then continued to attract the attention of physicists, especially for the knowledge it gives of the Earth's upper atmosphere and ionosphere, pure research interest in radio became dwarfed by comparison with that in atomic physics. Much effort, however, was devoted by radio physicists and engineers to the perfection of radio communication in its various forms, including the associated techniques of radar.

The astronomer has always held a unique place in science. In the interpretation of his observations he incorporates new aspects of fundamental scientific knowledge ranging from nuclear physics to cosmology. He observes phenomena in conditions impossible to attain in the laboratory. His inferences and speculations arouse widespread interest since they concern man's place in the universe. That radio should now be making a far-reaching contribution to astronomy is an unexpected development of recent years.

The explanation lies in the advance of radio technology as well as in astrophysical phenomena at radio wave-lengths. With radio receivers of special design the temperatures of objects can be measured by the radiation emitted to an accuracy of the order of one degree. Thus the temperature of the Moon can be measured by its radio emission. Radio can also measure the temperatures of ionized atmospheres such as the solar corona and interstellar ionized hydrogen in the vicinity of hot stars. In addition, there are solar and cosmic radio sources of amazingly high intensity, the interpretation of which is a challenge to the astronomer and physicist. Another discovery of great importance is the line emission at 1,420 Mc./s. (21 cm) from neutral hydrogen, from which there is no visual emission. This spectral line enables not only the spatial distribution of hydrogen in the galaxy to be studied, but also the velocity by the Doppler displacement. A valuable aid in determining the structure of the galaxy is thus provided. Radar techniques have been extended to the study of reflexions from meteor trails and echoes from the Moon. In these various ways radio has become the new tool of astronomy and has the advantage of being able to 'see' through terrestrial clouds and interstellar dust.

Dr. J. L. Pawsey is the leader of an Australian research group, in the Commonwealth Scientific and Industrial Research Organization, which during the past ten years has played a leading part in the development of this new branch of astronomy. In their new book, Dr. Pawsey and Dr. R. N. Bracewell have written a valuable survey and guide to the fundamentals of the subject. It is an excellent introduction for physicists wishing to learn both the radio principles and the astronomical background. Equally, it explains the radio methods to the astronomer, and astronomy to the radio physicist or engineer.

It is plainly not easy to plan a book covering such a wide field. The authors have approached their task by describing radio techniques and propagation through an ionized gas; then follows a chapter on visual solar phenomena and solar physics. It is not until p. 144, with the chapter on solar radio waves, that the detailed account of the radio astronomical observations begins. An initial perusal of the chapters on solar and cosmic radio waves may be advisable in order to appreciate more thoroughly the significance of parts of the previous chapters.

The whole book is clearly written and well illustrated. The authors have endeavoured to be impartial in choosing material from the now vast number of papers on radio astronomy. It is, of course, natural that any author should be most advantageously placed in describing the work of his own laboratory. The rate of progress in radio astronomy is so great that a book on the subject can never be completely up to date when it is published. Although inevitably there are omissions of some recent findings, this book by Dr. Pawsey and Dr. Bracewell admirably covers the basic work and fundamentals. J. S. Hey

The Boys' Country Book

Edited by John Moore. Pp. 352. (London: William Collins, Sons and Co., Ltd., 1955.) 15*s.* net.

Letters to a Young Naturalist

By Maxwell Knight. Pp. 192. (London: William Collins, Sons and Co., Ltd., 1955.) 10*s.* 6*d.* net.

THOSE who publish books for young people must find the task more difficult every day. First, because more books are being published than the reading public can buy. Secondly, because the books that are published are, on the whole, of good quality both in format and in content. It is not surprising, therefore, to find a well-known publishing company of children's books dipping into the past for ideas for new books which it hopes will be successful. The editor of the "Boys' Country Book" has turned to the "Boys' Own Book", published about 1860, and which contained much good advice about how to get the best out of riding, sailing, swimming, fishing, shooting and other activities beloved by boys; much country lore was intermingled with the advice. In his book John Moore has sought help from well-known writers like Spencer, Chapman, Jack Longland, Jacquetta Hawkes, Geoffrey Grigson, James Fisher, Eric Hosking and a score of others who write about country pursuits of diverse kinds. The majority have done their task well; a few have padded to fill out the pages and fortunately will be read and quickly forgotten by boys of good sense. Most of the book should arouse spontaneous interest with the majority of early teen-agers.

"Letters to a Young Naturalist" has been developed along the same lines as Gilbert White's "Natural History of Selborne". It may appeal more to young people than adults who, while recognizing the value of the natural lore it contains, would have preferred to have been spared some of the conversational exchanges between uncle, nephew and niece. Some children, too, might have preferred straightforward descriptions.

Careers for Graduates

A Handbook of Information. Edited for the University of London Appointments Board. Pp. vii+196. (London: The Athlone Press (University of London), 1955. Distributed by Constable and Co., Ltd.) 5*s.* net.

A VALUABLE service to graduates, headmasters and headmistresses, parents and scholars who hope to go to a university has been made available by the Appointments Board of the University of London. In 1924 the Board issued a handbook giving information about the avenues of employment open to graduates. This ran to three editions, the last being published so long ago as 1934. A fourth edition has now been prepared and is virtually a new book. So far as possible the employment of graduates and students in all faculties except theology has been considered, and the needs of both men and women have been taken into account.

The Handbook includes a select bibliography of current careers pamphlets, memoranda and books likely to be of interest to graduates, students and others; addresses likely to be required by those making inquiries and an index for convenience of reference. It is a model of succinct and lucid presentation, and should be a boon to many who have to choose careers for themselves; it will be even more useful to those who have to advise others about suitable means of training for careers. The weakness of the book is in its unconscious emphasis on 'professionalism'. It has long been known that Britain has not found enough enterprising young men to take the findings of scientific research and apply and develop them in industry. It is not enough to encourage graduates to seek careers in industry. They are most needed in production departments where qualities other than professional qualifications will be needed if they are to establish themselves and progress. It is difficult to see how, in a Handbook of this kind, the real challenge and opportunity which shop-floor industry presents could be presented. Perhaps that is a problem to which industry alone can find the answer.

T. H. HAWKINS

The Numbers of Man and Animals

Edited by J. B. Cragg and N. W. Pirie. Pp. viii+152. (Edinburgh and London: Oliver and Boyd, Ltd., 1955. Published for The Institute of Biology.) 15*s.* net.

IN September 1954 the Institute of Biology arranged a symposium in order to bring together specialists in many different subjects connected with the numbers of men and animals. Their deliberations were recorded and have now been put together in book form. The central theme of the conference was that, while the growth of human populations is strongly influenced by social and cultural factors which are much less important in other species, *Homo sapiens* is still an animal and many aspects of his relationship with his environment, with other species, and with other members of his own species, are open to biological analysis. The analysis extends into most aspects of biology and sheds light not only on the reproductive habits of man but also on those of his domestic animals, parasites and pests. It became clear from the symposium that a great deal of money will have to be spent, and the number of people engaged on biological investigations increased, if essential information on population control or stabilization is to be obtained.

The book contains a record of all the papers presented by speakers as well as an idealized version of the discussion. It has been ably edited on behalf of the Institute of Biology, and the Institute has increased its prestige by arranging such a desirable and useful symposium.

A Manual of Paper Chromatography and Paper Electrophoresis

By Richard J. Block, Emmett L. Durrum and Gunter Zweig, with the co-operation of Raymond LeStrange, Winston H. Wingerd and Kathryn W. Weiss. Pp. viii+484. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 8 dollars.

THIS book is written in two sections: the first, by R. J. Block and G. Zweig, is on paper chromatography; and the second, by E. L. Durrum, is on paper electrophoresis. The first section is a revised version of the well-known monograph, by Block, LeStrange and Zweig, published in 1952, and maintains the high standard of that work. All practical aspects of paper chromatography are treated with remarkable thoroughness and presented clearly with many helpful recommendations. This section is a complete practical guide for all who employ paper chromatography.

There is ample justification for a monograph on paper electrophoresis, since it is now well established, but it is questionable whether the best course was to have included it in one volume with another technique which occupies four-fifths of the space. Because of this restriction, the author has been unable to give the subject the thorough treatment that is such a notable feature of the first section. For example, little is mentioned about pathological sera, although the widest application of paper electrophoresis is in the clinical field, and, because of presentation, the beginner may have difficulty in finding guidance. However, Durrum has dealt adequately with the theoretical side and has been able, from his experience as a pioneer in this technique, to provide valuable information concerning many practical details. The whole volume is attractively produced and includes a very full bibliography.

R. Consden

The Archæology of Sussex

By E. Cecil Curwen. Second edition, revised. Pp. xx+330+32 plates. (London: Methuen and Co., Ltd., 1954.) 25*s.* net.

Dr. E. Cecil Curwen is a well-known pre-historian, and he therefore writes from first-hand knowledge. The second edition of his work on the archæology of Sussex has been entirely brought up to date and gives an excellent general picture of the remote past in that county. The book is not intended for the specialist, but rather for the instructed amateur interested in archæology who is studying the ancient story of one of the more interesting parts of Britain. Dr. Curwen first sets the stage and then proceeds to deal with Sussex during the Stone Ages, the Bronze and Iron Ages and the Roman period. All accounts of Saxon times in the county have been omitted.

The only criticism that can be made is of the deliberate omission of any kind of gazetteer of sites. Here I cannot agree with Dr. Curwen that such things are only useful to specialists. Anyone visiting the county and wishing to explore the countryside would have welcomed such a list of sites with their ages and references to any relevant literature concerning them. For the specialist, of course, such a gazetteer would have been invaluable. One rather fears that the publishers probably felt they could not face the extra expense involved. All the same, this second, revised edition is an excellent work and should be on the shelves of everyone interested in the remote past of that part of England. The illustrations are well chosen, both the line-blocks and the half-tones; and there are a welcome number of the latter.

Miles Burkitt

Transistors

Theory and Applications. By Abraham Coblenz and Harry L. Owens. Pp. xv+313. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 42*s.* 6*d.*

Three years ago the authors gave lectures on the transistor at laboratories of the United States Signal Corps, shortly afterwards converting them into eleven articles for the journal *Electronics*, and now into a book. They have thereby attempted the formidable task of describing semiconductor physics, the metallurgy of germanium and silicon, techniques for manufacturing transistors and the equivalent circuits and applications of transistors, in language suited, as they say, to the practical technician.

The background physics given in early chapters is, however, disjointed and not always helpful or accurate. The uncertainty principle, for example, might well have been omitted. Davisson and Germer did not, in confirming de Broglie, pass electrons through a nickel slab to obtain clear, circular diffraction patterns on a photographic plate. Mobility, lifetime of minority carriers and the Hall effect are surprisingly left until much later in the book. The chapters describing the electronics, elementary circuits, small-signal applications and cascading of transistors—the centre third of the book—are, on the other hand, very satisfactory and should be of wide use. A chapter on large-signal applications is too confined to early work.

Manufacture is interestingly described, but diffusion is said to be the mechanism responsible for the p-n junction formed by that extensively used process of alloying indium to n-type germanium. The fact is that, during the furnace operation, the indium dissolves some germanium, much of which, contaminated with indium, is precipitated during cooling on to the undisturbed germanium, at first continuing the monocrystalline structure; diffusion is unimportant. Very little information is given on the design of transistors. The presentation maintains the high standards of the publishers.

J. R. T.

An Introduction to the Theory of Numbers

By G. H. Hardy and E. M. Wright. Third edition. Pp. xvi + 419. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 42*s.* net.

This text, widely recognized as probably the best general introduction to number theory, now appears in a third edition; G. H. Hardy died shortly after the publication of the second edition of 1945, and the revisions have been made by Prof. E. M. Wright, utilizing recent work. For example, the 1945 statement that there is no easy proof of the irrationality of π has been replaced by a concise and elegant proof due to Niven. But the major change is the insertion of an 'elementary' proof of the Prime Number Theorem, that the number of primes less than x is asymptotically equivalent to $x/(\log x)$. This proof, obtained by Selberg and Erdös and here given with improvements due to Wright, is by no means easy, but is technically elementary since it makes no use of complex function theory, and its discovery was the mathematical sensation of 1949.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Edited by William S. Johnson. Vol. 34, 1954. Pp. vi+121. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 28*s.* net.

Among the thirty-four preparative methods described in this volume are two for cycloheptanone, each starting from cyclohexanone: the first method, using nitromethane and Raney nickel, gives a yield of 40–42 per cent; the second, in which *p*-tolylsulphonylmethylnitrosamide is used as a source of diazomethane, gives 33–36 per cent. The great variety of organic compounds contained in this latest issue may be indicated by mentioning azelanitrile, cetylmalonic ester, dimethylfurazan, diphenylacetylene, hemimellitene, 3-methylthiophen, *o*-phthaldehyde and tetralin hydroperoxide. The editors invite chemists to submit accurate details for the preparation of other compounds which might find a place in future issues, either by reason of their general interest or because they illustrate useful synthetic methods.

John Read

REVERSIBLE, HOST-INDUCED, CHANGES IN A STRAIN OF TOBACCO MOSAIC VIRUS

By F. C. BAWDEN, F.R.S.

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THE concept of variability is, perhaps, even less novel with tobacco mosaic virus, of which scores of strains have been reported, than with most pathogens, and describing yet another strain seems to need justifying. My justification is, not only that it changes more extensively than any strain previously described and that the large changes are reversible, but also that propagation in different host plants or environments so alters it that its properties depend less on those of the virus present in an inoculum than on the identity of the plants inoculated and the condition in which they grow.

Many of the reported strains were derived from Johnson's[1] tobacco virus 1, which is reasonably taken as the standard form of tobacco mosaic virus. These, like most others found infecting solanaceous plants, have very similar physico-chemical properties and are closely related serologically. Small antigenic differences have been detected between some, but most have been differentiated from the standard only because they cause a characteristic effect in some host plant.

A few strains differ from standard tobacco mosaic virus in many more characters than pathogenicity. Those most studied came from cucumber (*Cucumis sativus* L.)[2], plantain (*Plantago lanceolata* L.)[3] and tobacco (*Nicotiana tabacum* L.)[4]. Like the standard, they contain 6 per cent ribonucleic acid and occur in rigid rod-shaped particles of various lengths but uniform widths, 14·6 mμ for cucumber viruses 3 and 4 and 15·2 for the others[5]. They are precipitated by antiserum prepared against the standard tobacco mosaic virus, but the serological relationship is remote and most of the antigens contained by each one are specific to it[2]. They contain different quantities of some amino-acids, and a given amino-acid may occur in one but not in another[6]. They have different isoelectric points, electrophoretic mobilities and sensitivities to inactivation by ultra-violet radiation[4].

Some of these diverse types have been observed over years and in a range of plants without losing their distinctive properties. Like the standard tobacco mosaic virus, they give rise to variants with different pathogenicities, but otherwise they stay constant. It has been reasonable to assume that, if all have derived from a common ancestor, their current states were reached as the result of many small changes accumulated while they evolved separately, perhaps in different plant species, over a very long time. This may be true, but the behaviour of the virus I have been using shows that a protracted period of evolution is not always necessary to change a strain from one resembling the standard form into one with many distinctive properties.

This virus was discovered causing a mosaic disease of cowpea (*Vigna sinensis* Endl.) in Nigeria[7] and provided the first record of a strain of tobacco mosaic virus that infects leguminous plants systemically, although many cause necrotic local lesions in some varieties of French bean (*Phaseolus vulgaris* L.). When White Burley tobacco seedlings in a glasshouse are inoculated with the virus from cowpea, after first producing necrotic local lesions, they become systemically infected and show symptoms very like ordinary tobacco mosaic. The virus in the systemically infected leaves is closely related serologically to the standard tobacco mosaic virus and resembles it in all properties for which I have tested. The only way in which the two are distinguished readily is by inoculation to some leguminous plants, of which I have mostly used the Prince variety of French bean, when the cowpea virus produces a severe systemic disease and the other has no effect. Varieties of French bean, such as Pinto, which give necrotic local lesions with the standard strain, also give only local lesions with the cowpea virus from tobacco.

The virus obtained from diseased Prince beans is only remotely related serologically either to tobacco mosaic virus or to the cowpea virus obtained from mottled tobacco leaves. Specific precipitates are obtained only when the heterologous antiserum is used much more concentrated than is needed to precipitate its homologous antigen, and the cowpea virus from tobacco probably has fewer than 10 per cent of its antigens in common with the virus from beans. The cowpea virus obtained from the two hosts also has different electrophoretic mobilities, $-4{\cdot}7 \times 10^{-5}$ from bean and $-9{\cdot}4 \times 10^{-5}$ cm.^{2}/sec./volt from tobacco; the virus obtained from bean is also inactivated with much less exposure to ultraviolet radiation. I have not studied their amino-acid compositions, but, by analogy with other strains that have been examined, it can be assumed the two will differ considerably.

Pinto beans inoculated from infected Prince bean show no local lesions, but develop a systemic disease like that in Prince. Tobacco seedlings inoculated from systemically infected Pinto beans give local lesions and a systemic mosaic, but virus from the mottled tobacco leaves produces only necrotic local lesions when returned to Pinto.

Except for the few that affect cucumber, all strains of tobacco mosaic virus produce necrotic local lesions in *Nicotiana glutinosa* L. when growing at usual glasshouse temperatures. The size and character of these lesions vary a little with the age of the plants, and some strains produce rather larger and better defined lesions than others[3]. Cowpea virus obtained from mottled tobacco leaves produces lesions like those produced by standard tobacco mosaic virus; at 20° C. they become visible in 40–48 hr., and they reach a diameter of 3–4 mm. and are clearly defined with a pale centre surrounded by a broad ring of black necrotic cells. The cowpea virus obtained from bean produces lesions that differ more from the standard type than do those produced by any other strain of tobacco mosaic virus I have studied; the lesions are not visible until four days, few reach a diameter of 1 mm. and many are wholly white, though some have incomplete rings of black. The differences are ample to identify small amounts of the tobacco form of the virus in the presence of much more of the bean form, and the production of the tobacco form in plants inoculated with sap from beans can be readily detected by inoculations to *N. glutinosa*.

When tobacco leaves are inoculated, washed thoroughly, and samples taken at intervals to be macerated and inoculated to *N. glutinosa*, the course of virus multiplication can be followed. With sap from tobacco as the inoculum, less virus is recovered 24 hr. after inoculation than an hour afterwards, but newly produced virus is usually detectable 48 hr. afterwards, and at 72 hr. this has already much increased and it continues to do so rapidly. With sap from bean as the inoculum, less virus is usually recoverable 48 hr. after inoculation than an hour afterwards ; lesions begin to form after about 72 hr., and newly produced virus then becomes detectable. This is the bean form, for it produces only small, slowly developing lesions in *N. glutinosa*. It does not occur much more abundantly in later extracts, but at five days extracts from some plants start to produce large, quickly developing lesions, and from then on the amount of such virus in successive extracts increases rapidly with time. The plants of which the inoculated leaves give extracts that contain the tobacco form of the virus are those that later show systemic symptoms. This almost always happens in young seedlings, but becomes less common as the age of plants increases and is rare in those with leaves longer than 15 cm. Young tomato (*Lycopersicon esculentum* Mill.) and *Datura tatula* L. plants are also more likely than old ones to yield the tobacco form of the virus when inoculated from infected beans. Plants that are not members of the Solanaceae can also produce a changed form of the virus. Both forms multiply locally in leaves of sugar beet (*Beta vulgaris* L.), inoculum from beans producing lesions and from tobacco not ; leaves inoculated from beans first yield only the bean form, but after a week yield both.

The tobacco form seems not to be produced in *N. glutinosa* inoculated from beans, and when transferred from one *N. glutinosa* to another the virus has continued to produce only small, slowly developing lesions. From inoculated plants kept in usual glasshouse conditions with a mean temperature of 20° C., very little virus is recovered. *N. glutinosa* inoculated from beans and kept at 37° C. produce much more virus although their leaves show no lesions, but again it all seems to be of the bean form. The loss of pathogenicity towards *N. glutinosa* at 37° C. provides another contrast with the behaviour of the cowpea virus obtained from tobacco, for this, like standard tobacco mosaic virus, produces large chlorotic lesions.

The cowpea virus from beans also behaves differently in tobacco plants kept at the two temperatures. Inoculated leaves of plants kept at 37° C. show no lesions even after many days, although they then contain much more virus than do leaves at 20° C. when lesions develop. All the virus produced at 37° C. seems to be of the bean type and no large lesions are produced by inoculations to *N. glutinosa*. After a week at 37° C., plants moved to usual glasshouse conditions soon show large necrotic rings. Many show only this symptom, and from these the bean form only of the virus has been obtained ; but the young leaves of some later become mottled and they then contain the tobacco form.

I have done little to study the course of infection when bean leaves are inoculated from infected tobacco plants, for the work is complicated by the combination of a small virus content in such inoculated leaves with substances that inhibit infection in *N. glutinosa*. However, it has been possible to show that inoculated bean leaves at first yield only virus that produces large lesions in *N. glutinosa*, but that, after six to eight days, they also yield virus that produces the small, slowly developing lesions.

Changes in the properties of a virus culture when passed through different hosts could be explained simply by postulating that the culture contains two different strains that multiply differentially in the different hosts. My many attempts to gain evidence of such a mixture failed, and several facts conflict with this simple explanation. For example, inoculum from Prince beans, which will produce the tobacco form of the virus when inoculated to many species, produces no large lesions in *N. glutinosa*, and this inoculum can fail to produce the tobacco form when inoculated to tobacco plants in a physiological state that permits this form to infect and multiply when it is added to the inoculum. Also, if two strains are concerned, they must always go together through single local lesions in *N. glutinosa*. I have used extracts from single lesions, produced with diluted inocula, to infect other *N. glutinosa*, and then repeated the process serially. Ten cultures established in this way by four transfers through local lesions, six originally produced by virus from tobacco and four from bean, all resembled the bulk inoculum in their ability to infect both bean and tobacco plants and to show the characteristically different properties when propagated in the two species.

The failure of Pinto beans to become systemically infected when inoculated with extracts from mottled tobacco leaves also tells against the idea that the extracts contain the bean form of the virus. Further, Prince beans inoculated from tobacco take several days longer to show systemic symptoms than do similar plants inoculated from other beans. Similarly, tobacco seedlings show systemic symptoms sooner when inoculated with tobacco sap diluted almost to the infection end-point than when they are inoculated with undiluted sap from infected Prince beans. It seems, then, that inocula from mottled bean or tobacco leaves contain only one form of infective virus, and that the second form occurs only after the first has infected and multiplied in inoculated leaves of the alternative host.

After a prolonged period in either bean or tobacco, during which it has passed through many plants, the virus will still return to the other host, with its behaviour there apparently unchanged. Thus there seems to be a continuity of inherited characters, suggesting a genetic framework that remains stable through considerable changes in the gross properties of the whole virus particles. This could be conferred by the genetic determinants combining in new ways when new particles are synthesized; or the continuity may be only apparent, simulating stability by precisely reversible mutations. Before the second form occurs, some millions of particles are synthesized in inoculated leaves of the alternative host, so opportunity for such rearrangements or changes exists. Equally, though, the genetic material may remain unaltered, and the different forms the virus adopts in different hosts may be equivalents of phenotypic variations, perhaps providing extreme examples of the wide range of different proteins that can combine with the same nucleic acid.

There is much evidence that the multiplication of the standard tobacco mosaic virus is not the precise replication of the infecting particle to give a uniform end-product. In addition to infective variants, distinguishable by their distinctive pathogenicities and usually, though with little justification, called mutations, extracts from infected plants contain a range of specific proteins that resemble the virus in some respects but are not infective[8-10]. Plants systemically infected with the cowpea virus also yield more than one product, and beans appear to contain an unusually large proportion of non-infective protein. Whereas sap from infected beans contains about a tenth of the total specific protein in sap from tobacco, the tobacco sap is more than a hundred times as infective when tested on *N. glutinosa*.

Electrophoretic tests on purified preparations of the bean form, at 2 mgm./ml., show two components, a major one with a mobility of $-4 \cdot 7 \times 10^{-5}$ and a minor one with a mobility of $-9 \cdot 4 \times 10^{-5}$ cm.^{2}/sec./volt, the same as that for the single component detectable in preparations of the tobacco form at 2 mgm./ml. The minor component is about 10 per cent of the total protein; if it were the tobacco form of the virus, it should be detected by inoculation to *N. glutinosa*, for artificial mixtures containing 99 per cent of virus from bean and 1 per cent from tobacco produce the characteristic, large, rapidly developing lesions; but the preparations give only the small, slowly developing lesions. When examined at 20 mgm./ml., purified preparations of the cowpea virus from tobacco also show a small peak, which moves with the same speed as the main peak in preparations of the bean form. No such component has been noted in purified preparations of the standard tobacco mosaic virus, but non-infective proteins with this mobility have been obtained from sap after the infective protein was removed by high-speed centrifugation[10]. As components with the same mobility accompany two strains, only one of which infects beans, there is no need to regard that from tobacco plants infected with the cowpea virus as the bean form of this virus. Rather it is evidence that infection with different strains can lead to the synthesis of materials with common properties. There are other minor components, both in extracts from plants infected with the standard tobacco mosaic or the cowpea virus, with different mobilities, and these provide still further evidence of the range of anomalous proteins that occurs in cells when their metabolism is deranged by infection. It seems that, of the proteins that are synthesized, some may be able to combine with nucleic acid to give stable particles that are also infective, and others not. In the diverse metabolisms of such plants as bean and tobacco, or in tobacco at 20° and 37° C., the nucleic acid will be given opportunities to combine with different proteins. In an environment where the initial infecting particles are of a type that is as stable and as infective as any other that is synthesized, reasonable continuity of properties can be expected; but where they are not, they will soon be superseded by any more stable form that is also better fitted to spread from one cell to another.

The cowpea virus is not unique in its ability to adopt very different guises when multiplying in various kinds of hosts. Suspecting that some other of the reported diseases of leguminous plants might also be caused by strains of tobacco mosaic virus, I tested southern sann-hemp mosaic virus[11] from India. It is not identical with the cowpea virus from Nigeria, but the two behave similarly. The sann-hemp virus can be transferred between Prince bean and tobacco plants, and when derived from tobacco it closely resembles the standard tobacco mosaic virus, whereas when derived from beans it has properties very like those of the cowpea virus from bean.

I thank Mr. R. M. Lister and Dr. S. P. Capoor for sending me the cowpea and sann-hemp viruses, and Dr. A. Kleczkowski for making the electrophoretic measurements.

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MODELS FOR METALLO-ENZYMES*

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THE importance of metal ions in biological systems has become more clearly recognized in recent years. Tentative explanations have been put forward of the role of the cations in the reactions of enzymes; but many of these explanations lack a reasonable basis when they are compared with the known interactions of cations with simpler organic molecules[1]. The purpose of the present article is to direct attention to such shortcomings and to consider different possible functions which cations could assume in biological systems. To this end the article consists of a critical survey of the properties of complex ions in solution, with special reference to their absorption spectra and stability, followed by a brief discussion of some properties of metallo-enzymes.

Stability of Complex Ions

Sufficient data have been obtained in the study of complex ions in aqueous solution to warrant the general conclusion that no one parameter, such as the electronegativity of the cations, can be dominant in the formation of all the complexes of any one ligand. Even the correlation between a 'corrected' electronegativity and the stability of a wide variety of cations with one ligand should be suspected as

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* Substance of four public lectures on "Metal Complexes as Models for Metallo-enzymes" given at University College, London, on November 17, 24, December 1 and 8. The lectures will be published by the Athlone Press, University of London, in due course.

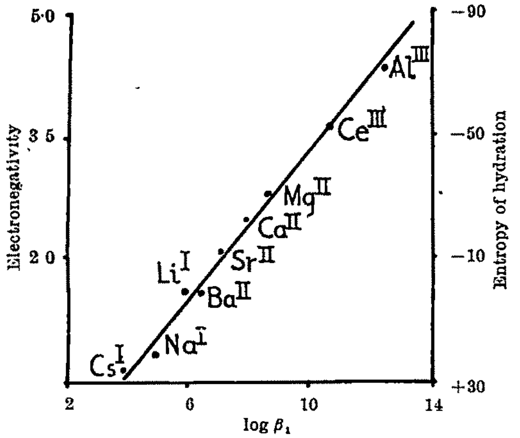

Fig. 1. Relationship between the logarithm of the stability constant for a number of complexes of dibenzoyl-methane with A-subgroup cations and either the electronegativity of the cation or its entropy of hydration

arising rather from the nature of the corrections than from any fundamental importance of the correlation[2]. For example, if the IA, IIA and IIIA subgroup cations of the periodic table are compared in their ability to form complexes with an anion such as dibenzoyl-methane, then the stability of the complexes is as good a function of the entropy of hydration of the cations as of their electronegativity (Fig. 1). The entropy-change of the reaction, a charge neutralization,

$$M^{+} + L^{-} \rightleftharpoons ML$$

is very probably the main 'driving force' in the formation of these A-subgroup cation complexes and is derived from the loss of hydration[3]. The data available at present suggest that reactions of these cations, involving neutralization of charge, are often endothermic[3]. With these same cations the parallel between electronegativity and stability of complexes arises coincidentally from the rough relationship between electronegativity and entropy of hydration. Reasons for this correlation are not difficult to find, for among A-subgroup cations electronegativity $\propto$ ionization potential $\propto$ ionic potential (z/r) $\propto$ entropy of hydration.

On the other hand, the dependence of stability upon the 'electronegativity' of the ground state of the cation in the series

$$\mathrm{Zn^{II}} < \mathrm{Cu^{II}} > \mathrm{Ni^{II}} > \mathrm{Co^{II}} > \mathrm{Fe^{II}} > \mathrm{Mn^{II}}$$

is well established, although the relationship mainly applies to the four-coordinated complexes[3]. There are several exceptional complexes which do not conform to the general pattern, but the exceptions only appear upon six-coordination. Notable among exceptional ligands is orthophenanthroline, which forms a particularly stable ferrous complex. The ferrous ion does not have the ground-state electronegativity in this complex. Now although on an absolute basis the ferrous ion does not form a more stable complex with phenanthroline than does the cupric ion, the relative differences in stability in the presence of a second ligand, for example, glycine, are such that ferrous can appear as a phenanthroline complex while cupric appears as a glycine complex in a mixed solution of both ligands. Analysts frequently employ a combination of two such reagents. They refer to the second one as a masking reagent. Such masking reactions are particularly important in biochemistry, for they lead to a selective combination of cations and ligands, not on an absolute basis of stability, but on the relative basis of competition of excess ligands for all kinds of cations. Inspected in this way, it seems at least probable that in a biological system at pH 7·2, zinc should be found held in complexes with sulphide, iron in complexes with imines, and magnesium found mostly with oxyanions[1].

Bonding in Transition Metal Complexes

The bonding in complexes of transition-metal cations is now known to be more complicated than was at first thought[4]. The general suggestion that π-bonds as well as σ-bonds control stability has been increasingly supported since it was first introduced by Pauling[4,6–8]. The relevant molecular orbitals for both types of bond can now be given, and it can be shown theoretically and experimentally that there is need to include two sets of such interactions: first, those described by Pauling, in which an empty orbital of either the ligand or the cation acted as an acceptor of electrons from its coordination partner; and second, the further bonds between half-filled d orbitals of the cation and the full levels of the ligand necessitating the partial use of anti-bonding states (Fig. 2). The total stability will be a function of the proper mixture of the two interactions. A change of emphasis is now required when relating the stability of a complex with ionization potentials or electronegativities, for the latter do not truly reflect the energy-levels of a cation in the field of a ligand, that is, the electronegativity is a function of the bonding. In particular, the original discussion given by Irving and Williams of their stability series is seen to be incorrect, in that it ascribed all bonding differences to acceptor characteristics of the cations, without the essential consideration of the ways in which both acceptor and donor properties of cations were influenced by the ligand. Discussions by Fernelius and his co-authors[3] are similarly in error. A proper consideration of the effect of the ligand-field[8] explains why the six-coordinate complexes of nickel are equally stable with the cupric complexes, an observation not in accord with the earlier theories. The Irving–Williams series is an empirical order applicable to complexes in which replacement of water takes place in four or fewer positions in the coordination sphere of the cation[3].

Absorption Spectra of Complex Ions

The absorption bands of chelating ligands such as 8-hydroxy quinoline are affected by cations to but a

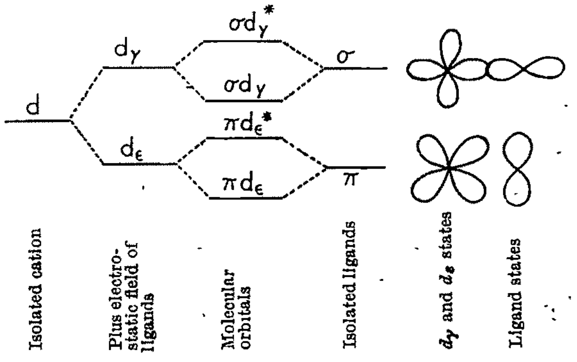

Fig. 2. Stark splitting of d-states together with the formation of bonding and anti-bonding orbitals between the split d-states and states of the ligand. The diagram also illustrates the way in which the orbitals overlap

slight extent. The shifts appear to be in the order $Zn^{II} < Cu^{II} > Ni^{II} > Co^{II} > Fe^{II} > Mn^{II}$ and $Zn^{II} > Mg^{II} > Ca^{II} > Ba^{II}$. These orders clearly reflect the 'electro-negativity' of the cations[9]. In their complexes with ligands such as porphyrin and phthalocyanine, however, the 'electronegativity' of all the cations is not that of their ground states, for several of them are in states of lower spin-multiplicity; for example, in nickelous porphyrin and cobaltous phthalocyanine. These and other cations such as palladous have an enhanced electronegativity in porphyrin and similar complexes, and the order of the shifts of the ligand absorption bands becomes[9]:

$$(Fe^{II}) > Ni^{II} > Co^{II} > Cu^{II} > Zn^{II} > (\overset{*}{Fe}{}^{II}) > Mn^{II}$$

The ferrous complex has different properties depending upon the solvent in which the complex is dissolved. In dioxan the absorption band is at a wave-length and of an intensity similar to that of the zinc complex; but in pyridine the absorption spectrum closely resembles that of a nickel complex. It can be said that the electronegativity of the ferrous ion is a function of its coordination—in pyridine the ferrous complex is diamagnetic, but it is paramagnetic in dioxan.

Not all the absorption bands of complex ions are to be described as modified ligand bands. In the ferrous, cuprous and cobaltous complexes of diimines, for example, terpyridyl, there are absorption bands which can only be attributed to transitions of the cation electrons bound in molecular orbitals which include the ligands. The influence of substituents in the ligand upon the position of the absorption bands in these complexes further suggests that the excitations involved are partial electron transfers to the ligand[9]. Now while there are many examples of partial charge-transfer bands in which charge is increased on the ligand, there are many bands in the absorption spectra of the complexes of oxidizing cations which can be confidently attributed to partial transfer of electrons to the cation. Of particular interest are the bands in ferric complexes generally, and in particular with phenanthroline and porphyrins[9].

All the absorption bands discussed so far are intense. Certain bands of transition metals, $d - d$ spectroscopic transitions, are usually weak. It is now thought that these d states can become mixed with energy states of the ligand, forming the molecular orbitals referred to in the above discussion of stability, both through π- and σ-bonding (Fig. 2). The formation of such molecular orbitals can be used to account for features of the band position and band intensity in the spectra of complexes[7,8]. In biological systems, however, it is not possible to study the weak bands because of the dilution of the cation and of the presence of other strong bands.

Biological Systems

The subject-matter under this heading will be divided into two parts. In the first, the major concern is the way in which cations, which are, in general, loosely held by the enzymes, can change the rates of reaction of the enzymes with substrates. A brief reference to the Lewis acid properties of cations is used as an introduction.

From a comparative examination of a large number of model systems, the catalytic effect of a cation in acid-base reactions has been shown to parallel the stability of the complexes of the cations with the activated state of the substrate[10,11]. The formation of a complex with the normal state of the substrate can be detrimental to reaction rather than favourable to it. In the first transition series, the catalytic efficiency of cations follows the Irving–Williams order:

$$Zn^{II} < Cu^{II} > Ni^{II} > Co^{II} > Fe^{II} > Mn^{II}$$

in all the model systems examined so far. However, in not a single biological system has this order of catalytic efficiency been observed[1]. The differences between the models and the biological systems are obvious. The models present one (or two) possible chelating groups to the cation. The protein/substrate system of a biological reaction presents very many different possible chelating centres. In acid-base reactions certain types of chelation will be effective and others detrimental. It would appear that electronegative cations, combining preferentially with sulphydryl groups, generally form chelates detrimental to acid-base reactions, and that therefore such cations as lead, mercury, copper and nickel are often enzyme poisons. The best cations for the catalysis of acid-base reactions, which involve substrates which can coördinate through oxygen only, are magnesium and manganese. If the substrate contains nitrogen-coordinating groups, on the other hand, then zinc, cobaltous and ferrous are often equally effective. If the cation function is not to bind the substrate but is merely to provide a method of bringing a coenzyme and a protein together in a correct stereochemical alignment, then the competition that must be considered is that between the chelating centres of the coenzymes, of the various sites of the protein, and of the substrates. Consideration of these possibilities reveals the ways in which one cation acts as an inhibitor, another as a catalyst[1], or even the way in which a cation can be an activator of an enzyme at low concentration and an inhibitor at high concentration[12].

The second major influence of cations in biological systems is upon oxidation-reduction reactions. For example, the reactions of iron porphyrin proteins are of the utmost importance in biological systems. They carry oxygen and transport electrons. However, there is a complete parallel group of copper enzymes which perform similar functions, but these proteins contain no porphyrin. Again, there is a group of cobalt complexes, not found in biological systems as yet (apart from vitamin B_{12}), which can show certain of the reactions of the biologically important copper and iron compounds. From this evidence I tentatively conclude[13] that the function of the ligand in all these complexes is to induce similar properties in three dissimilar cations. The absorption spectra of the complexes of these cations reveal that the property induced is the willingness of the reduced states of the cations, cobaltous, ferrous or cuprous, to donate d_ε electrons into π-orbitals of their ligands[9]. This donation of d_ε electrons accounts for the double bonding in oxygen, carbon monoxide, nitric oxide and cyanide complexes. The d-electrons are also donated to any other unsaturated ligand to which the cations are bound, for example, to porphyrin in a ferrous porphyrin complex. When ferrous is bound to both porphyrin and carbon monoxide, there is a competition between the two ligands for the d-electrons. Now the absorption of light by the ferrous porphyrin results in enhanced donation of electrons to this ligand, as in the models (see above), that is, the removal of d-electrons from the cation. The removal of d-electrons must weaken bonding to

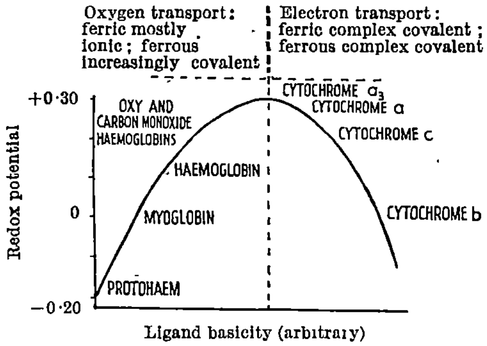

Fig. 3. Proposed relationship between ligand basicity (or electronegativity) and the oxidation-reduction potentials of their iron complexes. The basicity, plotted on an arbitrary scale, is used in preference to the electronegativity because of the difficulty of assessing the electronegativity of the ligand

carbon monoxide. The sensitivity of carbonyl ferrous porphyrin complexes to light absorption can now be understood. Many other features of the absorption spectra and properties of the ferrous porphyrin proteins can be explained in terms of the spread of the *d*-electrons over the porphyrins[13].

The iron and copper proteins also have in common oxidase properties. Small differences in coordination bring about the large differences in reactivity between the oxidases and the oxygen-carrying proteins. For example, cytochrome *b* is not a very different protein from hæmoglobin—they contain the same ferrous porphyrin. There is, however, the major difference that the ferrous ion is only diamagnetic in hæmoglobin when combined with oxygen, while the ferrous ion in cytochrome *b* is always diamagnetic. Only when the ferrous ion is diamagnetic is it a good electron donor. In the cytochrome, then, ferrous donates electrons to the porphyrin (the only ligand which is a good acceptor) and is readily oxidized. In oxyhæmoglobin, on the other hand, the major electron acceptor is oxygen (oxygen restricts electron donation to the porphyrin) and therefore prevents the hæmoglobin entering oxidative reactions. A detailed study of the absorption spectra and paramagnetism of these and other iron complexes[13] as compared with the model systems gives very strong support for these views. In fact, a study of the absorption spectra and the oxidation-reduction potentials of the whole series of hæm-proteins known in biological systems reveals steady gradations in properties which can be correlated with the change in the function of the proteins. Some of the properties are referred to in Fig. 3. Other series of ferrous complexes show similar changes in the same properties (for example, the phenanthrolines and the simple porphyrins), but in these cases the series obtained are the same as those formed by gradations of basicity (or electronegativity) among the ligands of the complexes. It seems likely that the hæm-proteins are also arranged in a series of changing ligand basicity (or electronegativity) as in Fig. 3.

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MOVEMENTS IN THE IONOSPHERE

THE Royal Astronomical Society held a Geophysical Discussion on November 25 on the subject of irregularities in the ionosphere and their horizontal movements. Most of the British workers on the subject were present, and the meeting took the form of a free discussion on a series of points introduced by the chairman. Those taking part were J. A. Ratcliffe (in the chair), W. J. G. Beynon, E. N. Bramley, B. H. Briggs, P. C. Clemmow, M. Dagg, J. W. Dungey, E. T. Eady, J. S. Greenhow, A. Hewish, I. L. Jones, M. Ryle, R. S. Scorer, K. Weekes and M. V. Wilkes. The main points in the discussion are summarized below, and the initials in brackets refer to the speakers.

Horizontal drifts of irregularities of electron density in the ionosphere are detected at different heights by radio methods as follows: between about 80 and 100 km. by the drift of meteor trails; between about 90 and 130 km. (*E* region) by observation of the fading on close-spaced receivers; between about 200 and 300 km. by similar fading observations, and also by the observation of large-scale travelling 'ripples' which show as 'kinks' on *P′*(*f*) or *P′*(*t*) ionospheric records; and above 400 km. by the fading, or scintillation, of the radio waves received from radio stars.

Briggs and Spencer have given a summary of the knowledge obtained by these methods[1]. In the *D* and *E* regions there is a mean drift, with a velocity of about 50 m. sec.$^{-1}$, which changes with the seasons and on which is superimposed a drift with a velocity of about 30 m. sec.$^{-1}$ that rotates twice in 24 hours. In the lower *F* region the east–west component of the velocity is towards the east by day and towards the west by night. The north–south component by day is towards the pole in summer and towards the equator in winter; by night it is small. The ripples observed in the *F* region usually have a quasi-wave-length of 100–200 km. and their deformation in the vertical direction is such that, if there were real concave mirrors of this extent, their depth would be 5 km. or less. The irregularities responsible for the scintillation of radio stars are markedly anisotropic, and are probably a few kilometres in extent in their smallest dimension.

The discussion brought out the fact that there is a well-established height-variation of the phase of the 12-hourly rotating component in the *E* region. This has been observed (J. S. G.) by working with meteors, the height of which can be measured, and by observing (I. L. J.) the fading of waves on two neighbouring frequencies, which are reflected from somewhat different heights. The results of the two sets of observations agree, and indicate that the phase advances by about 5° km.$^{-1}$ for heights between about 85 and 130 km. The meteor observations (J. S. G.) also indicate that the phase alters with seasons, and both sets of observations show that the magnitude of the rotating velocity-component increases with height. Although at greater heights movements of irregularities in the electron density will not necessarily follow the movements of the air (P. C. C.), or of the surrounding electrons, there is every reason to suppose that meteor trails, at levels near 90 km., indicate the movements of the air itself. Since the deductions made from observations of meteor trails are consistent with those made on the fading of reflected waves, it is reasonable to suppose that the latter, also, indicate air movements. It is then interesting to inquire what sort of movement might be expected from theoretical considerations.

The theory of semi-diurnal tides in the atmosphere (K. W., M. V. W.) leads us to expect a rotating component of the drift velocity of the order of the observed one in magnitude, but until now the phase has not been as expected. The new observations that the phase varies with height could be explained in terms of a temperature gradient, but it is difficult to explain why the phase changes with the seasons.

Since in the *E* region the electron movements seem to be determined by the air movements, it is interesting to consider what air movements might be produced by other than 'tidal' forces. It was pointed out (E. T. E., R. S. S.) that horizontal temperature gradients might be great enough to produce eddies, and that waves produced by the flow of air over obstacles near the ground could probably extend upwards into the *E* region. It was also pointed out (R. S. S.) that the technique of observing noctilucent clouds has been improved recently and that observations on a larger scale can be expected in the next few years.

The most interesting piece of new information (B. H. B.) about the lower *F* region was that simultaneous measurements made on large-scale ripples, and on the small-scale irregularities which produce fading, show that both these irregularities travel with the same speed. If this observation is correct, it has important implications for the theory, since the present tendency is to suppose that the 'ripples' represent the travel of a distortional wave-motion through the electrons, and that the movements of the small-scale irregularities are produced by the joint effect of electric and magnetic fields.

Spencer[2] has shown that the scintillations of radio stars are produced by irregularities of electron density, at heights above 400 km., which are elongated and are oriented along the direction of the Earth's magnetic field. These irregularities produce an anisotropic diffraction pattern at the ground, of which the direction of elongation changes through the day and through the year as the position of the star changes. The observations have now been continued (I. L. J.) for a complete year, and the expected results have been obtained. A more detailed analysis of the results has shown that the length of the irregularities is about three or four times their breadth, and not about ten or twenty times as was originally supposed. Because the irregularities are elongated, any measured drift velocity is biased towards a direction perpendicular to the long axis. In practice, only the component of the true drift in this direction can be observed. By making observations (M. D.) on two radio stars almost simultaneously, two velocity components can be derived and hence the true direction of drift can be deduced. In this way, it has been shown that the true drift is towards the south-west; not simply towards the west as previously supposed.

It is difficult to account for the occurrence of these elongated irregularities, which are detected only at night and at heights greater than 400 km. It was once thought (Ryle[3]) that they were produced by interstellar matter attracted to the Sun and intercepted by the Earth on its dark side. Recent work (A. H.) has shown that the irregularities, as evidenced by radio stellar scintillation, do not occur at the same time at Washington, D.C., Cambridge and in the Gold Coast. Scintillations are twice as common at sunspot minimum as at sunspot maximum. Theory suggests that, at these heights, movements of electrons would not follow movements of the air, so that simple turbulence is not a likely cause for the irregularities. If, however, there was turbulence in the *E* layer for any reason, it was suggested (M. D.) that the resulting irregular electrostatic field might be transferred, along the magnetic lines of force, to the *F* region in such a way as to produce irregularities of electron density there. In support of this idea it was stated that increased scintillations are sometimes accompanied by a magnetic disturbance, but there is no one-to-one correlation. It was also suggested (J. W. D.) that a type of electromagnetic disturbance could perhaps travel from the *E* to the *F* region along a line of magnetic force, in such a way as to produce irregular variations in the *F* layer.

Attention was also directed (M. R.) to recent studies on the counterglow by workers in the U.S.S.R. They have interpreted this as a result of streaming of the upper atmosphere away from the Earth on the night side. This atmosphere is supposed to be repelled by the Sun, much as a comet's tail is repelled. It would tend to stream along the magnetic lines of force, and possibly with an irregular density, and might be responsible for the scintillations.

J. A. RATCLIFFE

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OBITUARIES

Sir Arthur Trueman, K.B.E., F.R.S.

WHEN Sir Arthur Trueman died on January 5 at the early age of sixty-one, in his house in London, his passing left a gap in many circles created by his wide intellectual interests and attainments. By profession he was a geologist, and few have attained greater eminence or contributed more to the science by research, by teaching, or thorough administration. His early training at the High Pavement School and later at University College, Nottingham, laid the foundations for his subsequent eminence as a palæontologist concerned with various aspects of the faunas and of the stratigraphy of Carboniferous and Jurassic rocks. These researches were carried out during an unusually full and rich academic career, which commenced with his appointment as lecturer at University College, Cardiff, in 1917, where he came under the influence of Franklin Sibly. This was followed by appointment to the chair of geology and geography at Swansea (1921), and the subsequent tenure of chairs at Bristol (1933) and at Glasgow (1937–46).

Trueman's researches, though closely related, fall into three main categories largely resulting from and conditioned by the experience gained from his detailed and original morphological, ontogenetic and phylogenetic studies on ammonites. Accounts of the evolution of several families of ammonites were followed by similar studies on gastropods and the lamellibranch *Gryphaea*. Characteristically, Trueman recognized the implications of his palæontological discoveries in terms of their practical application towards a fuller understanding of Jurassic chronology and of their usefulness in zonal subdivision of these rocks in the field. Thus concomitant work described the palæontology of the Lias rocks from Lincolnshire and South Nottinghamshire to Somerset and Glamorganshire.

There followed that part of his work concerned with appreciation of the fundamental conceptions involving genera and species, of populations and of variability, and of the impact of such considerations upon taxonomy. His contributions to the more philosophical aspects of palæontology ranged among other topics, from lineage and orthogenesis, to a reconsideration of the species concept in palæontology, and culminated during his revision of the Coal Measures Non-marine Lamellibranchs (1927) in the application of biometric techniques to a study of variation in fossil communities and to the use of statistical investigations in detailed correlation. Work by Trueman, and others who have since extended his conceptions, has led to radical changes in outlook and added considerably towards evaluation of fundamental processes in evolution.

Trueman's later work dealt with the palæontology and with varied aspects of the stratigraphy of the British Coal Measures. The purely palæontological studies of the Coal Measures non-marine lamellibranchs from South Wales soon enabled him to indicate their practical applications in the identification of coal seams, and resulted in a zonal subdivision of the South Wales Coal Measures in 1927, leading to a suggested correlation of the British coalfields (1933). The detailed application of this zonal scheme to every major British coalfield, and the utilization of the accruing evidence in exploration within coalfields, or during boring for extensions or for new fields, by Trueman, independent workers and by officers of the Geological Survey bear witness to its efficacy. Indeed, this subdivision has formed the accepted method of presentation in all important papers and memoirs since its inception, and has contributed largely to a rationalization of Coal Measures stratigraphy, as summarized by Trueman in his presidential addresses to the Geological Society of London. The publication of a Palæontographical Society Memoir on the Coal Measures non-marine lamellibranchs in collaboration with Dr. J. Weir marks still further an important permanent record of widespread researches which constitute a major contribution to geological science.

Acknowledgment of his work by election to the Royal Society followed in 1942; the Geological Society of London awarded him the Bigsby Medal (1939) and the Wollaston Medal (1955).

Sir Arthur was energetically concerned for the welfare of geological science at all levels and published a number of books, in general illustrated by himself, and which were of interest to the layman, the school pupil or the student. However, his interests and knowledge were considerably more widespread and embraced many aspects of the educational field and of its organization and its contacts with science and industry. This knowledge made him a welcome member of many committees, such as the Elliot Commission on educational problems in West Africa, the Advisory Council on Scientific Policy, and as chairman of the Geological Survey Board.

Those who were fortunate to come under his influence either as students or staff regarded him with respect and affection, for his kindness, integrity and sympathetic understanding made him a friend in whom one felt complete confidence. His charm of manner and keen sense of humour, combined with a remarkably quick grasp of problems and wise judgment in their solution, convinced one of his very personal interest in every member of his department, student and staff alike. No student ever sought Trueman's help or advice in vain. He was always ready to discuss work and ideas and contrived to make all feel their ideas were interesting and their results important. As a leader he was a deep source of inspiration and encouragement, and possessed that inestimable gift of putting a person at ease. His enthusiasm and zeal were combined with a vital and ceaseless energy which he imparted to others; his lucidity of mind and exposition made him a great lecturer and superb teacher, in the lecture theatre, and above all in the field.

This remarkable combination of wide university experience, achievement, leadership, organizing ability and high moral integrity led to his appointment as deputy chairman of the University Grants Committee in 1946, and its chairman in 1948. In this office, at a time of critical importance in the developments of the British university system, Trueman contributed much by his knowledge, influence and wise counsel. Unfortunately, his period of office was limited, for he fell ill late in 1952 and soon afterwards resigned.

During the last years of his life Trueman struggled with great and uncomplaining fortitude against increasing physical disability, his mind alert and active, his sense of humour unimpaired; and during this time, with indomitable spirit he wrote parts of, and edited contributions for, his last book, "The Coalfields of Great Britain", a project which had been in his mind for many years.

Sir Arthur is survived by Lady Trueman and their son, E. R. Trueman. Lady Trueman's companionship, help, understanding and encouragement contributed greatly towards his many achievements, and her unselfish devotion during the later years enabled him to face his disability with great courage.

LESLIE R. MOORE

Prof. Duncan Leitch

THE tragically premature death of Prof. Duncan Leitch at the age of fifty-two, a week after that of his friend and colleague, Sir Arthur Trueman, came as a shock even to those friends who knew of his grave illness.

Leitch was a graduate of the University of Glasgow and served there as assistant and lecturer in geology until, in 1947, he succeeded Prof. T. Neville George in the chair of geology at the University College of Swansea.

Leitch's main scientific work was concerned with the palæontology and stratigraphy of the Coal Measures. He collaborated with me in zoning the

Scottish Coal Measures by the successive assemblages of non-marine bivalves that are fossilized in these rocks. Afterwards he used the zones in elucidation of an obscure section of Coal Measures in Arran, and gave accounts of variation in several groups of these fossils, notably of Lower Carboniferous and Namurian *Naiadites* which are peculiar to Scotland and are doubtless forerunners of the numerous and more widely distributed guide fossils of this genus in the Coal Measures. His most notable work on this line, however, was the admirably detailed biometric description of variation in a community of *Anthraconaia* [*Anthracomya*] from the Central Coalfield of Scotland, prepared with the help of Dr. R. A. Robb, which made an important contribution to taxonomic method in the study of these highly variable animals, and explained various anomalies in their vertical distribution within the Coal Measures.

At Swansea Leitch had established a research team to continue the study of these principles and their application to field-problems, especially in the structurally difficult measures of Pembrokeshire; but his premature death has inevitably deferred the fulfilment of this work.

For several years he was secretary of Section C (Geology) of the British Association.

Leitch was a kindly, friendly man who loved company, an attribute that was reflected in his happy relations with students in laboratory and field. He leaves a widow and young son. J. Weir

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Sir Richard Redmayne, K.C.B.

Sir Richard Redmayne, who died on December 27, was born at Low Fell, County Durham, in 1865. He was the son of John Marriner Redmayne, of Low Fell—a lover of the fine arts and no mean painter in water colours and a devout Christian: attributes fully inherited by his son. His grandfather, Giles Redmayne, built and endowed Brathay Church in Westmorland and was complimented on its structure by the poet Wordsworth.

Sir Richard served his apprenticeship at the Hetton Collieries under William Armstrong, a famous mining engineer who had been apprenticed to the celebrated John Buddle, the 'father of the Coal Trade' and intimate friend of George Stephenson of locomotive fame. At one period in his training he rose at 2.30 a.m., and walked a mile and a half to the mine, which he descended at 3.30 and came out at 10.30. In the afternoon he attended the office to write reports and do other administrative work. He also studied at the Durham College of Science—now King's College, Newcastle upon Tyne. He became an under-manager and in 1891 left England to undertake mining operations in South Africa. In 1893 he was appointed manager of a group of collieries at Seaton Delaval. On that occasion the Rev. C. H. Boutflower—afterwards Bishop of Tokyo and later of Southampton—wrote as follows:

"Turn on the buzzer, blow the horns, bang all the tubs together!
Let every Gall'way neigh response, each driver crack the leather!
Oh happy day—let Seaton say—and happiest news to tell of all
Dick is become our Manager of Mines at Seaton Delaval."

In 1902 Sir Richard was appointed professor of mining at the University of Birmingham and, writing as one of his first students, I can say that all those who studied under him will honour his memory for his great kindness and the hospitality of his home by the then Mrs. Redmayne, who was the ideal hostess. Sir Richard retired from the chair at Birmingham to become the first H.M. Chief Inspector of Mines at the Home Office, and I was very fortunate in serving him as private secretary for two years. His appointment caused a little jealousy among a few of the then senior inspectors, but the justification of his selection was soon evident. Very early he had to investigate and report upon some of the largest colliery explosions which have occurred in Britain. At that time the late Sir William Garforth had conducted large-scale experiments at Altofts Colliery, where there had been a serious explosion, demonstrating the explosive nature of coal dust and the possibility of neutralizing its nature by the application of stone dust. Sir Richard decided immediately to strengthen the regulations relating to safety and drafted a Bill which became the Coal Mines Act, 1911. This Act, based on practical and scientific knowledge, foresight and common sense, is, at the moment, still in operation. This fact indicates the soundness of its structure. In my opinion this Act was Sir Richard's *magnum opus*. Its enforcement resulted in diminishing rapidly the loss of life from such disasters.

Another potential source of danger existed—the danger of open sparking and shock from the application of electricity in mines; and a committee of experts was appointed to consider the inadequacy of the Electrical Special Rules of 1905. The committee consisted of Sir Richard as chairman, Mr. C. H. Merz and Mr. Robert Nelson, who had been appointed the first H.M. Electrical Inspector of Mines. New rules were established and Mr. Nelson enforced them with tact to the great benefit of the industry.

After the firedamp explosions at the Jamage Pit in North Staffordshire and at Cadeby Colliery in Yorkshire (where the Divisional Inspector and eighty-seven others were killed), which were caused as the result of spontaneous combustion, the Home Secretary set up a departmental committee with Sir Richard as chairman to inquire into the circumstances in which spontaneous combustion of coal occurs in mines, its causes and the means of preventing it, and a Blue Book was issued. A code of rules was afterwards drawn up on the organization for rescue and aid in the case of accidents in mines. Now there are numerous rescue stations and trained men in all the coalfields of Britain.

It is perhaps true to say that no man in his profession has filled so many posts and performed such various duties. Sir Richard was a member of three Royal Commissions. He was chairman of the Board for Mining Examinations for many years and was external examiner in mining for the Universities of London, Birmingham, Wales and New Zealand, and examiner for the Camborne School of Mines, the Board of Education and the City and Guilds of London. Sir Richard was held in such high esteem by H.M. Civil servants that he was elected for thirty-three years in succession as president of the Institution of Professional Civil Servants. He was also a past-president of the Institutions of Civil Engineers and of Mining and Metallurgy.

This appreciation might appear to be overloaded if a complete list of the offices Sir Richard held were given. He had been a director in a number of colliery and other companies and for many years acted as a consulting mining engineer. He found time, however, to produce text-books on colliery working and management and the valuation and rating of coal and mining properties. He had a wonderful memory, and his book on "Men, Mines and Memories" is a most fascinating and instructive work. In 1914 he was made K.C.B., and in 1918 he became a chevalier of the Legion of Honour; he was also a companion of the Order of St. John of Jerusalem.

Though such a distinguished and highly gifted man, his personal friends will perhaps remember him chiefly for his sense of humour and great personal charm. He married Edith Rose Richards, daughter of Thomas Picton Richards, of Swansea, in 1898; she died in 1942. There were two sons and two daughters of the marriage. One son died as the result of a motor-car accident. The three others survive him.

GRANVILLE POOLE

NEWS and VIEWS

Physics at Bedford College, London: Prof. H. T. Flint

THE retirement of Prof. H. T. Flint from the Hildred Carlisle chair of physics in Bedford College, University of London, constitutes a severe loss to the scientific personnel of the University, for he was a man of exceptionally wide interests. Not only was he a most able teacher whose text-book (with B. L. Worsnop) on experimental physics in the laboratory has for decades been a standard work for honours students, but also his contributions to quantum theory, to relativity and to field theories generally have formed a continual stimulus to workers on these subjects. In addition, his training in medicine and the possession of a medical degree have made him a valued referee for numerous bodies requiring advice on medical physics. His colleagues in the University of London are immensely indebted to him for the many administrative duties which he has generously undertaken as chairman of the University of London Board of Studies in Physics and chairman of the Examining Board. A graduate of the Universities of Birmingham and London, much of his life was spent as reader in physics at King's College, London, when the Wheatstone chair was held successively by Sir O. W. Richardson, Sir Edward Appleton and Sir Charles Ellis. His appointment to the chair at Bedford College in 1944 enabled him to use his long-proved abilities, during the difficult post-war decade, for the development of both theoretical and experimental physics at Bedford College to the maximum possible capacity. He leaves Bedford College in the knowledge that he will not be saying farewell to his innumerable friends, who will continue from time to time to seek that advice which has been so freely and generously given in the past.

Prof. H. O. W. Richardson

PROF. FLINT is succeeded by Prof. H. O. W. Richardson, who has held the chair of physics at University College, Exeter, for the past three years. A son of Sir O. W. Richardson, he graduated at King's College, London, and proceeded to the Cavendish Laboratory, Cambridge, where he received the Ph.D. degree for his researches on applications of the cloud-chamber technique to problems in radioactivity. After further research work at King's College and Bedford College in the University of London, he was appointed a lecturer in the Department of Natural Philosophy at Edinburgh under Prof. N. Feather. It was there that he carried out his important theoretical and experimental studies on the β-ray spectrometer. Brought up in the atmosphere of scientific research, possessed of an original and inventive mind and personality, and with wide experience of a variety of laboratories, Prof. Richardson has much to contribute to the development of physics teaching and research at Bedford College.

Editorship of *Discovery*: Mr. William E. Dick

MR. WILLIAM E. DICK has resigned from the post of editor of *Discovery* after just over twelve years in the chair. During that period, scientists and laymen alike have watched the considerable improvements made in that journal, for Mr. Dick has become established as one of Britain's leaders in the presentation and interpretation of science to the public (see also *Nature*, 172, 1028; 1953). He has now undertaken the editorship of the newly established journal *British Chemical Engineering*, the first issue of which will be published in May (Drury House, Drury Lane, London, W.C.2).

Dr. Anthony Michaelis

DR. ANTHONY MICHAELIS succeeds Mr. Dick as editor of *Discovery*. Dr. Michaelis obtained his degree in chemistry at the Imperial College of Science and Technology. After several years spent in industrial research laboratories, he joined the headquarters staff of British Intelligence Objectives Sub-committee and during the period 1945–48 he edited the series of the Sub-committee's overall reports. He has since specialized in scientific films, and has devoted particular attention to the use of cinematography as a research tool. He is closely connected with the Scientific Film Association, and has served on the executive committee of that organization (see also p. 298 of this issue). At the Bristol meeting of the British Association in 1955 Dr. Michaelis was mainly responsible for organizing the successful scientific 'film festival', during which some forty films were exhibited.

Russell H. Chittenden (1856–1943)

RUSSELL HENRY CHITTENDEN, the 'father of physiological chemistry in the United States', was born at New Haven, Connecticut, one hundred years ago on February 18, 1856, of a family that had emigrated from Kent in 1639. Almost his entire scientific career was spent in the city of his birth. In 1874, when he was eighteen, he was placed in charge of "the first definitive laboratory of physiological chemistry in America for the instruction of students" in the Sheffield Scientific School at Yale University. In the following year he obtained the degree of B.Sc. with a thesis on glycogen and glycocoll in the muscular tissue of *Pecten irradians*, which was published in the *American Journal of Science and Arts*. It was the German translation in Liebig's *Annalen der Chimie* that gained him entrance into Willy Kühne's laboratory at Heidelberg in 1878. Four years later he was appointed professor of physiological chemistry in Yale University (the first chair of its subject in the United States). From 1898 until 1922 he was director of the Sheffield Scientific School. His most important work was concerned with the protein element in human nutrition in the days when Carl von Voit's dietary standards were generally accepted; as a result of experiments performed during 1902–3 on himself, his colleagues, students and volunteers from the United States Army, Chittenden showed that good health, physical vigour and nitrogenous equilibrium can be maintained on levels of protein intake considerably below those specified by Voit. In 1909 he served on the Remsen Referee Board to report on the toxicity of sodium benzoate in foods, and after the First World War, together with Graham Lusk, he represented the United States on the Inter-Allied Scientific Food Commission in London, Paris and Rome. His best-known books are "Physiological Economy in Nutrition" (1904) and "The Development of Physiological Chemistry in the United States" (1930). Many honours came his way. In 1896 he was elected president of the American Physiological Society, which office he held for a record number of nine years, and in 1906 the first president of the American Society of Biological Chemists. A scrupulously neat person, who possessed an unerring flair for attracting worth-while pupils, Chittenden died at New Haven on December 26, 1943, in his eighty-seventh year.

Lobachevski and Non-Euclidean Geometry

THIS year marks the centenary of the death of the Russian mathematician, N. I. Lobachevski, on February 24, 1856. He was born in 1793 at Nijni Novgorod, and at the age of eight became a scholar at the Gymnasium at Kazan, where he made remarkable progress in the study of mathematics and classics. When fourteen years of age he entered the University of Kazan and spent the next forty years there, first as a student, then as a professor and finally as rector. Lobachevski played a major part in the development of the University and undertook a great deal of teaching and administration. In spite of this, he was still able to give time to mathematical thought and succeeded in creating a new field of mathematics. For more than two thousand years the question remained unsolved as to whether Euclid's parallel postulate is an independent axiom or can be deduced from other axioms. Lobachevski was the first to settle the question by constructing a non-Euclidean geometry, based on the hypothesis that through a fixed point there is an infinity of lines parallel to (that is, not meeting) a given line. This situation occurs on a pseudosphere. In 1855 "Pangeometry", the completed works of his mathematical life, was published; it was written in French and Russian and had been dictated because of his blindness.

Inland Waterways in Britain

THE Minister of Transport and Civil Aviation announced in the House of Commons on February 1 that he has appointed a Committee of Inquiry into Inland Waterways with Mr. Leslie Bowes as chairman. The other members of the Committee are Messrs. J. Corbett, G. C. Godber, H. E. Hopthrow, W. A. Muddell (chairman of the Land Drainage Committee of the River Boards' Association), F. Ritchie (National Parks Commission), M. Rowe and J. Wilson. The Committee will consider and report on the future of the system of inland waterways in Britain and propose any measures necessary to achieve: (i) the maximum economic use of the system; (ii) the future administration of and financial arrangement for inland waterways which cannot be maintained economically for transport purposes, having regard to requirements of public health and safety, and the facilities which these waterways can provide for recreation, water supply, land drainage and dispersal of effluents; and (iii) the conversion of canal sites to other purposes when this is desirable and practicable. The Committee will also consider the present law relating to the closing of waterways to navigation, and make recommendations.

Permanent Exhibition of Scientific Instruments in London

A PERMANENT exhibition of instruments made by a selection of the hundred and forty member firms of the Scientific Instrument Manufacturers' Association of Great Britain was opened on February 9 by Sir Norman Kipping, director-general of the Federation of British Industries. The exhibition is housed at the Association's headquarters at 20 Queen Anne Street, London, W.1, and though not intended to be public, it is open to all those interested in scientific instruments, especially visitors from overseas. Besides being a centre where visitors can see a representative selection of instruments, the display will also serve as a meeting-place for makers and users of instruments in Britain. An extensive catalogue library is being built up. Since it is impossible to give space to all member firms at the same time, a rota system has been worked out so that each member will have a chance to exhibit, and at the same time the character of the display will change constantly. In opening the exhibition Sir Norman said that the output of the British instrument industry is valued at £60 million a year, of which £15 million is exported. Stressing the importance of instruments in all branches of industry, he said that the fact that of the fifty thousand workers in the instrument industry in Britain, two thousand five hundred are engaged on research and development work augurs well for the future.

Shortage of Science and Engineering Graduates in British Industry

A LETTER sent to Mr. Iain Macleod, Minister of Labour, signed by Sir Norman Kipping, director-general of the Federation of British Industries, reaffirms the concern of the Grand Council of the Federation at the continuing shortage of science and engineering graduates. It not only urges that industry is handicapped by the general shortage, but also refers to the growing effect of the selective deferment from National Service which is granted to such graduates who take up government or government-supported jobs related to national defence; the effect in practice is that these men remain in the same sort of job and are lost to industry indefinitely. The Federation regards the situation as so serious that, while appreciating the difficulties of exempting all science and engineering graduates from National Service, it urges the Government most strongly to grant deferment where requested to all science and engineering graduates with first- or second-class honours degrees who take up employment in industry generally as well as in government establishments or on government-sponsored projects, and to continue deferment so long as they remain in such employment. It estimates that the entire annual output of science and engineering graduates in Great Britain is 1·5 per cent of the number of men eligible for National Service, and that for one reason or another some 50 per cent of the latter are never called up.

Babel: An International Journal of Translation

The first number of *Babel*, an international journal of translation, has appeared, published by the International Federation of Translators, with the support of Unesco, the Director-General of which contributes a foreword (1, No. 1; 1955. Pp. 40. From the Federation, 16 rue Pierre Charron, Paris; 5*s*. an issue, or 17*s*. annual subscription). It represents the results of the first efforts, after the phase of organization, of the Federation, which was founded in 1953. The most important article in the present issue is that of R. W. Sumpelt outlining the general policy of the Federation and its affiliated organizations with regard to scientific and technical translating and indicating some of the problems with which it is proposed to deal in *Babel*. These include the recording of scientific and technical terminology on an international scale; the improvement of dictionaries and other lexicographical aids; and research in semantics and linguistics to decide what terms would be improved by standardization, and whether standardization should further cope with entire patterns of expression and of thought. Questions on costs of translation will also be considered, and, besides authoritative studies on these and other subjects, reports on current activities and meetings of other organizations of interest to the Federation are also invited. The present issue outlines the translation programme of representative works of Unesco and includes an article by Dr. S. D. Limaye discussing some basic aspects of scientific translation in India and the building up of an Indian scientific vocabulary.

British Rainfall during 1953

Under the title "British Rainfall 1953" is published the ninety-third annual volume of the British Rainfall Organization and the thirty-fifth as a Meteorological Office publication (M.O. 588; pp. 216. London: H.M.S.O., 1955; 25*s*. net). Each volume in the series summarizes the rainfall measured during a year at more than five thousand stations, many kept by voluntary observers, in Great Britain and Northern Ireland. The year was on the whole a dry one over most of the country, with amounts of less than 20 in. and less than four-fifths of the average over much of England and Wales. Over north-west Scotland, it was rather wet with up to six-fifths of the average. At Pontefract the total was only 15·43 in. against an average of 23·3 in. The low rainfall over England and Wales was due to the winter months at both ends of the year being dry; the summer was rather a wet one. January was notably dry with a general average of only 1·4 in. over England and Wales and was part of one of the driest winters on record. The heaviest fall in one day was one of 6·5 in. on November 26 at Cwm Dyli, Snowdon. Some very heavy falls of rain occurred in the heavy thunderstorms of June 26, on which day at Eskdalemuir, Dumfries, 2·09 in. was measured in half an hour—the heaviest known fall recorded in the country in that period of time—and 3·54 in. in fifty-five minutes; on the same day 1·72 in. fell in fifteen minutes at Nelson, Lancs. Mr. J. Grindley contributes a useful tabulation, county by county, of the very heavy rainfalls observed since 1860 in periods up to two hours. They are those of, or exceeding, the "Noteworthy" category, which ranges from 0·43 in. in less than five minutes to 1·19 in. in two hours. These show the heaviest fall in ten minutes to have been 1·3 in. at Chagford, Devon, on September 23, 1927, in an hour 3·63 in. at Maidenhead, Berks, on July 12, 1901, and in two hours 4·8 in. at Churchstoke, Montgomery, on June 26, 1895.

Psychological Tests for Accident-Proneness and Industrial Proficiency

Memorandum No. 31 of the Medical Research Council, entitled "Psychological Tests for Accident Proneness and Industrial Proficiency" (pp. 30. London: H.M.S.O., 1955; 2*s*. net), is a reprint of the Industrial Health Research Board reports (Nos. 38, 55, 68, 74 and 84) on accidents, and its appearance is very welcome. The author of the summary, E. G. Chambers, has studied this problem with the late Prof. Greenwood, Miss E. M. Newbold and Eric Farmer for many years. He notes in the introduction that the investigations reported have extended over fifteen years and have involved more than four thousand subjects and the use of more than thirty different tests. The object of the study was to discover what relationship existed between the test scores of the subjects tested and the recorded accidents. It was hoped that some idea would be gained of the measurable psychological qualities involved in proneness to sustain accidents, with the ultimate practical object of choosing tests to help in the selection of workers for dangerous occupations. Whenever possible, records of industrial efficiency were obtained so that the effect on the proficiency of selection for accident-proneness could be demonstrated. The reports give details of the tests, together with the inter-relations of the tests and their prognostic value, and the present memorandum is a summary of the main conclusions described in the five reports beginning in 1924. No new material is incorporated, and the data are not treated in any new way. Of course, since the publication of these reports, statistical techniques have improved and now the experiments would be planned differently; but a fairly extensive knowledge of recent work makes one realize that the present-day techniques have done little to increase our knowledge. The subjects tested included dockyard apprentices, naval ratings, London and provincial bus-drivers and various groups of trainees. The tests included sensori-motor, æstheto-kinetic, mental and intelligence, physiological, and nervous stability tests. Details of the tests and the precautions taken are given. The outbreak of war in 1939 terminated this research.

Statistical Review of England and Wales

The General Register Office has recently issued the "Text Volume" of the "Registrar General's Statistical Review of England and Wales for the Year 1952" (pp. 256, 8*s*. net) and the "Medical Tables, Part 1", for 1954 (pp. 375, 12*s*. 6*d*. net). (Both published by H.M.S.O., London.) There are few changes in the presentation of the tables: the most important is the inclusion of tuberculosis notifications in the table relating to notifiable diseases, data which have hitherto only been given in the annual reports of the Chief Medical Officer to the Ministry of Health. There have also been minor changes in the method of classifying hospitals for the chronic sick, which may affect the comparability of local death-rates. The text for 1952 consists of the usual commentary on population movements in that year. There were no violent changes to report: fertility remained at a stable level, and the concentration of childbearing in the early years of marriage continued. The report brings out the remarkable increase in the married population; in the age-groups 15–19, 20–24 and 25–29 the proportion of women who were married exceeded that in 1938 by 83, 49 and 21 per cent, respectively. An interesting report on marriages by method of solemnization shows that 13·6 per cent of the 1952 religious marriages were celebrated according to Roman Catholic rites against 9·1 per cent in 1934, the last year for which figures were collected. Civil marriages as a proportion of all marriages increased from 28·4 per cent to 30·6 per cent in the same period. The mortality section of the text includes a detailed analysis of cancer mortality.

Vitamins: Memorial Essays to Sir Edward Mellanby

The January issue of the *British Medical Bulletin* (12, No. 1; from the British Council Medical Department, 65 Davies Street, London, W.1; 15*s*.) is a memorial number to Sir Edward Mellanby, the late secretary of the Medical Research Council. As the article on him and his work by Sir Charles Harington, director of the National Institute for Medical Research, so clearly shows, his death deprived British medicine of one of its most influential figures. The number consists of a series of essays on the vitamins, written by experts, which were originally planned by a committee with Sir Edward as chairman, and he himself intended to contribute to it. Now it appears as a memorial to him—a fitting memorial, for it was in the field of vitamins that Sir Edward did such notable work. It is fitting, too, that one article describes the work of the Accessory Food Factors Committee and Mellanby's influence on the work of this Committee. It is impossible to select, from a list of sixteen articles, all written by leading authorities, any that excel the others. The whole issue is valuable; and those interested in any way in vitamins will find that the summaries given of recent work, and the bibliographies that accompany each article, are sources of information which will add to their understanding of a volume of work that is now so extensive that few, if any, can follow all its many aspects and applications. An excellent photograph of Sir Edward, taken in Lucknow, accompanies the number.

Recording of Animal Sounds: Conference in Pennsylvania

The commercial development of tape recorders during recent years has fostered a great deal of scientific research in the recording of sounds made by animals. Unfortunately, the comparison of results by different workers is very difficult: the printed word in a journal is obviously inadequate; the physical analysis of sounds into 'pictures' has little meaning to biologists, and it is not practicable to convert the picture back to the original sounds for retesting; and even the exchange of actual tapes between workers may be useless if the associated machines are of different types. To make a start on these problems a conference will be held during April 16–19 in the United States at the Pennsylvania State University, at which it is hoped to reach agreement on acceptable procedures for recording animal sounds and start a repository of tapes. The first day of the conference will be devoted to reports of research on animal behaviour in which sound-recording techniques have been used, given by the following: Prof. Donald Griffin (Harvard University), Dr. R.-G. Busnel (Laboratoire de Physiologie Acoustique, France), Prof. F. Möhres (University of Tübingen) and Prof. R. J. Pumphrey (University of Liverpool). The remaining days will be devoted to informal discussions on recording techniques and standards. Further information on the conference can be obtained from Prof. H. Frings, Department of Zoology, University Park, Pennsylvania.

University of London: Appointments

Dr. D. R. Cox, visiting research professor in the University of North Carolina, has been appointed to the University readership in statistics tenable at Birkbeck College.

The title of reader in the University of London, in the subjects indicated, has been conferred on the following in respect of the posts that they already hold: Dr. E. J. Harris (biophysics), University College; Dr. Leonard Saunders (pharmaceutical chemistry), School of Pharmacy; Dr. John Sutton (geology), Imperial College of Science and Technology.

Royal Astronomical Society: Officers

The following have been elected officers for 1956 of the Royal Astronomical Society: *President*, Sir Harold Jeffreys, Plumian professor of astronomy in the University of Cambridge; *Vice-Presidents*, Dr. A. Hunter, Dr. J. Jackson, Prof. A. C. B. Lovell, Dr. R. A. Lyttleton (*Geophysical Secretary*); *Treasurer*, Prof. L. M. Milne-Thomson; *Secretaries*, Prof. C. W. Allen, Prof. H. Bondi; *Foreign Secretary*, Sir Harold Spencer Jones.

Announcements

Dr. Claude E. Shannon, research mathematician at the Bell Telephone Laboratories, Inc., has been appointed visiting professor of electrical communications at the Massachusetts Institute of Technology. He will be associated with the Institute's Research Laboratory of Electronics, and will lecture on advanced information theory, based on his recent research at the Bell Laboratories. Dr. Shannon's work in mathematical theory has led to the development of maze-solving machines, and more recently he has been studying problems in probability, such as the design of reliable machines consisting of unreliable components.

The Ergonomics Research Society is arranging a symposium on "Human Factors in Road Transport", to be held in the University of Bristol during April 16–19. The first session will be a general one, though most of the papers will deal with some aspect of visibility, and the second and third sessions will be devoted to driver behaviour and physiological aspects, respectively. The fee for the symposium is 5*s*. for members of the Society and 35*s*. for non-members. Accommodation can be booked at the Manor Hall, one of the University halls of residence. Further information can be obtained from H. Murrell, The Miners' Arms, Priddy, Wells, Somerset.

Erratum. The article on "Structure of Semi- and Non-crystalline Materials" in *Nature* of January 21 contains a reference to a paper by Dr. E. J. W. Whittaker (p. 122, col. 2, line 5 from bottom); in this reference, for "chrysolite" read "chrysotile".

THE NUFFIELD FOUNDATION

REPORT FOR 1954–55

THE tenth report of the Nuffield Foundation, covering the year ended March 31, 1955*, the first year of its third quinquennium, has been published, and records that allocations from income totalled £681,397 during the year, a figure only exceeded when, in 1952–53, the Foundation made its second large five-year allocation to the National Corporation for the Care of Old People. Expenditure for research and experiment within the United Kingdom was maintained undiminished at £445,079, in the year 1954–55 more than a quarter of the expenditure on grants was spent on helping research workers and students overseas. While during 1943–49 this expenditure averaged about £53,000 a year, during 1949–54 the average was £120,000; the report notes that the Foundation's contribution to date of just over £1 million to travelling and research grants and other projects in the British Commonwealth overseas may be the largest private contribution from Britain to the finance of organized academic and professional relations within the Commonwealth, and it also expresses the Foundation's hope that other private resources may be available to enter a field where the opportunities are so great and so rewarding.

Grants within the United Kingdom during the same twelve years have included £875,000 for medical research (including £295,000 for rheumatism); £586,000 for biological research; £614,000 for research in the physical sciences; £684,000 for projects in the social sciences; £37,000 for architectural studies; and £32,000 for agricultural research. Grants for the care of the elderly and research on problems of ageing have totalled £970,000; for fellowships and scholarships for residents of the United Kingdom, £292,000; and for miscellaneous projects, £277,000.

For the year under review, the projects overseas have taken the largest single share (£133,732) of the year's grants, including the creation of a new unit at the University College of East Africa, Kampala, for research into education in Africa; the building of new halls of residence for students at the Imperial College of Tropical Agriculture, Trinidad; £20,940 over four years for Prof. L. C. Beadle's programme of research on tropical swamps; research in Africa which necessitates the participation of trained non-European research workers; marine biological studies in South Africa; and assistance to the newly formed *Journal of the Anatomical Society of India.* The second largest share (£112,541) went to biological studies in the United Kingdom, and more than half of these grants were renewals or additions to earlier ones. Grants to medical research in the United Kingdom totalled £106,560, nearly half of this, including £22,060 from the Oliver Bird Fund, being for research into rheumatism, while fellowships, scholarships and similar awards accounted for £102,566, nearly two-thirds being for residents overseas in the Commonwealth.

A feature of this report is the evidence that the projects which the Foundation has fostered are coming to fruition, and this is to be found in the tribute paid to the important scientific results which have now come from two earlier grants through the University of Oxford. In August 1955 Dr. Dorothy Crowfoot Hodgkin, as a result of the detailed X-ray analysis of crystals of complex compounds that are of interest in biology and medicine, conducted by her small research team, was able to announce the solution of the crystal structure of a degradation product of vitamin B_{12}, and with it the structure of almost the whole of the chemically unknown part of the molecule. The second result is the discovery, made by Dr. R. G. Macfarlane and associated workers as part of a long-term programme on blood-diseases, of a method of extracting highly concentrated anti-hæmophilic globulin from ox and pig blood for the treatment of hæmophilia, injection of which into hæmophilic patients undergoing surgery, skin-grafting and dental extraction invariably completely prevented abnormal bleeding.

Of the seventeen grants for biological research made during the year, about half the total was for new grants, more than half of which were for research in departments of botany. New grants include £16,000 over five years to the University of Liverpool for studies on the chemistry and microbiology of the polyphenolic types in the soil; £15,000 over three years to the University of Oxford for research under Dr. Honor Smith into certain immunological reactions of the central nervous system; and £6,000 over three years to University College, London, for electron-microscopical studies of the central nervous system. A grant of up to £3,000 over three years has been made to the University of Oxford to assist Prof. C. D. Darlington's work on chromosomes and £2,500 over three years to the University of Southampton to enable Prof. W. T. Williams to engage two additional research workers for his study of etiolation in plants. Additional grants include a further £5,005 over the remaining two years of the university quinquennium in support of Prof. J. F. Danielli's investigations at King's College, London, into the nature of differentiation and the factors controlling it, particularly the relative importance of nucleus and cytoplasm; a further £22,500 for four years to the Nuffield Institute for Medical Research, Oxford, to support Mr. H. B. Parry's research on pregnancy toxæmia of sheep; and a further £1,550 a year for the two years 1955–57 and £235 for equipment to the University of St. Andrews for Prof. H. G. Callan's work on comparative endocrinology.

On the recommendation of the Department of Scientific and Industrial Research, the Foundation has decided to spend up to £35,000 to finance a pilot aeromagnetic survey to ascertain whether the extensive use of such surveys in Great Britain would be justified on economic and technical grounds. A grant of £7,200 over three years has been made to Birkbeck College, London, to support Dr. A. D. Booth's work on mechanical translation, and the Foundation is also providing a sum of up to £7,000 over three years to the University of Oxford to meet the running cost of the Archæological Research Laboratory, after which, it is understood, the University is prepared to take over the whole recurrent cost. A progress report from the Foundation's Division for Architectural Studies records that during 1954 a pilot study on the use of space, services and equipment in research laboratories was made in two of the major establishments of the Agricultural Research Council and that the first appointments have been made to the two postgraduate fellowships in architecture, tenable within the Division.

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* The Nuffield Foundation. Report for the Year ended 31 March, 1955. Pp. 125. (Tenth Report.) (London: Nuffield Foundation, 1955.)

The major part of the year's grants for medical research went for further fundamental research in the chronic rheumatic diseases, and the Oliver Bird building, which houses the clinical and laboratory research of the Rheumatic Unit, Northern General Hospital, Edinburgh, was completed and opened during the year. New grants for medical research included £17,500 (including £1,250 for capital expenditure) to the Frenchay Hospital, Bristol, to finance current expenditure over five years on Dr. R. M. Norman's research into the causes of certain types of mental deficiency; and £5,000 to the University of Durham for a survey of Tyneside industry by the Nuffield Department of Industrial Health. A further grant of £5,000 over three years was made to University College Hospital Medical School, London, for the continuation and development of Dr. N. Smyth's work on the application of electrical techniques in medicine, in particular for the study of the womb in childbirth, which has already made a contribution to the safety of mother and infant; and an additional £4,000 was offered to the Oxford Regional Hospital Board to enable the project on the relation between physique and behaviour, with special reference to psychiatric disorders, at the Warneford and Park Hospitals, to continue for another year.

Most of the allocation for social research and experiment was to complete the grant of £100,000 additional to the permanent endowment of Nuffield College, Oxford. New grants include £2,500 a year for three years for a bibliographical programme in the social sciences, aimed at the production of good bibliographical tools by elaborating a series of consistent schemes or recipes which will facilitate the provision of abstracts or bibliographies in the social sciences. It will include a survey in London of the adequacy of existing library and research facilities for social scientists. Another new grant of £3,300 a year for three years was made to the University of Oxford in support of Lady Hall's empirical research into the distributive trades; £2,600 a year for five years has been given to the Shoreditch Project Committee for launching an experiment in preventive social work, and a research scholarship of £1,250 a year for three years to Dr. V. L. Allen for his proposed study at the London School of Economics and Political Science of the role of trade unions in Britain during the past thirty-five years. A final grant of £3,000 has been made to the Institute of Statistics, University of Oxford, for completion of the national survey of incomes and savings.

A grant of £8,000 over four years was made to St. Bartholomew's Hospital Medical College, London, to support Prof. K. J. Franklin's research into the physiology of ageing, and one of £5,000 over two to two-and-a-half years to Lord Beveridge to enable him to carry further his history of prices and wages in England. A miscellaneous project of some wide interest is the inquiry into the best means of assisting the learned periodicals. A sum of £43,750 over five years has been allocated for this purpose; in the meantime the British Academy and the Royal Society have been informed that a sum of £8,000 a year will be available over the next five years to be spent on the support of primary journals in primary subjects, and that up to a further £750 a year will be available for the payment of any necessary professional advisory fees on such questions as printing economy, publication and distribution. The distribution of the grant will be entrusted to two special committees, one for periodicals in the humanities, and one for scientific periodicals. With the taking over by the Kent County Council of the Mersham reception centre for deprived children, established with the help of the Caldecott Community, the balance of the Foundation's grant has been allocated to establish an experimental remedial education centre.

Of the eighteen new projects in the Commonwealth overseas, besides those already noted may be mentioned: £5,200 to the University of Adelaide for studies, by electrophoresis diffusion, of substances and systems of biological interest; £6,800 to the Australian National University, Canberra, towards the first three years cost of a five-year research project on post-war immigration into Australia; £3,200 to the University of Sydney in support of a small medical and anthropological expedition to the high country of New Guinea; £3,700 over three years to the Cawthron Institute, Nelson, for research on symbiotic association in New Zealand plants, with special reference to their nutrition and growth on soils poor in certain nutrients; and £3,000 a year for three years to the University of Otago for a combined investigation there and at Canterbury Agricultural College, Lincoln, into endocrine problems of lactation.

During the year twenty-two awards were made to residents of the United Kingdom and forty-three to residents of the Commonwealth overseas (including the first five Canadian study-grants for short-term research in the United Kingdom). Eleven awards were made under the scheme of visiting lectureships and special grants, open to residents of the whole Commonwealth, and fifteen appointments were made in 1954 under the Royal Society and Nuffield Foundation Commonwealth bursaries scheme.

SCIENCE AND TECHNOLOGY IN WESTERN GERMANY

THE brief review of the scientific recovery of Western Germany, compiled by Mr. K. H. Lauder, scientific attaché to the British Embassy in the Federal Republic and issued by the Department of Scientific and Industrial Research*, is of great interest both to the scientist and technologist. It outlines in the first place, very briefly, the action taken by the United Kingdom authorities from 1946 onwards to assist the rehabilitation of academic science in Western Germany—action with which the Department of Scientific and Industrial Research has been associated from the start, primarily by financing the preparation of reports by German scientists; nearly thirty such reports, which are listed in an appendix to this review, were later issued in Britain as "Sponsored Research (Germany) Reports". To this work a generous tribute is paid in a letter from Prof. Otto Hahn, president of the Max-Planck-Gesellschaft zur Förderung der Wissenchaften, Göttingen, and the review itself shows the success which has attended this action.

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* Department of Scientific and Industrial Research. A Brief Review of Science and Technology in Western Germany. Pp. viii+103 (London: H.M.S.O., 1955.) 4s. net.

Secondly, the review gives a concise but authoritative picture of the present organization of science and technology in Germany and the way in which, following the almost complete collapse of scientific and technological activity, this has been rebuilt on modern lines. Its successive chapters, dealing with physical sciences and technology, electrical engineering and electronics, engineering (except electrical), chemical sciences and technology, metals, biological and medical sciences, agriculture and forestry, and productivity in industry, facilitate an accurate appreciation of the strength and weakness of Western Germany's position in world technology, outside the restricted or prohibited fields of aerodynamics, radar and nuclear science; and it shows how serious a challenge Western Germany offers to British technology now that the post-war phase is over and Western Germany has emerged as a sovereign power. Thirdly, while it is in no way intended as a reference book, the review brings together in convenient form much useful information on universities, technical and scientific institutions in Western Germany, research expenditure and the like.

Damage to research institutions in Western Germany at the end of the Second World War is estimated to have averaged 61 per cent of the total destruction, equipment was non-existent and scientific research and technological development were at a standstill. From the nucleus of scientists collected at Göttingen in 1946 has grown the Max-Planck-Gesellschaft, which to-day is probably the most significant non-industrial research organization in Western Germany, and, except in fields highly significant in defence, the recovery of science is now practically complete. On an average the rebuilt research establishments and the buildings and equipment of the many new research institutes appear to be better than corresponding ones in Great Britain. Staffing, however, has been a major problem, though the rebuilding of research institutes has been accompanied by an intensive programme of education in the expanded universities and colleges of technology, including generous subsidies for travel abroad, to repair the gaps in scientific knowledge and man-power.

Government expenditure on scientific research in academic and independent research organizations is estimated at more than DM. 600 million during the past financial year and is still increasing, while industry is spending a like sum in its own research establishments, estimated at about 5 per cent of turnover for the chemical industries and 1 per cent for engineering: expenditure by the Farbenfabriken Bayer, by the Badische Anilin- und Soda Fabrik and by the Farbwerke Hoechst is estimated at about DM. 40 million each, and the former is completing a fourth new laboratory for research and development at Leverkusen at a cost of DM. 15 million. Siemens und Halske (now reported to be the third largest electrical undertaking in the world) has recently completed a new research and development laboratory at Munich to accommodate twelve hundred research workers. Considerable effort is devoted to fundamental research, and the mounting cost of research is encouraging co-operative research.

The review suggests that the gap between scientific research abroad and that in Western Germany is narrowing and that in some fields, such as electron microscopy, Germany is abreast, if not ahead, of the rest of the world. The chemical industry has put a very large amount of money into research during the past three or four years, and Western Germany has also gone far to organize a healthy growth of its chemical engineering industries. A research association has been set up and long-term plans have been made for the provision of research institutes, each concentrating on specific fields. The first of these, at Aachen, is already operating, and others are planned at Darmstadt, Munich and Karlsruhe. Much attention is being given to rationalization, and several teams have visited the United States to study American methods in automation. After allowing for the heavy social burdens carried by industry, it is estimated that the real cost of labour is 90 per cent of that in the United States. Some fundamental research has already been carried out in aerodynamics, radar and nuclear science, and now that these fields are open, extensive programmes of applied research have been planned.

It is probable that, although somewhat elaborate, the organization of science and technology in Western Germany is now better than ever. The major scientific bodies are as follows: the Deutsche Forschungsgemeinschaft, or German research council; the Stiften-Verband für die Deutsche Wissenschaft e.V., a society of influential men, chiefly industrialists, concerned with collecting money from industry for the support of science; the Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.. a re-creation of the Kaiser Wilhelm society; the Deutsche Verband Technische-Wissenschaftlicher Verein; the Arbeitsgemeinschaft Industrielles Forschungsvereinigungen, co-ordinating the activities of twenty-three industrial research associations; the Nordsheim Westfälische Arbeitsgemeinschaft für Forschung; and the Deutsche Gesellschaft für Dokumentation. The work of the Deutsche Forschungsgemeinschaft is described at some length. Besides its research programme, for which the Federal Government's current grant runs at DM. 10 million a year, it makes an annual grant of DM. 1 million to about thirty-five scientific libraries on condition that their literature is available to scientists generally and also makes grants for the printing of *Habilitationsschiften* (probationary treatises embodying the results of original research) and *Fortsetzungswerke* (revised or supplementary works), particularly those that may have a very limited circulation.

An increasing tendency to contract research is noted; two and a half years ago the Battelle Memorial Institut für Deutschland e.V. was established at Frankfurt am Main, beginning work in December 1953, and the establishment of an agency for contract research, known as the Vermittlungsstelle für Vertragsforschung e.V. is planned. Although Western Germany has no government department specifically charged with looking after scientific research, most ministries support research in some form or other, and grants proposed in the Federal Budget for 1955 for scientific research and technological establishments totalled more than DM. 164 million, as against DM. 75·9 million in 1954. In 1954, moreover, taking into account contributions from State governments, from district councils and municipalities and from other donors, the total contribution for non-industrial scientific research, including scientific teaching, totalled DM. 663·8 million compared with DM. 391·6 million in 1950. Independent calculations indicate that the average cost of research in Western Germany per head of staff is about DM. 9,000, and about four times this figure per head of qualified staff. Among Government research institutions may be mentioned the Physikalisch–Technische Bundesanstalt, which conducts research on standards of physical quantities and on equipment, for example, where safety is involved, and the Bundesanstalt für Mechanische und Chemische Materialprüfung.

There is no exact equivalent in Germany of the Royal Society, the body most nearly corresponding to it in pre-war days, the Deutsche Akademie der Wissenschaft in Berlin, being now under the control of the East German Government. There are, however, four academies of science in Western Germany; and, with the founding of the Johannes Gutenberg University at Mainz in 1946 and of the Free University of Berlin in 1948, and the conversion, in 1945, by addition of a humanistic faculty, of the College of Technology, Berlin-Charlottenburg, into the Technische Universität, Berlin, there are now in the Federal Republic of Western Germany and the Western Sector of Berlin sixteen universities, eight 'Technische Hochschulen' (colleges of technology with university status), and eight other colleges with university status but more highly specialized. The Technische Hochschulen aim to achieve a blending between teaching and applied research, and much of the undergraduate research is undertaken in industry itself. Many industrial research institutes are associated with these Technische Hochschulen, either as part of a teaching department or as separate research institutions.

At the end of the Second World War the German patent system had ceased to exist; but after protracted discussions a Western German patent office was re-established in October 1948, moving later to new premises in Munich, and in 1953 the number of patent applications was about 7 per cent higher than in the whole German Reich in 1938, the trend being towards a further increase. The emphasis on applied research is growing. Even in general terms this is an impressive achievement; and, of all the achievements in particular fields that are summarized in the review, it is difficult to select examples that illustrate more emphatically the extent to which Western Germany is prepared to make the scientific research effort upon which to-day the economic and political strength of any country depend. It might be added, however, that Western Germany can again supply the bulk of its own requirements for scientific instruments and that these are finding a growing market abroad, that the Institute of Radiation and Nuclear Physics at the University of Bonn plans to instal a 30-MeV. synchro-cyclotron, that there are estimated to be eight thousand ultrasonic generators in Western Germany, and that there has been intensive development of the electron microscope which is widely used as a research tool. In electrotechnology there have been notable developments in power technology, in the field of heavy equipment, in electrical instruments of all kinds and in electronics, particularly the development of computers.

In mechanical engineering the traditional interest in machine-tool design has been maintained, and major developments are proceeding in railway transport. Gas turbines are being investigated for heavy road vehicles and stationary power plants, and extensive use of newly developed building aids and techniques has enabled the building industry to achieve a building-rate second only to that of Sweden. Much attention has been given to road research, while in chemical industry the Gelsenkirchen firm, Bergwerke A.G., has commenced production of dicyclopentadiene based on raw benzole, and the Krupp Kohlenchemie G.m.b.H. the Fischer–Tropsch synthesis of hard paraffins. Rheinpreussen A.G. has extended its plant for propyl and butyl alcohol to a capacity of ten thousand tons annually, and Farbenfabriken Bayer, Leverkusen, is continuously improving its methods of producing dyestuff intermediates and general textile chemicals, including preservatives, detergents and emulsifiers, and is taking a great interest in automatic processing. Germany now claims second place in world plastics production, and a new research centre at Darmstadt is investigating the structure of plastics and setting up methods of testing. In the biological and medical sciences the impact of new physical techniques is evident, and some of the most significant researches are those on the fundamental chemical processes of cell metabolism, biochemical mechanisms and chemotherapeutics. Much effort is directed to the solution of Germany's difficult agricultural problems, and particular attention has been paid to soil humus, potato cultivation and systemic insecticides.

ELECTRON MICROSCOPY OF FIBRES

During January 3–4 the Electron Microscopy Group of the Institute of Physics held what was originally intended to be a small specialist conference on the electron microscopy of textile and other industrial fibres, in the Department of Textile Industries of the University of Leeds. The response, in attendance and papers offered, showed that the experiment was amply justified. In all, more than sixty delegates, eight from overseas, attended, and eighteen papers were read and discussed. There were three half-day sessions, devoted to techniques, protein fibres and cellulose fibres, respectively.

In the first session O. C. Wells (Cambridge) described the scanning electron microscope developed at Cambridge, and gave examples of its use for studying fibre surfaces. Whether the scanning microscope or the reflexion microscope (which was used by J. A. Chapman (Manchester) in a study of abraded nylon fibres) will ultimately 'corner' this particular field was the subject of much speculation; neither is yet capable of the resolution of the conventional transmission instrument, but each has certain advantages. On the whole, opinion seemed to be that the added complication of the scanning instrument would, at present, prevent its competing effectively with the other, but further developments will be eagerly awaited by microscopists.

Replication techniques were discussed by D. G. Drummond (Manchester) and by L. Oster, J. Sikorski and H. J. Woods (Leeds). Both schools find two-stage replicas most satisfactory in practice; Drummond has been working with the polystyrene/carbon process[1], but the Leeds workers still favour their silver/SiO technique, which they are using to study merino wool and nylon surfaces. Drummond stressed the desirability of reducing preparatory techniques to a routine capable of being followed by unskilled assistants; but the Leeds team seemed to imply that this was crying for the moon, since in their experience replication is an art which can only be learned by experience.

Ultra-thin sectioning is at last becoming a major tool in fibre microscopy, and a number of papers were devoted to investigations in this field. A. O. T. Charles and J. Sikorski (Leeds) have studied the polymerization of embedding methacrylates, an important process in the preparation of specimens for sectioning; they discussed the advantages and drawbacks of the technique they favour, namely, polymerization by ultra-violet light. P. Chippendale (Manchester) showed sections of wool, rayon and nylon fibres and illustrated how skin and core effects can sometimes be detected in the man-made fibres. Although some details of the cellular constitution of the cortex could be seen in his wool sections, the results emphasized that normal wool has only slight variations in electron density between histological components in the cortex. G. E. Rogers (Cambridge) presented two papers which described what were technically the most beautiful micrographs shown at the conference. His sections of the wool follicle, although enormously superior in resolution, could be compared for clarity with the best results of the histologists using light microscopes, who seem to be left with few distinctive tools other than stains and the polarizer. Enthusiasm for sectioning must, however, be tempered by the fact that the examination of normal mature natural fibres by this technique has not yet produced any very remarkable results, and it remains to be seen whether the argument, that sectioning is the only correct technique because it does not involve degradation, is still valid. A point of view which found support was that the use of sectioning or disintegration in conjunction with controlled chemical treatments is still one of the most fruitful fields of investigation.

In the second session Sikorski and Woods pointed out the difficulty of reconciling the macrofibrillar type of structure observed in the follicle of a wool fibre with the occurrence of extended microfibrillar sheets in disintegrated fibres. They suggested that keratinization might involve the stabilization of a microfibrillar texture which is not yet obvious in the matrix regions of the cortical cell in the follicle, and the uniplanar linking together of the microfibrils to form sheets. They reported that different methods of attacking the disulphide links in keratin (for example, by reduction or oxidation) may lead to distinctive disintegration products when specimens are prepared for examination by the electron microscope. M. S. C. Birbeck and E. H. Mercer (London) described sections of hair in their study of the cuticle layer. They now believe, on the basis of histochemical experiments, that the endocuticle is non-keratinous in character; they also emphasized the importance of the cell membranes both in the cuticle and the cortex of the fibre. An interesting suggestion was that in human hair, where the cuticle cells have large overlaps, the epicuticle seems to be tucked in beneath the scale which it is covering; this feature is less obvious in wool fibres.

D. Burton, R. Reed and M. J. Wood (Leeds) discussed the hydrothermal shrinkage of leather, a phenomenon of great technological importance in the control of leather manufacture. In the early stages of hydrothermal treatment, tanned collagen fibrils swell and assume a helical form, while the cross-striations come closer together. Similar structures, with left- or right-handed twist, also occur during the heat treatment of native collagen fibrils. The fibril is therefore considered to be a cross-helical array of polypeptide chain bundles, these being of variable chemical composition and hence sensitivity towards heat. Tanning forms cross-links between the two helical arrays, while shrinkage involves the relative movement of the cross-helical structures.

K. M. Rudall (Leeds) showed pictures of the thin ribbon-like units of the ootheca of the praying mantis. Structurally, these protein sheets are important in that they possess a modified α-type structure with preferred orientation in the transverse plane; although the polypeptide chains are parallel to the length of the ribbon, a feature of the electron micrographs is the appearance of striations inclined to the length at an angle of approximately 22°. A. B. Meggy and J. Sikorski (Leeds) described microcrystals of the two forms of polyglycine [see also p. 326 of this issue]; the most notable micrographs showed that polyglycine II crystallizes in hexagonal laminæ, in agreement with the trigonal structure proposed recently by Crick and Rich[2]. Growth spirals are observed in the crystals, and the growth steps correspond roughly, but not exactly, with the mean chain-length. Although both forms of polyglycine can absorb considerable quantities of dye (for example, orange II), there is no direct evidence either from X-ray or electron microscope studies as to where the dye is located in the structure.

The final session started with a paper by E. Frei and R. D. Preston (Leeds), who showed micrographs of serial sections of conifer wood tracheids, in which the spiral angle of the microfibrils could be observed. They confirmed that the structure of the various layers in the cell wall is substantially the same as had been suggested by previous X-ray and polarization microscope results; in particular, the basic structure of the outer layer of the secondary wall is a flat spiral, although microfibrils running at a steeper pitch are also present. Somewhat similar results were obtained by H. W. Emerton (Kenley), who is concerned with the outer layers of the cell wall because of their importance in connexion with paper-making. In his striking pictures of softwood tracheids obtained with the reflexion microscope, however, he observed only the macrofibrils, and this provoked a discussion as to why his severely treated beaten fibres should show such remarkable macrofibrils, whereas the (presumably) more gently treated material of Frei and Preston should give remarkably clear microfibrils. There is a curious antiparallel here with the results previously mentioned for keratin, where disintegration was claimed to lead to microfibrils and sectioning to macrofibrils. To make matters more obscure, S. Asunmaa (Stockholm) showed sections of laboratory pulps impregnated with heavy-metal atoms, in which little in the way of a fibrillar structure could be seen at all. Some of her preparations did reveal a striated structure, and there were differences attributable to the effects of various chemical treatments.

R. H. Marchessault (Marcus Hook, U.S.A.) and B. G. Rånby (Upsala) have extended the work on the hydrocelluloses produced by the action of mineral acids on cotton and wood, which reduce the microfibrils to elongated rod-like particles, and attempted to correlate the lengths of the particles with the degree of polymerization (osmotic value). A problem which they had to solve was to produce well-dispersed samples; they found sulphuric acid preferable to hydrochloric acid as a hydrolysing agent, while the concentrated acid, low-temperature technique of Mukherjee and Woods[3] gave better dispersions than the dilute acid, high-temperature process of Rånby and Ribi[4]. Sulphation of the surface layers of the particles was suggested as a reason for this.

A long paper on the fine structure of viscose rayon was presented by P. Kassenbeck (Paris). Among other topics, he considered the possibility of obtaining crimped fibres by bilateral heterogeneity, the influence of spinning conditions on the fine structure, and the question of a surface skin on the fibres. He suggested that the skin usually observed in the light microscope is covered by another very thin superficial layer. Can we expect now another battle of nomenclature ?

Much credit for an interesting and stimulating conference is due to Dr. Sikorski, the local organizer.

[1] Bradley, D. E., Inst. Phys. Electron Micr. Group Conf., Glasgow (1955).

[2] Crick, F. H. C., and Rich, A., *Nature*, 176, 780 (1955).

[3] Mukherjee, S. M., and Woods, H. J., *Biochim. Biophys. Acta*, **10**, 499 (1953).

[4] Rånby, B. G., and Ribi, E., *Acta Chem. Scand.*, **3**, 649 (1949).

PHYSICS OF ATMOSPHERIC CLOUDS

DURING January 4–5 the Physical Society and the Royal Meteorological Society held a joint conference on cloud physics in the Department of Meteorology, Imperial College of Science and Technology, London. It was so arranged that on each day four speakers outlined recent developments in a particular branch of the subject ; unusually generous periods were allotted, and needed, for discussion.

On the first day Mr. B. J. Mason (Imperial College) gave a short introductory talk on the scope of the cloud physics to be reviewed, which extended from the laboratory studies of the microphysical processes affecting the formation and growth of cloud particles, to the properties of the extensive cloud systems responsible for cyclonic rains. He was followed by Dr. C. Junge (United States), who spoke on the nuclei of atmospheric condensation, a subject on which much of our present knowledge is due to Dr. Junge's own researches, mostly made since the Second World War, first in Germany and more recently in the United States. He described how the composition and size distribution of the particles of atmospheric aerosol have been investigated, over the enormous range of sizes from a radius of about 10^{-7} cm. to about 10^{-3} cm. The smaller of these particles are the most numerous, usually occurring in concentrations of about 10^4/cm.^{3}, and are those predominantly precipitated in conventional nucleus counters (the 'Aitken nuclei'). Particles with diameters exceeding about 10^{-5} cm. are usually found in size distributions characterized by the relation $dn/d(\log r) = \text{const.}/r^3$, where dn is the concentration of particles in the range of radius dr. The largest particles, the giant nuclei, with radius exceeding 10^{-4} cm., occur in concentrations of less than 1/cm.^{3}, but are important in cloud formation, for they produce a small proportion of unusually large cloud droplets which may readily grow to raindrops by settling through and sweeping up the remainder (the 'coalescence process' of rain formation). The giant nuclei are composed mainly of sea-salt derived from sea-spray, and have been extensively sampled by Dr. A. H. Woodcock (United States) and Dr. H. Dessens (France), who also took part in the conference. Dr. Junge discussed the composition of the somewhat smaller nuclei, which produce the bulk of cloud droplets, and showed that the important constituents are ammonium and sulphate radicals. He particularly emphasized the importance of generating processes and of coagulation and precipitation processes in maintaining the characteristic size-distributions, and the need for more study of the trace materials present in the air in similar concentrations, but in the gas phase. The discussion became a debate on the proportions of cloud droplet nuclei which are produced by sea spray ; the general opinion was that it is their size, rather than number, which makes the sea salt nuclei important.

Dr. H. Weickmann (United States) reviewed information on the constitution of non-precipitating clouds, dividing them for this purpose into stratified and convective clouds. He gave special attention to the relations between the droplet size distribution, the total concentration of condensed water, and the visibility in clouds. He mentioned that the local conversion of supercooled clouds into crystal clouds by seeding is useful as a kind of marking which gives insight into ordinarily invisible turbulent and other air motions in the clouds. Illustrations of the peculiar crystal forms found in ice clouds were drawn from a remarkable series of high-altitude flights in an open-cockpit aircraft which Dr. Weickmann made in Germany during the Second World War. He finally mentioned the iridescent colours, and by inference the droplet constitution, of the rare stratospheric mother-of-pearl clouds, the temperature of which is thought usually to be as low as −80° C. This provoked discussion and alternative inferences from the physicists, who now believe that liquid water freezes spontaneously at about −40° C.

In the afternoon of the first day, Mr. B. J. Mason, speaking rapidly, gave an impressive account of the growth of research upon the nucleation of supercooled water—the initiation and the growth of ice crystals. He discussed the role of homogeneous and heterogeneous nucleation of supercooled droplets, and concluded that in the atmosphere they have predominant importance at temperatures near and below −40° C., and above about −30° C., respectively. He supposed that the effective particles at the higher temperatures are wind-raised silicates. Much more efficient ice nuclei can be made from the iodides of lead and silver, whereas practically all other chemicals can be shown to be inactive. Mr. Mason then reviewed the growth of ice crystals by condensation, and remarked especially that the preferred habit changes with temperature : down to −4° C. hexagonal plates predominate ; between −4° C. and −8° C., and below about −20° C., prisms occur ; while between about −8° C. and −20° C. plates and stars are found. In the laboratory, crystals of startling shape have been grown by varying the temperature : for example, long prisms have been made to sprout upwards from the corners of a hexagonal plate. In the discussion, some speakers challenged the view that only the temperature controls these changes in crystal habit, and Prof. J. D. Bernal doubted if they could be explained by considering only equilibrium states. Dr. Dessens mentioned a small sausage-shaped (presumably organic) type of particle which has been identified as an active ice nucleus in the atmosphere at temperatures below −12° C. Mr. J. S. Turner (Australia) announced a recent experiment which shows that the loss of nucleating activity to which silver iodide smokes are subject in the daylight does not occur at night.

Dr. R. Braham (United States) reviewed the physics of precipitation mechanisms, and emphasized the lack of knowledge of the processes of collision and coalescence between small droplets, which hinders correct appreciation of the importance of the coalescence mechanism of rain formation. He showed that showers form purely by this mechanism in the Caribbean, and that the mechanism still operates in the larger clouds of the eastern United States, whereas the Bergeron–Findeisen ice-crystal mechanism might be the more important in the arid south-western States. These challenging statements and striking flight-observations provoked a lively discussion.

On the second day, Mr. F. H. Ludlam (Imperial College) pointed out that the partitioning (into micro-, macro- and synoptic-physics) of cloud studies, though convenient, must not be made too rigid. It is particularly important that meteorologists (especially dynamicists) should develop the difficult studies of individual clouds, in order that the meteorological conditions within which the microphysical processes operate should be better understood. He illustrated the links which must be sought between the main divisions of the subject by describing some features of convection clouds in the lower troposphere (cumulus), the upper troposphere (cirrus), and the stratosphere (noctilucent clouds). It has been found in Sweden that showers form in cumulus if their tops exceed a rather well-defined level which varies from day to day, and at which the temperature varies from −4° C. to about −25° C. It seems that the coalescence mechanism is responsible for both the shower formation and the extensive production of crystals in the cloud tops. Studies of the other clouds show that there must be a source of atmospheric nuclei, not only at the Earth's surface, but also in the high atmosphere. Examinations of the outer solar corona and the zodiacal light support the hypothesis that cosmic dust settles into the atmosphere at a rate sufficient to provide practically all the nuclei present in the upper troposphere, and to provide concentrations of about 100/cm.^{3} of Aitken nuclei near the ground. The implications of such a universal pollution of practically invisible particles (diameter about 10^{-5} cm.) need careful consideration.

Mr. J. S. Sawyer (Meteorological Office) discussed the properties of the great layer-cloud systems which are associated with cyclones and fronts. The computations of the vertical motion in these atmospheric disturbances, which can now be made with the help of machines, are incapable of resolving internal details that can be deduced from rainfall records and flight investigations. Probably the formation of these cloud systems plays a significant part in cyclone development, for their presence reduces certain braking-effects due to the stable stratification of the atmosphere. Mr. Sawyer described new models of the vertical structure of frontal clouds, based mainly on observations of the Meteorological Research Flight.

On the final afternoon Prof. J. S. Marshall (McGill University) spoke on radar studies of clouds and precipitation. He described the use of millimetre radar, which can 'see' a high proportion of non-precipitating clouds, and of centimetre radar to obtain a three-dimensional representation of snow streamers, which are a characteristic feature of about half of the winter snowfall in Canada. These streamers fall from self-propagating convective cells. He also reviewed new information on the formation of 'bright-band' precipitation echoes, radar evidence of the importance of the coalescence mechanism in shower formation, radar 'angels' at a sea-breeze front, the peculiar hook-shaped echoes associated with tornados, and the spiral-band echoes received from tropical cyclones.

The last contribution was from Dr. T. W. Wormell (Cambridge) on the generation of electricity by thunderstorms. He summarized existing evidence on the distribution of electricity in thunderclouds, and on the rate of charge re-separation in the intervals between lightning discharges. After outlining the classical and more recent theories of charge generation, he remarked that strong electrical activity is found only in clouds containing ice particles. The most recent theory of charge generation, due to Reynolds in New Mexico, attributes it to collisions occurring between ice crystals and small hailstones which are growing by sweeping up supercooled droplets, and which have a surface temperature a degree or two higher than the crystals owing to the release of the latent heat of fusion. This promising theory is now being developed quantitatively; but it is likely to have competition, for a new paper is expected from C. T. R. Wilson, and a proposal by Vonnegut that the large cumulus is for macrophysical reasons an influence machine is attracting attention.

The conference was notable for the very substantial participation of overseas physicists and meteorologists, and for the enormous range of the topics raised. The expansion of cloud physics has been so great that it is now impossible to describe the progress of research other than cursorily in a two-day meeting, even if no reference is made to the possibilities of weather modification which have been such a strong spur to recent work. It was unfortunate that a smog reduced the attendance of the conference; but the audience each day exceeded one hundred and fifty, and its members must have been impressed with the present scope of the subject and the vigour with which its many problems are being attacked.

F. H. LUDLAM

BRITISH COUNCIL

TWENTY-FIRST ANNIVERSARY REPORT

THE twenty-first anniversary report of the British Council*, which includes a congratulatory message and a tribute to the services of the Council from the Prime Minister, covers the year 1954–55 and is unusually brief. Acceptance of the broad principles of the Drogheda Report was only announced by the Government in December 1954, but the effect of the new policy, which included the devotion of £100,000 to the expansion of the Overseas Information Service (including the Council) in 1954–55 and again in 1955–56, has already been felt. For the first time in seven years the Council's grant-in-aid was not reduced, and negotiations were commenced with the Treasury for the establishment of an amalgamated Council service, for the improvement of conditions of service, and for the introduction of a satisfactory pensions scheme. The Council's work and establishment in several Western European countries were reduced, and the small cultural establishment in Germany was disbanded; university teachers were supplied to the Universities of Berlin (Technical University), Göttingen, Hamburg and Mainz. Additional allocations were made for the cultural activities of the

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* Report on the Work of the British Council, 1934–1955. Pp. vi + 121 + 6 plates. (Twenty-First Anniversary Report.) (London: British Council, 1955.) 2s. 6d.

Brussels Treaty Organization (Western European Union and the Council of Europe). The Council's representation in New Zealand was withdrawn, and its establishments in Australia and Ceylon were closed; but work in Persia was resumed.

The number of students who were met on their first arrival from overseas reached the record total of 4,164, 3,771 being Colonial students, while new and better premises for this work among students were acquired in Aberdeen, Belfast, Edinburgh and Oxford. Two awards were made to university professors for short visits to the United Kingdom, and seven for visits to other Commonwealth countries, while forty-two travel grants were made to university teachers or postgraduate workers for study visits to the United Kingdom, ten for study visits from the United Kingdom and two for study visits between overseas countries. There were also forty-nine short visits to the United Kingdom universities and forty-nine visits to foreign universities. Some twenty-nine lecture tours and advisory visits overseas were arranged in science, medicine, agriculture and engineering, and twenty-one in education, sociology, philosophy and law; besides tours and exhibitions, the Council supplied about 82,000 books to Council and Council-associated libraries and secured 6,921 reviews of British books in overseas periodicals. Of the lecture tours arranged, 33 per cent were in medicine and science, and 25 per cent in education, while of the 1,488 film prints distributed in fifty-five countries, 216 were medical and 220 scientific and technical.

Most of the report is occupied by a historical review by Sir Harold Nicholson of the inception of the Council and the development of its work from 1934 to 1955, including a critical appreciation of that work. This is followed by an appreciation of its present activities by the new director-general, Sir Paul Sinker, and there is also an appreciation of Sir Ronald Adam's work by Sir Philip Morris. Since the end of the Second World War the Council has arranged programmes for 35,726 overseas visitors, mainly professional people or technicians, including many who have come under United Nations or Colombo Plan programmes; but the proportion of such visits financed wholly or in part by the Council has fallen from 66 per cent in 1945–46 to 16 per cent in 1954–55.

LONG ASHTON RESEARCH STATION

REPORT FOR 1954

A CONSIDERABLE number of papers on various aspects of disease control is to be found in the report for 1954 of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, which has recently been published*. Such a concentration in no way disturbs the general efficacy and breadth of the report, as it relates to other aspects of fruit culture and fruit products. It serves, rather, to integrate the results of several workers, thus giving a special, as well as a general, significance to an annual report of progress.

On the question of materials for disease control, G. V. Coles, J. T. Martin and R. J. W. Byrde have investigated the fungicidal properties of coal-tar distillates against *Ceratostomella fimbriata*, causing mouldy rot of newly tapped bark of the rubber tree. The predominating effect of the phenol fraction in determining fungicidal efficiency was confirmed by chemical analysis and bioassay. R. J. W. Byrde and A. T. K. Corke found that sporulation of *Nectria galligena* on apple cankers was reduced for about eighteen months, following treatment with 0·3 per cent phenyl mercury chloride. Burgundy mixture has been used for a long period of years, but E. Somers has demonstrated that the mixture 10 lb. copper sulphate, 14 lb. sodium carbonate, 100 gall. water, gives the best tenacity on potato foliage, when applied against blight. Post-dormant sprays of DDT and BHC kill some predators of the red spider mite; H. G. H. Kearns, N. G. Morgan and A. H. Wilkins have found that eggs of the mite can be controlled effectively by spraying with 0·05 or 0·02 per cent chlorbenside (*p*-chlorbenzyl *p*-chlorphenyl sulphide). Applications were made at the pink-bud stage of Worcester Pearmain apples, and were not effective at earlier stages.

Specifications for two light-weight small-power sprayers are given by H. G. H. Kearns and N. G. Morgan. They use 34-c.c. and 70-c.c. petrol engines, and deliver 8 and 19 pints/min., respectively, both at 75 lb./sq. in. There is considerable interest in the relative efficacy and operational economy of small-volume air-flow spraying. Messrs. Kearns and Morgan have also found the method effective against potato blight, but the same authors, with R. W. Marsh, record that apple scab control using lime sulphur or captan required more air-flow applications to be as effective as large-volume spraying. Small-volume sprayings accentuate the need for studies on spray-droplet size and distribution. C. G. L. Furmidge has two papers on this question; one of them describes field methods in which droplets are estimated as impressions in magnesium oxide, or as stains on glass, plaster of paris or various paper surfaces. Methods for the assay of captan deposits are described by J. T. Martin and J. A. Pickard, while the distribution of copper and DDT deposits are discussed in relation to the method of application by N. G. Morgan and J. T. Martin. Finally, R. W. Marsh considers results on apple scab control over eleven years with a view to the formulation of a modern spray policy for the fruit grower. Results from 1954 are marshalled to the same end by R. J. W. Byrde, G. M. Clarke and C. W. Harper. The general conclusion from both these papers appears to be that captan and phenyl mercury chloride, among the newer fungicides, are most likely to find places in the normal spray schedule for apple varieties which are 'russeted' by lime sulphur.

The mycological side of plant pathology is represented by a paper by A. T. K. Corke, who finds that inoculations with mycelium of the bitter rot fungus *Gloeosporium perennans* on apple branches produced cankers at all times of the year. Inoculations with spore suspensions, however, were generally successful only in November and December. From the section of pomology, R. R. Williams, continuing an earlier study, has described a further eleven varieties of perry pears from Herefordshire and Gloucestershire. The same author has a final report on yields and orchard behaviour of thirty-two varieties of cider apples grown as bush trees during 1950–53, and pollen requirements of these particular apples have been studied. A. I. Campbell has found that Brompton and Common Mussel plum stocks are suitable for the four new plum varieties Teme Cross, Severn Cross, Frome Cross and Thames Cross, all raised at Long Ashton. A report by D. L. Abbott shows that 2 : 4 : 5-TP at 40 p.p.m. was effective as a fruit-ripening agent on Worcester Pearmain apple when sprayed on the leaves rather than on the fruit. Barbara A. Rake has studied the influence of basal wounding and size of shoot on the rooting of hardwood cuttings of the gooseberry.

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* University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1954. Pp. 207+13 plates. (Long Ashton: The Station, 1955.) 15s.

Two crop failures on acid soils are described in the section on plant nutrition. One (by C. Bould and E. G. Bradfield) was of apples, in soil of pH 3·9–4·2, and the other (by W. Plant, of the Agricultural Research Council Unit of Plant Nutrition) was of carrots at pH 4·5.

The vintage quality of cider produced from bush trees has been evaluated by L. F. Burroughs. Many samples were of excellent quality, but the locality at which the fruit was grown influenced the composition of the juice and the vintage quality. F. W. Beech describes two methods of producing bottled cider free from deposit, either by sterile filtration before bottling or pasteurization after bottling. Alice Crang and Margaret Sturdy present continuing progress reports on the preservation of vegetable varieties by canning and freezing, and on fruit varieties by bottling and freezing.

The annual report is produced to the usual high standards of printing and illustration, and as a final instance of its comprehensiveness, there is a paper on statistics by G. M. Clarke and A. T. K. Corke. This considers sources of variability in sampling black currants for leaf-spot. It leads to the conclusion that a redeployment of available labour would have brought greater precision if more bushes had been sampled with fewer shoots per bush. This is a good example of the team work and integration which are evident from all the work of the Station.

JOHN GRAINGER

RELATIONSHIP BETWEEN LENGTH OF DAY AND GEOTROPIC RESPONSE IN SEEDLINGS

By E. DOROTHY BRAIN

SENSITIVITY and response to gravity in fern fronds[1] and various species of seedling[2] have been shown to be influenced by the stage in development rather than the size or growth-rate of the plant organ. Sensitivity to light has also been found to vary with the age and stage of development of the seedling of *Avena* at the time of illumination[3]. It is therefore significant that seasonal variation in response to gravity which has been recorded for *Lupinus polyphyllus* seedlings[4,5] can be correlated both with the rate of development of the seedling and the distribution of statolith starch in the developing plant. Experiments have shown that both response to gravity and efficiency of the statolith apparatus decreased in the winter months in plants grown entirely in the dark and under normal conditions. If the plants were given longer daily periods of light in the winter by illumination with a 25-watt 'Mazda' electric bulb, their rate of development was increased and they became more reactive in response to gravity in the later stage of the seedlings' development, when response in control plants was falling off. The pattern of their geotropic response became similar to that for the summer when activity is at its optimum. In summer, when the day was lengthened by giving 2 or 2·5 hr. extra light artificially, the response to gravity was raised above that of the controls, and with 4 hr. extra light the increased response was more marked. Comparisons were based on the percentage of plants in a series which responded to a stimulus (that is, period of horizontality) of 20 min., which was known to be the presentation time for the *Lupinus polyphyllus* seedling.

An examination of the distribution of statolith tissue, at different times of year, in seedlings grown in the dark and in the light, has shown a similar variation. There was found to be an optimum condition of the statolith apparatus in seedlings for the summer which corresponded with the optimum for geotropic activity in the later stage of development when the cotyledons were opening and the epicotyl beginning to develop.

An examination of the statolith distribution at this stage has also been made in seedlings which were given extra light in the winter and summer months. The methods used were the same as those described in a recent publication, and the seedlings were classified into the following groups according to: (*a*) The extent of statolith tissue in the hypocotyl: (1) from the cotyledonary node to the collet; (2) from the cotyledonary node half-way down to the collet; (3) at the apex or in the cotyledonary petioles; (4) having no statoliths. (*b*) The number of statoliths seen in transverse section at the upper part of the

Table 1. PERCENTAGE OF PLANTS

		No. of plants	Extent of statolith tissue (1)	(2)	(3)	(4)	Number of statoliths (1)	(2)	Size of statoliths (1)	(2)
Nov.	Control	17	23 52	52·94	23 52	0·0	70 58	29 41	47·04	52 94
,,	6·5 hr. extra light	6	83 33	16 66	0·0	0·0	50 0	50·0	50·0	50 0
Jan.	Control	15	13·33	13 33	66·66	6 66	60·0	33·33	46·66	46·66
,,	6·5 hr. extra light	15	26 66	26 66	40·0	6·66	46·66	46 66	20·0	73·3
June	Control	3	100·0	0 0	0 0	0 0	100·0	0·0	100·0	0·0
,,	2·5 hr. extra light	4	100·0	0 0	0·0	0 0	100·0	0 0	75·0	0·0
,,	4·0 hr extra light	4	100·0	0 0	0 0	0·0	100·0	0·0	75·0	0 0

hypocotyl: (1) more than four; (2) less than four. (c) The size of the individual statoliths in statocytes at the upper part of the hypocotyl: (1) diameter 4·9μ; (2) diameter 2·5μ or less. The numbers found in each group were compared as percentages of the series and the results are shown in Table 1.

It will be seen that plants given extra light in the winter had a higher percentage with the maximum amount of statolith tissue than controls. In June no effect of extra light was shown on the extent of statolith tissue; but in January and June there was a tendency for the statoliths to be smaller in plants which had received extra light. A quantitative examination of the statolith apparatus* in some fifteen species of seedlings made by Hawker[2] demonstrated a very close correlation between the volume of statolith tissue and the degree of sensitivity to gravity. Seasonal variation in geotropism in *Lupinus polyphyllus* gives another example of this. In winter, when development is slow, geotropic response and the amount of statolith tissue declines before the epicotyl develops. By increasing the period of light received daily the epicotyl development is hastened and geotropic response and statolith efficiency are also increased. In summer, when normally development and geotropic response are at their maximum, extra light raises the response to gravity in the later stage of development.

It therefore seems evident that it is the effect of light on the rate of development of the seedling which is the factor responsible for the changes in geotropic response which have been observed.

[Nov. 18

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SPONTANEOUS CHROMOSOME BREAKAGE IN ENDOSPERM

By Dr. A. RUTISHAUSER
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Recent studies have shown that endosperm nuclei may show a higher incidence of spontaneous chromosome breakage than those in any other plant tissue. A possible exception is the nuclei in the tapetum, where conditions are not particularly favourable for study. Its incidence in endosperm nuclei seems to be related to special genetic and hybrid conditions. For example, mass chromosome breakage was found in endosperms of a lily hybrid, and similarly a high degree of breakage was observed in endosperms obtained from self- and cross-pollinations of *Ranunculus auricomus*[1].

It was concluded by Brock[2], from a study of endosperms obtained from crosses between hyacinth varieties, that chromosome balance had a marked effect on breakage conditions. He found breakage was slight in endosperms from diploid–diploid crosses, but became progressively greater in endosperms from diploid–trisomic and diploid–triploid crosses.

The present investigation is largely concerned with an attempt to evaluate the effect of hybridity involving nuclear and cytoplasmic interaction on chromosome behaviour in endosperm tissue. To obtain this we have used endosperms from intergeneric fertilizations using *Paris quadrifolia* $2n = 20$, *Trillium cernuum* and *T. grandiflorum*, both $2n = 10$. This material is particularly favourable since in the hybrid endosperms we can readily distinguish at least four of the five *Trillium* chromosome types from the chromosomes of *Paris* by a difference in heterochromatin content (Fig. 1). With cold treatment only the *Trillium* chromosomes show weakly-staining and therefore readily distinguishable blocks of heterochromatin (Fig. 2)[3]. In *T. grandiflorum* it is sometimes the *A*- and in *T. cernuum* the *C*-chromosome which shows no such distinguishing feature.

To reveal the heterochromatic segments, plants with developing seed pods received a four to five day treatment at just above 0° C. prior to fixation and preparation of the endosperm for chromosome studies[4]. Because of slow development, cold treatment was not given until twenty to forty days after pollinations were made.

Spontaneous chromosome breakage was found in endosperms from all three kinds of crosses made. It was high in endosperms of *Paris* ovules fertilized with *Trillium* pollen, and low in the reciprocal cross *T. grandiflorum* × *Paris*. Ovule development was poor

Table 1. Frequency and Distribution of Spontaneous Chromosome Breakage in *Trillium* Chromosomes* from Hybrid Endosperms of *Trillium* × *Paris* and *Paris* × *Trillium*

Cross	*A*			*B*			*C*			*D*			*E*			Total		
	Normal	Broken	%broken	Normal	Broken	%broken	Normal	Broken	%broken	Normal	Broken	%broken	Normal	Broken	%broken	Normal	Broken	%broken
T. grandiflorum × *Paris*	36	—	—	41	—	—	38	—	—	37	1	2·6	38	1	2·6	190	2	1·0
Paris × *T. grandiflorum*	87	14	13·9	112	15	11·8	101	7	6·5	107	6	5·3	47	93	66·4	454	135	22·9
Paris × *T. cernuum*†	47	41	46·6	67	20	23·0				83	4	4·6	48	40	45·4	245	105	30·0

* The unequal frequency of chromosome types is mainly due to chromosome loss.
† The *C*-chromosome is not readily distinguishable.

in this latter cross, but sufficient endosperms were examined to show that the difference in breakage, which is of an order of about 20 : 1, is a valid one (Table 1).

It can be noted that the low frequency of breakage in *Trillium–Paris* crosses is not significantly higher than that in endosperms obtained from *Trillium–Trillium* crosses (unpublished data from examination of more than two thousand nuclei in fifty crosses).

A particularly interesting feature was that breakage is confined to *Trillium* chromosomes. We must emphasize that none of the broken chromosomes could have been transmitted through the pollen, because many of the hybrid endosperm nuclei contained normal unchanged *Trillium* chromosome sets.

Breakage occurs both in eu- and hetero-chromatic segments. Unfortunately, an exact analysis of initial breakage is not possible, since secondary changes arising from breakage of bridges at anaphase are superimposed on initial breakage, which we believe occurs spasmodically throughout endosperm development in this material. Breakage of chromosomes is followed by reunion to give dicentrics, rings, translocation and sister reunion, all of which occur in our material. Our analysis at metaphase is based on these changes, together with changes disclosed by visible loss or gain of segments. This is made possible by the pattern of eu- and hetero-chromatic segments.

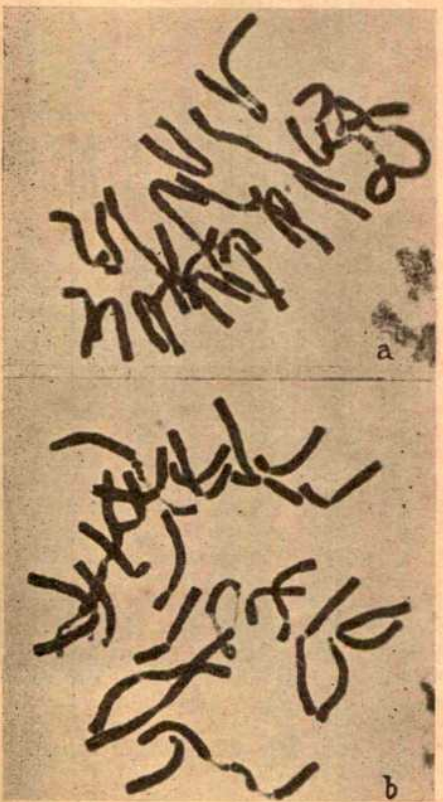

Fig. 1. Microphotographs of metaphases from endosperms of the cross *Paris quadrifolia* × *Trillium cernuum* showing 25 chromosomes. The five *Trillium* chromosomes show heterochromatic segments revealed by cold treatment. In (*a*) a *Trillium* *A*-chromosome shows loss of part of an arm; in (*b*) again loss in an *A*-chromosome together with a dicentric chromosome. × 1,200 *Note.* The embryo-sac development in these species is of the '*Allium* type' and the endosperm nuclei are therefore triploid in constitution. Endosperms from *Paris* × *Trillium* contain 20 *Paris* chromosomes and 5 *Trillium* chromosomes and in the reciprocal cross 10 from each parent

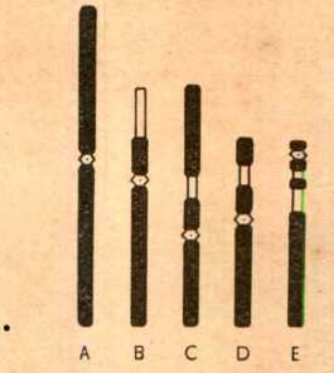

Fig. 2. Diagrammatic illustration of the five chromosome types in *Trillium grandiflorum* showing relative lengths of eu- and hetero-chromatic segments. Heterochromatin in outline, euchromatin in black and centromeres in outline with a dot

Some interesting features emerge when we study the distribution of breakage between chromosomes and in individual chromosomes. First there is an extremely unequal distribution of breakage between chromosomes. In the crosses between *Paris* and *T. grandiflorum*, most of it occurs in the *E*-chromosomes, and clearly this is not related to chromosome length or heterochromatin content (Fig. 2). Secondly, within the *E*-chromosomes of this cross, we find distribution of breakage is non-random.

If we divide the *E*-chromosome into seven parts, namely, short arm, centromere and eu- and hetero-chromatic segments, we find breakage in the long arm is relatively greater in segments distal to the centromere, and somewhat disproportionate in eu- and hetero-chromatic segments according to length (Fig. 3). Although it is perhaps unwise to speculate unduly on the significance of these observations, nevertheless it is tempting to invoke centromere interference as favouring the distal distribution.

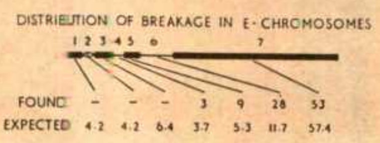
DISTRIBUTION OF BREAKAGE IN E-CHROMOSOMES
1 2 3 4 5 6 7
FOUND – – – 3 9 28 53
EXPECTED 4·2 4·2 6·4 3·7 5·3 11·7 57·4

Fig. 3. Expected values based on a random distribution

It is clear, at least from the *Paris–Trillium* cross, that hybridization can influence the rate of spontaneous chromosome breakage in endosperm nuclei. It might be thought that the difference in response of *Paris* and *Trillium* chromosomes to change of cytoplasm is against the view that the *Paris* cytoplasm plays a predominant part in influencing breakage in *Trillium* chromosomes. Alternatively, we might suppose that the interaction of two genetic systems leads to special conditions favouring the induction of chromosome breakage by changes in cell metabolism. At the moment, because of insufficient evidence, we can make no decision as to which of these views we most favour.

One of us (A. R.) is the recipient of a grant from the Swiss National Fund. [Sept. 23

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Dimorphism of Polyglycine

THE two crystallographic forms of polyglycine observed by Meyer and Go[1] have recently been re-investigated by other workers[2-4]. This problem has also been studied in these laboratories.

Polyglycine prepared by the polymerization of diketopiperazine in water at 60°–180° C., or by direct polymerization of glycine at 140° C.[5], shows strong X-ray reflexions at 3·45 A. and 4·4 A.; this is polyglycine I [3]. It is similar to the material obtained by the polymerization of anhydrocarboxyglycine in hot pyridine[1] or in ethyl acetate[2], and its structure, proposed by Astbury[2], resembles that found in the polyamides[6].

If polyglycine I, prepared as in ref. 5, is dissolved in saturated calcium chloride solution and precipitated at 20° C. by the addition of water, the product shows reflexions at 4·15 A. (vs) and 3·1 A. (m); this is polyglycine II [3]. A structure for this material has recently been proposed by Crick and Rich[4], in which the polymer chains are packed hexagonally.

Our preparations of polyglycine II, when examined under the electron microscope, showed crystals almost hexagonal in shape. Slow precipitation of the last, most soluble, portion of our preparation gave hexagonal crystals as in Fig. 1; with lithium bromide[1] the regularity of the crystals was less perfect. The crystals show growth steps, similar to those observed by Dawson and Vand[7] for homogeneous substances, though the formation is less perfect.

The number-average degree of polymerization of our preparation, in bulk, was 12·2, although that of the fraction which gave Fig. 1 may be lower. The expected height of successive steps would be about 40 A. for a degree of polymerization of 12·2; this is somewhat higher than the value estimated from the apparent length of shadows in the electron micrographs. This discrepancy is caused by the necessarily low accuracy of the latter method, and uncertainty as to the actual degree of polymerization of this particular fraction of polymer.

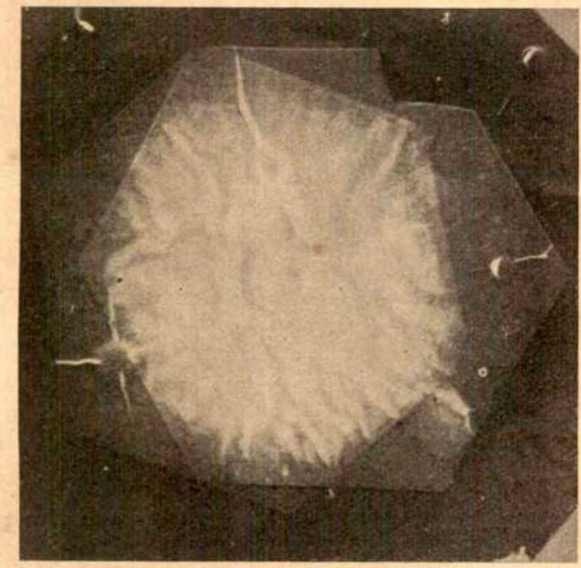

Fig. 1. Polyglycine type II (ref. 3); two overlapping hexagonal crystals. × 6,000

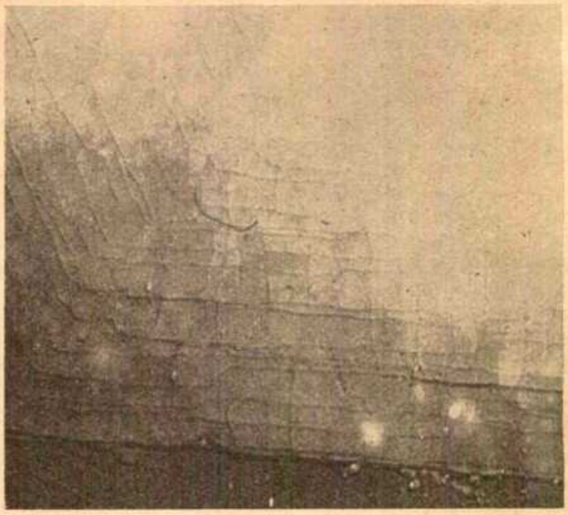

Fig. 2. Same as Fig. 1; details of terrace structure and lattice dislocations. × 30,000

The formation of growth steps in the case of homogeneous materials is due to the occurrence of dislocations in the crystal lattice. The occurrence of dislocations is not surprising in our material, since it is not homogeneous with respect to degree of polymerization. We have, so far, not been able to obtain crystals thin enough to demonstrate, with a sufficient degree of contrast in the photographic reproductions, the details of the dislocations in the centre of the crystals, although the examination of some of our original electron micrographs confirms the appearance of such effects. However, close examination of the fine detail near the edges of crystals in most of our electron micrographs, even at moderate magnifications, shows this effect very clearly (Fig. 2).

Fig. 1 shows two superimposed and relatively thin crystals obtained from the same fraction. The unfractionated polymer, degree of polymerization 12·2, gives crystals which are smaller and more opaque to electrons, that is, thicker. The material in Fig. 1 is probably lower in degree of polymerization and more homogeneous; it seems that this increases the rate of condensation on the edges and reduces it on the face of the crystal.

The transition polyglycine I ⇌ polyglycine II seems to be dependent on temperature. When a solution of polyglycine I in calcium chloride is precipitated at 100° C., polyglycine I is recovered; electron micrographs obtained during preliminary work show flat parallelograms (axial ratio 0·9, acute angle about 70°). At temperatures between 100° C. and 60° C. the product shows an X-ray diffraction pattern intermediate between I and II, with a rather marked change at 60°, below which type II polymer is obtained. On the other hand, if type II polymer is dissolved in calcium chloride solution and precipitated at 100° C., type II polymer is recovered. It seems that there is a tendency for the polymer to be precipitated in the form in which it went into solution, presumably due to the persistence of crystal nuclei. If type II polymer is heated to 140° C. in water, it is partially converted into type I. We believe that polyglycine has a transition temperature in the region of 60° C. The type II polymer obtained at 100° C. was probably a metastable preparation.

The importance of the thermal equilibrium in the mechanism of the formation of dislocations has been stressed by Frank[8], and we believe that further work on such effects may prove to be of great value in the studies of protein denaturation.

The density of polyglycine was determined with a specific gravity bottle at 22·5° C. and 65 per cent relative humidity, using toluene as displaced liquid.

Polyglycine (type)	I	II	I
Degree of polymerization (number average)	8·4	10·6	12·2
Density (gm./c.c.)	1·469	1·475	1·486

Thus there is an increase in the density with increasing value of the degree of polymerization. The structure of polyglycine I requires a density of 1·56 gm./c.c.[2], and the structure proposed by Crick and Rich[4] for polyglycine II 1·54 gm./c.c.

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Dec. 2.

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Temperature Effects in the Paper Partition Chromatography of Sugars

The maintenance of a constant and uniform temperature within the apparatus is universally recognized as an essential for the production of satisfactory paper partition chromatograms. The effect of the temperature at which the chromatograms are made has, however, been comparatively little studied.

Consden, Gordon and Martin[1] reported variations in the R_F values of amino-acids chromatographed over the temperature-range 7–25° C. Hough, Jones and Wadman[2], who chromatographed sugars at 20° C. and 37° C., reported that at the higher temperature there was faster movement, improved definition of the spots and higher R_F values. Counsell, Hough and Wadman[3] also showed that in the chromatography of sugars the R_F values were influenced by the temperature of working, and that somewhat larger quantities of material could be handled at higher temperatures. They also stressed the importance of maintaining the whole apparatus at a constant temperature and of ensuring adequate equilibration within the apparatus before starting the chromatogram. These conditions may be difficult to fulfil using a large conventional tank, and we have described elsewhere[4] a small all-metal apparatus designed to facilitate working at temperatures other than that of the laboratory. Using this apparatus we have been able to compare the R_F values of a number of sugars throughout the temperature range 0–50° C.

This series of experiments showed that R_F values of sugars vary considerably with temperature and it became apparent that, as in the case of the amino-acids reported by Consden, Gordon and Martin, the factor exerting the greatest influence was the water-content of the solvent. In the case of solvents having an increased water content at higher temperatures the R_F values increased over the range 0–50° C. The opposite effect was shown by solvents having a negative temperature coefficient with respect to water content, that is, the R_F values decreased over the range 0–50° C. Since they are so greatly influenced by the temperature of working, it follows that when R_F values are quoted the temperature at which the separations were made should be specified.

Isherwood and Jermyn[5] have related the R_F values of any individual sugar in a series of different solvents to the molar fraction of water present in each solvent. They obtained a straight line on plotting log $(1/R_F - 1)$ against $-\log N$ (where N is the molar fraction of water in the moving phase). Apart from R_F, N is the only variable in this equation, which should, therefore, be applicable to the changes in R_F produced by using the same solvent at different temperatures, if these variations are dependent on the water content of the solvent. Plotting log $(1/R_F - 1)$ against $-\log N$ for our data, using values for N calculated from data given in the International Critical Tables, a straight line is obtained. Some examples are shown in Fig. 1. Thus we have been able to confirm the Isherwood and Jermyn relationship and to show that the effects of temperature on the R_F values are the result of the variations in the solubility of water in the moving phase.

Changes in temperature also influence the speed of development of the chromatogram since the

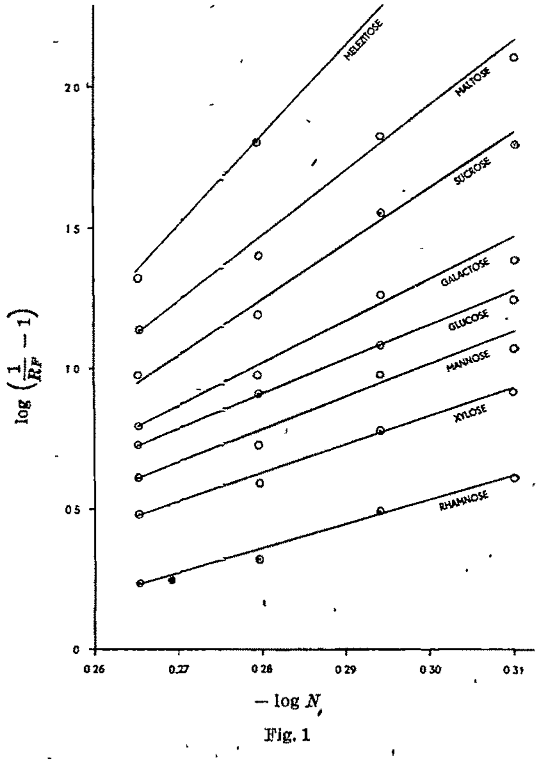

Fig. 1

Table 1

MELEZITOSE R_F × 100

Solvent	0°	20°	37°	50°
n-Butyl alcohol	0·3	0 5	1·5	4·4
iso-Butyl alcohol	0·4	—	1 2	—
n-Amyl alcohol	—	—	—	0 3
Phenol	23·5	23·8	34·6	39 3
s-Collidine	—	20 2	9·8	5·1

GLUCOSE. R_F × 100

Solvent	0°	20°	37°	50°
n-Butyl alcohol	4·7	7 5	12·3	15 8
iso-Butyl alcohol	3 8	—	9·5	—
n-Amyl alcohol	—	—	2·9	3 9
Phenol	30·3	32·7	41·0	45 3
s-Collidine	—	38 6	27·7	22 6

RHAMNOSE. R_F × 100

Solvent	0°	20°	37°	50°
n-Butyl alcohol	19 1	24·4	31 9	36·9
iso-Butyl alcohol	19 6	—	27 0	—
n-Amyl alcohol	—	—	13 2	17·4
Phenol	54·1	53·9	61·5	62 4
s-Collidine	67·7	64·9	56 4	53·8

physical characteristics—density, viscosity and surface tension—of the solvent are affected and hence the 'diffusion coefficient' of the paper. Müller and Clegg[6] have investigated the rate of the movement of the solvent along the paper. They conclude that the distance moved by the solvent front is in accordance with the equation

$$h^2 = Dt - b$$

where h is distance moved by the solvent front, D is diffusion coefficient, t is time, b is a constant. The diffusion coefficient can be expressed in terms of the physical constants of the solvent by using the relationship

$$D = a\gamma/\eta d + b$$

where γ is surface tension, η is viscosity, d is density and a and b are constants for the paper.

Thus temperature effects on the diffusion coefficient and hence on the distance moved by the solvent front in a given time can be predicted from a knowledge of the temperature coefficient of the ratio $\gamma/\eta d$. The physical data available are unfortunately insufficient to allow of a quantitative treatment.

All separations were carried out on strips of Whatman No. 1 filter paper six inches wide and cut across the machine direction of the paper. Five standard solutions each containing three different sugars were prepared, and aliquot portions were applied to the paper in the usual way. Thus, fifteen sugars could be compared on one paper. After application of the spots the apparatus was set aside for a minimum of four hours to allow the paper, the atmosphere and the solvents to reach a state of equilibrium. In order to reduce the number of variables to a minimum, only two-component solvent systems were investigated. In every case the phases were allowed to equilibrate at the temperature at which the chromatogram was to be made before the organic phase was introduced into the apparatus. Table 1 gives the results at four different temperatures for three typical sugars—melezitose, glucose and rhamnose—with a number of different solvents. Fig. 2 illustrates the relation between R_F values and temperatures for a series of sugars chromatographed with water-saturated butanol. Since solvents having a decreased water content at higher temperatures are much the rarer kind, R_F values for this type can be given only for *s*-collidine. Experiments with triethylamine, however, have shown the same general tendency, although the extreme volatility of this solvent makes it impossible to give accurate results.

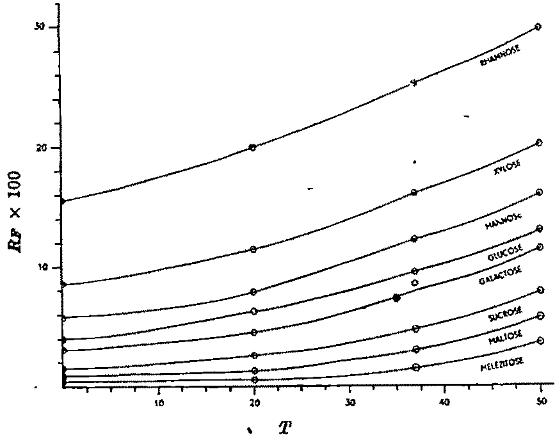

Fig. 2

MARGARET ALCOCK
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Thomas Kerfoot and Co., Ltd.,
Vale of Bardsley,
Ashton-under-Lyne,
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Sept. 30.

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Bacterial Degradation of Nicotinic Acid

A BACTERIUM utilizing nicotinic acid was isolated from culture media made up of a solution of nicotinic acid and dilute sodium sulphide and inoculated with a small amount of Potomac mud. After allowing the bacteria to grow anaerobically, several successive transfers were made into a medium containing nicotinic acid, peptone, yeast extract, metals, phosphate and sodium sulphide. The mixed bacterial suspension was then serially diluted in agar media of the same composition under anaerobic conditions. This serial dilution was repeated until the bacterium utilizing nicotinic acid was isolated in pure culture. By this enrichment culture technique, an anaerobic spore-forming rod was isolated which ferments nicotinic acid and which utilizes high concentrations of this compound for its growth. Maximum growth is achieved in the presence of 0·6 per cent yeast extract, 0·2 per cent peptone and 0·4 per cent nicotinic acid. No growth occurs with yeast extract and peptone alone. Neither will the bacterium grow on nicotinic acid as a sole source of carbon.

In growing cultures of this organism, it was observed that acetic and propionic acids were formed from nicotinic acid. These acids were determined by paper chromatography[1] and also separated on a silica-gel column[2]. They were present in equal amounts. Further studies with resting cell suspensions demonstrate that nicotinic acid was fermented to ammonia, carbon dioxide, acetic and propionic acids according to the following reaction:

$$4H_2O + C_5H_4N\text{—}COOH \rightarrow NH_3 + CO_2 + CH_3COOH + CH_3CH_2COOH$$

TABLE 1

Additions: 20 mgm. washed cell suspension, 200 µmoles phosphate buffer *p*H 6·0, nicotinic acid as indicated, water to 2 ml. final volume. Gas, nitrogen. Temperature, 26° C. Reaction started with the tipping of the bacteria and continued to cessation of gas production. Figures corrected for endogenous metabolism

Nicotinic acid added (µmoles)	0·94	1·89	3·76
Carbon dioxide produced (µmoles)	0·82	1·65	3·25

TABLE 2

Additions: 20 mgm. washed cell suspension, 50 µmoles potassium bicarbonate, nicotinic acid as indicated, water to 2 ml. final volume. Gas, 5 per cent carbon dioxide in nitrogen. Temperature, 26° C. Experiment started with the tipping of the bacteria and continued to cessation of gas production. Figures corrected for endogenous metabolism

Nicotinic acid added (µmoles)	0·94	1·89	3·76	5·65	7·5
Acid produced (µmoles carbon dioxide)	0·94	1·88	3·20	4·70	6·15

Table 1 demonstrates that resting cells will catalyse the formation of carbon dioxide from nicotinic acid. In Table 2 it can be seen that for each mole of nicotinic acid in the reaction mixture approximately one mole of acid was produced as measured by the release of carbon dioxide from bicarbonate buffer at *p*H 7·4. Since three acids and one base are produced from one acid by this reaction, only one acid equivalent can be measured by this technique.

In a typical large-scale experiment, 131 µmoles of nicotinic acid were incubated in bicarbonate buffer at *p*H 7·4 with a suspension of resting cells until acid production ceased. All the nicotinic acid, as determined by the cyanogen bromide method[3], had disappeared. As measured by release of carbon dioxide from the bicarbonate buffer, 109 µmoles of acid, corrected for endogenous acid production, were formed. 122 µmoles of ammonia was also formed.

The reaction mixture was then acidified and steam distilled, and 345 µmoles of steam-volatile acids collected. This was shown to be, by paper chromatography, a mixture of acetic and propionic acids. A comparable cell suspension incubated without nicotinic acid produced 128 µmoles of acetic acid and no propionic acid. Thus, correcting for this endogenous production of acetic acid, 217 µmoles of acetic and propionic acids was produced from nicotinic acid. Determination of the Duclaux numbers of this mixture demonstrated that, of the total acid produced from nicotinic acid, 110 µmoles was acetic acid and 107 µmoles was propionic.

The acid mixture was separated on a silica gel column into acetic and propionic acids. These were identified by their positions on silica-gel columns and paper chromatograms, and by Duclaux distillation. Acetic acid was also characterized as the sodium uranyl acetate[4].

I wish to thank Dr. E. R. Stadtman for helpful discussions during the course of this work.

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Preparation of Antiglobulin Sera

THE antiglobulin test of Coombs, Mourant and Race is already widely employed in routine practice, and many laboratories are producing for themselves antiglobulin sera. Rabbits were commonly immunized by unchanged human serum or its globulin fraction. The latter method, especially in the smaller laboratories, meets difficulties.

The technique employed by us is very simple. To 1 ml. of packed rabbit red cells are added 10 ml. of pooled human serum heated for 30 min. at 56° C. The tubes are then left in room temperature for 30 min., being shaken several times. The agglutinated cells are washed three times with saline, suspended in 3 ml. of saline and injected into the ear vein. For immunization two injections weekly were carried out for six weeks. For each injection freshly prepared agglutinate was used. The rabbits did not show any abnormal symptoms.

By this method four antiglobulin sera were obtained, and they have been used for the past six months in routine tests of our laboratory. All the antiglobulin sera have sufficiently high titres; human red cells sensitized by incomplete anti-*D* sera were agglutinated by two antiglobulin sera up to the dilution of 1 : 1,280; the titres of the remaining two sera were 1 : 5,120 and 1 : 20,480 respectively. The injections caused no increase in the titre of natural heteroagglutinin against human red cells, and the titre of this antibody remained low, that is, about 1 : 4. Our antiglobulin sera could be therefore employed (without previous absorption) at several dilutions, and errors caused by zonal phenomena could be eliminated.

Antiglobulin sera obtained by our technique contain antibodies against globulin denatured on the surface of red cells as a result of antigen–antibody reaction. In this connexion one would expect greater specificity of the tests performed with our sera than with sera obtained otherwise.

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Metabolism of Sorbitol

WE have recently investigated the metabolism in man of sorbitol uniformly labelled with carbon-14. The results show clearly that sorbitol is rapidly and relatively completely metabolized to carbon dioxide in the normal and in the diabetic subject. Table 1 shows that, after an oral dose of 35 gm. of sorbitol containing carbon-14 sorbitol (total activity 30 µc.), the expired carbon dioxide became highly radioactive within an hour and remained active for a further 8 hr. Only about 10 per cent of the activity appeared in urine and fæces. The exact percentage of recovery of radioactive carbon in the expired carbon dioxide cannot be calculated in these two cases without certain assumptions regarding the total

Table 1. Activity of Expired Carbon Dioxide after the Ingestion of 35 gm. of Sorbitol uniformly labelled with Carbon-14 (total activity 30 μc.)

Normal subject		Diabetic subject	
Time after ingestion of sorbitol (hr.)	Counts/min./gm. carbon dioxide	Time after ingestion of sorbitol (hr.)	Counts/min./gm. carbon dioxide
1	411	½	54
3	820	1	134
4	838	3	519
6	475	4½	750
8	260	5½	670
24	0	7½	456
		10½	260
		24	0

carbon dioxide production, which for experimental reasons could not be measured in these tests. Nevertheless, at least 70 per cent and probably 90 per cent of the activity administered can be acounted for in the expired carbon dioxide.

Our investigations so far throw no light on the pathway of metabolism of sorbitol, but show clearly that this polyhydric alcohol must provide calories. Its precise mechanism of metabolism in both the normal and diabetic subject requires further investigation.

We wish to thank Messrs. Howards of Ilford, Ltd., for financial support of this investigation.

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Antenatal Sex Determination

For thousands of years people have had a desire to know the sex of an expected child. Many methods have been tried for antenatal sex determination; but even modern ones, based upon scientific hypotheses, have failed to receive sufficient confirmation for general acceptance.

Since Barr *et al.*[1], in 1949 in *Nature*, described morphological sex differences of the nerve cell nuclei of cats, their observations have been repeated on several human and animal cell types. The observation that the cell nuclei of the amniotic membrane in cats[2] and of the oral epithelium of newborn infants[3,4] exhibit easily demonstrable sex differences led to an investigation whether human amniotic fluid contains enough well-preserved desquamated cells to make possible the determination of the fœtal sex.

Amniotic fluid was collected from pregnant women at term by rupture of the membranes for induction of labour. In a few cases the fluid was obtained in the middle of pregnancy from cases for surgical interruption, by puncture of the membranes through the uterine wall either vaginally or through a laparotomy. Care was taken to avoid admixture of maternal cells. The specimens were centrifuged and the vernix and supernatant fluid removed. The cells were smeared on microscopical slides coated with egg-albumin or human serum and fixed in Papanicolaou's fixative. The staining procedure was carried out with cresyl violet as described by Moore and Barr[4].

The smears were examined by one of us without knowledge of the fœtal sex even in those cases where delivery had taken place before the examination could be carried out. One of our first specimens was misinterpreted owing to lack of experience, but after that our results have been correct in all of twenty cases. Numerous well-preserved cells are found at term, and enough in the middle of pregnancy to allow a definite distinction between male and female cells by the absence or presence of the typical sex chromatin mass in the cell nuclei. Many of the cells have a close resemblance to those of oral smears and might conceivably be epithelial cells from the fœtal alimentary or genito-urinary tracts.

The crucial point of the method is the avoidance of admixture of maternal cells. If the puncture is made through the uterine wall, a needle with a stylet should be used; and if the amniotic fluid is collected by rupture of the membranes from below, a catheter should be inserted into the bag of water. The specimens should be fixed as soon after collection as possible to avoid autolysis.

Although transabdominal puncture of the uterus has been carried out often for therapeutic and experimental reasons without accidents, mere curiosity does not justify the procedure, and its practical value is probably limited in the human. If the results are confirmed in animals, however, it might become of great significance in veterinary practice.

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Effect of ββ-Methylethyl Glutarimide and Amytal on Rat-liver Mitochondrial Respiration

In 1954, Shaw *et al.*[1] showed that ββ-methylethyl glutarimide was capable of reducing the narcotic effect of barbiturates in animals and man, and suggested that in therapeutic dosage it exerts a direct antagonism to barbiturates.

It has been known for a long time that barbiturates depress the respiratory system of the cells, and preliminary experiments[2] seem to show that a certain correlation exists between the narcotic effect of barbiturates and their ability to depress the respiration in an isolated liver mitochondrial system. This prompted me to see if ββ-methylethyl glutarimide exerted an antagonistic effect on barbiturates in this system.

Mitochondria were prepared from rat-liver homogenates made in 0·25 *M* sucrose[3] containing 0·01 *M* ethylenediaminetetraacetic acid (versene)[4], and incubated in the presence of glutamate, orthophosphate, adenylic acid, glucose and yeast hexokinase. The amytal (5-ethyl-5-*iso*amylbarbituric acid) used was an ordinary commercial product. The ββ-methylethyl glutarimide was a sterile solution containing 50 mgm. in 10 ml. of normal saline ('Migimide' from Nicholas Products Laboratories, Ltd., Slough).

It appears from Table 1 that the oxygen consumption of the mitochondria decreased with increasing amytal concentrations. Addition of ββ-methylethyl glutarimide, 0·8 and 1·6 μmoles/ml., had no effect on the oxygen consumption, whereas ββ-methylethyl glutarimide in concentrations of 3·2

Table 1. Effect of $\beta\beta$-Methylethyl Glutarimide and Amytal on Respiration of Rat-liver Mitochondria

Additions	Respiration (μ atoms oxygen)					
	Experiment 1			Experiment 2		
Amytal	Without $\beta\beta$-methylethyl glutarimide	With $\beta\beta$-methylethyl glutarimide 0·8 m*M*	With $\beta\beta$-methylethyl glutarimide 1·6 m*M*	Without $\beta\beta$-methylethyl glutarimide	With $\beta\beta$-methylethyl glutarimide 3·2 m*M*	With $\beta\beta$-methylethyl glutarimide 10 3 m*M*
0	23·0	—	24·7	17·3	15·7	7 1
0·45 m*M*	16·0	15·7	16·1	—	—	—
0·9 m*M*	7·7	8·0	7·7	14 4	10·7	4 9

Each Warburg vessel contained: mitochondria, 1/12-rat liver; glycylglycine, 200 μM; potassium chloride, 150 μM; glucose, 200 μM; *dl*-glutamate, 60 μM; orthophosphate, 100 μM; adenylic acid, 6 μM; magnesium ions, 6 μM; yeast hexokinase ('step-5' purity according to Berger *et al.* (ref. 5), preparation from 11 kgm. yeast dissolved in 30 ml. of 1 per cent glucose), 0 1 ml. Final volume 2·2 ml., *p*H 7·6. Temperature 30° C.: gas phase, air. Time of incubation, 30 min.

µmoles/ml. or more depressed the oxygen consumption. If ββ-methylethyl glutarimide was added to mitochondria, the oxygen consumption of which had beforehand been inhibited by amytal, low concentrations did not exert any effect, whereas higher concentrations which *per se* inhibit the oxygen consumption of the mitochondria intensified the depressing action of amytal.

Thus, the investigation did not disclose any antagonistic effect of ββ-methylethyl glutarimide on amytal in this system. On the contrary, in higher concentrations it intensified the depressing action of amytal on the mitochondrial respiration.

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Oct. 6.

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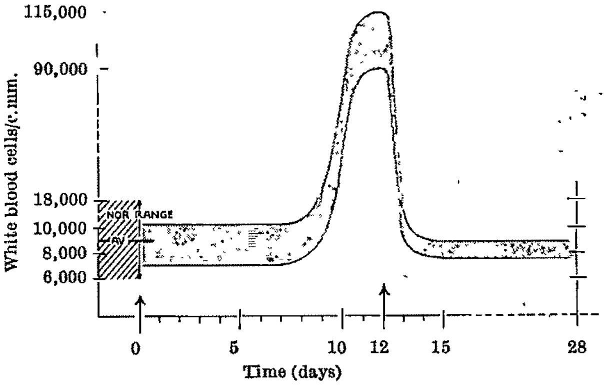
Remission of Rat Lymphocytic Leukæmia 8 following Intravenous Administration of 4-(*p*-Diethylaminostyryl)quinoline Dihydrochloride

Earlier studies[1] indicated that oral administration of certain styryl quinolines resulted in complete absorption of lymphoma 8 growing in inbred rats of the strain of its spontaneous origin. The neoplastic cells of this lymphoma appear in the bloodstream of the host animal as early as 18 hr. after subcutaneous implantation[2] and increase greatly, in some instances, to as many as 100,000 per c.mm. in the eighteen to twenty-one days before death of the rat. Intraperitoneal injection of 1 ml. of this lymphogenous blood into normal rats of the same strain produces a lymphocytic blood picture which bears a resemblance to certain types of clinical lymphocytic leukæmia. This lymphocytic leukæmia (rat lymphocytic leukæmia 8) is always fatal within twelve to twenty days. In view of their anti-lymphoma action, it seemed of interest to determine whether styryl quinolines, intravenously administered, would have any effect on this type of leukæmia in rats.

The two compounds, 4-(*p*-dimethylaminostyryl)-quinoline and 4-(*p*-diethylaminostyryl)quinoline, which possessed the greatest anti-lymphoma properties, are not soluble in water and only slightly soluble in propylene glycol. Among the compounds which we synthesized, two (the mono- and the di-hydrochloride of 4-(*p*-diethylaminostyryl)quinoline) were soluble in aqueous solution. The dihydrochloride, being the more soluble, was selected for this study.

The sixteen rats in our experimental series varied in weight from 150 to 200 gm. Each rat was injected intraperitoneally with 1 ml. of lymphogenous blood (from the heart) of a rat in which lymphoma 8 had been implanted subcutaneously fourteen to eighteen days previously. The number of white cells present in blood of normal rats is more variable than that of humans. Counts range from 6,000 to 18,000, with an average of 9,000 per c.mm.; the majority (60–70 per cent) of the white blood cells are lymphocytes rather than polymorphonuclear neutrophils. As shown in Fig. 1, the white cells in the blood increased slowly during the first five to seven days after transmission of the disease; the number then rose rapidly, reaching as high as 115,000 per c.mm. twelve days after the intraperitoneal injection. Stained preparations (Wright's stain) of the blood of untreated rats showed numerous large lymphoblast-like cells, some in mitotic division. On the twelfth day all the rats were extremely ill. On this day, twelve of the rats were each given a single intravenous injection of 4 mgm. of 4-(*p*-diethylaminostyryl)quinoline dihydrochloride dissolved in ¼ ml. of sterile distilled water. The remaining four rats were not treated. On the following day the four untreated and one treated rat were dead. On the second day after treatment, the surviving eleven rats had recovered their vigour, and the white blood cells had dropped to 8,500–10,000 per c.mm. (Fig. 1). On the third day after treatment, the white blood cells were 7,500–9,500 per c.mm. The rats gained weight and the white blood cells remained at this level during the following fourteen days (Fig. 1). In stained blood smears during this



Arrow at 0 days marks an intraperitoneal injection of 1 ml. of blood from rat lymphoma 8; arrow at 12 days marks an intravenous injection of 4 mgm. of 4-(*p*-dimethylaminostyryl)quinoline dihydrochloride

Fig. 1. Total white blood-cell counts in rat lymphocytic leukæmia 8 before and after intravenous administration of 4-(*p*-diethylaminostyryl)quinoline dihydrochloride. Normal range, hatched; average, stippled

period, only normal white cells could be found. The large lymphoblasts present in the blood before treatment seemed to have disappeared entirely.

These results seem to indicate that the intravenous administration of 4 mgm. of 4-(*p*-diethylaminostyryl)-quinoline dihydrochloride was followed by a remission of the leukæmic blood picture in rat lymphocytic leukæmia 8, but not by a depression of the total white count below the normal level in a fourteen-day observation period.

This investigation was supported in part by grants from the Pew Memorial Foundation and the Medical Research Foundation and in part by grant *C*-285(*C*7) from the National Cancer Institute, Department of Health, Education and Welfare.

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Responses of Domestic Animals to Infections of *Trypanosoma vivax*, *T. congolense* and *T. brucei*

In an extensive investigation, involving more than a hundred domestic animals in the Gold Coast (goats, sheep and horses), on the hæmatological and biochemical changes produced by trypanosomiasis infections, forty animals have died with noteworthy findings.

The types of response could be arranged in four categories: acute, sub-acute, chronic and cryptic. In most cases, the animals developed a severe anæmia which in the acute response proved rapidly fatal (about six weeks). An attempt at recovery of erythrocyte values was made in the sub-acute response, followed by a fall which terminated in death in about three months from inoculation. Chronic responses showed an initial fall in red cells with subsequent recovery, often to normal levels, which was maintained over a long period. Of the animals which have died in the chronic response group, there was often a terminal fall in red-cell count. In the cryptic infections in which no trypanosomes were demonstrable in the peripheral blood, there were characteristic changes in the red-cell count which resulted in anæmia similar to that observed in the other categories. The erythrocyte sedimentation-rate in the goats remained normal (0–1 mm.) throughout the entire period, while in the sheep and horses it gradually increased. The leucocytes fluctuated in total count and the differential percentages varied, but they have not, as yet, been correlated with other recorded data.

An improved method of estimating the degree of trypanosome infection in the peripheral blood has been devised. Wide variation occurred from day to day in the number of trypanosomes in the *T. vivax* and *T. congolense* infections, with long periods when none could be found in the peripheral blood. In the case of *T. brucei*, trypanosomes were only seen on one or two occasions even though the infection extended over several months. This is of interest in view of the low incidence of *T. brucei* hitherto recorded in game and domestic animals of the Gold Coast. No trypanosomes occurred in the peripheral blood in cryptic infections.

Blood sugar, bilirubin and specific gravity remained unchanged in most of the animals. In the final stages of the disease, the animals were often emaciated and showed a severe reduction in weight. Temperature readings revealed no significant variations.

Histopathological material was collected from all the dead animals, some of which showed interesting pathological changes in the lung tissue with extensive congestion of the alveoli.

A detailed account of this investigation will be published elsewhere, as well as a report of the histopathology.

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5-Hydroxytryptamine in Serum

The pharmacologically active substance 5-hydroxytryptamine is known to be liberated from platelets during clotting. The amount estimated in serum has, however, been found to depend on the way the serum is prepared, and the purpose of this communication is to direct attention to this phenomenon, which may cause discrepancies between the results of different workers.

Human blood was withdrawn from an arm vein into a glass syringe which had been treated with a liquid silicone (D.C. 550). The first 2 ml. of blood was taken in a separate syringe and discarded to avoid contamination with tissue thromboplastin.

The blood was allowed to clot at 37° C. in the following ways: (1) The blood was placed in a glass test-tube and allowed to stand without agitation for 30 min.; (2) the blood was placed in a glass test-tube containing a glass marble; the tube was stoppered and placed in a machine which tipped the tube through ± 20° from horizontal at a rate of 15 cycles per min., for 30 min.

In each case the clotted blood was centrifuged at 3,000 rev./min. for 30 min., by which time the serum was free of platelets. The serum was transferred to a small glass bottle and stored at − 17° C. until extracted.

Acetone extracts of the serum were assayed on the rat uterus, as recommended by Amin, Crawford and Gaddum[1]. An attempt to simplify this procedure by testing the serum directly on the uterus was unsuccessful owing to the presence in the serum of a substance causing a slow contraction of the uterus and not antagonized by lysergic acid diethylamide. The effects of the acetone extracts were invariably abolished by this drug, as were those of 5-hydroxytryptamine itself. Zucker and Borrelli[2] tested serum directly on the rat colon and do not seem to have met complications.

Table 1. 5-HYDROXYTRYPTAMINE EQUIVALENT OF SERUM (μGM./L.)

Stationary	160	154
Tipped	116	75

The results in Table 1 indicate that agitation during clotting results in a decreased amount of 5-hydroxytryptamine in the serum.

In another experiment a large amount of serum was prepared without agitation. Part of this serum was then tipped, part was allowed to stand, and part was tipped with added clot, all at 37° C. for 30 min. There was no significant difference between the 5-hydroxytryptamine equivalents of these three fractions, and none could be extracted from the clot. This result suggests that the clot does not adsorb 5-hydroxytryptamine and that mechanical disturbance after clotting even in the presence of the clot does not destroy it.

If serum is tipped during clotting, as recommended by Biggs and Douglas[3] for thromboplastin generation tests, its 5-hydroxytryptamine equivalent is likely to be lower than that of serum prepared without tipping.

Thanks are due to Dr. G. D. Forwell for assistance in preparation of serum samples.

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Phosphorylation as a Possible Factor in the Pasteur Effect in Plants

AFTER the discovery of the participation of phosphate in glycolysis, suggestions that the Pasteur effect might be explicable in terms of the different rates of aerobic and anaerobic phosphorylation were made by Lennerstrand[1], Turner[2] and especially by Johnson[3]. In modern terms, the conservation of carbon by oxygen, which has been defined as the Pasteur effect, could be due to oxidative phosphorylation lowering the concentration of inorganic phosphate, or the ratio of adenosine di- to adenosine tri-phosphate, to levels which would limit the rate of glycolysis. The development of methods for measuring the concentration of these substances enables investigation of this hypothesis. The work to date has been restricted to measurements in the developing pea seed, in which the concentration of the phosphate esters is relatively high, and for which satisfactory analytical methods have been developed.

A typical experiment utilized six comparable samples of pea seeds taken from two pods past commercial maturity, each sample comprising two seeds, one from each pod. The testas were removed from all seeds (because they were shown to restrict gaseous diffusion), and the peas were placed overnight in water-saturated air. The experimental procedure is outlined, together with a typical respiration-rate curve, in Fig. 1. For each analysis the vessel was removed from the manometer, quickly stoppered, taken to a cold room and the seeds extracted by grinding with a small glass pestle and mortar with 3 ml. 5 per cent perchloric acid. The extract was centrifuged, the supernatant solution neutralized with potassium hydroxide and held overnight at – 15° C. Next day the material was thawed and the precipitate (potassium perchlorate) removed by centrifugation. The concentrations of adenosine tri- and di-phosphate, hexose monophosphate (the sum of glucose 1-phosphate, glucose 6-phosphate and fructose 6-phosphate) and hexose diphosphate (fructose 1 : 6-diphosphate) in each extract were measured by the method of Slater[4], the concentration of inorganic phosphate by the method of Allen[5] or of Weil-Malherbe and Green[6]. The respiration of each sample of two peas was measured in oxygen at 25° by the manometric method of Dickens and Simer[7]. After the tipping of the acid and the measurement of the carbon dioxide output, the vessel was flushed with pure nitrogen gas, and the succeeding pressure differences recorded gave a measure of the rate of fermentation, as shown in Fig. 1. The mean R.Q. of the seed without testa was 0·87 ± 0·01 (13 observations); that of the seed with testa in oxygen, or without testa in air, was about 1·1, which suggests that some fermentation occurs under these conditions due to the high diffusion resistance of the seed coat and cotyledon. In Fig. 1 the respiration-rates are plotted as production of carbon dioxide.

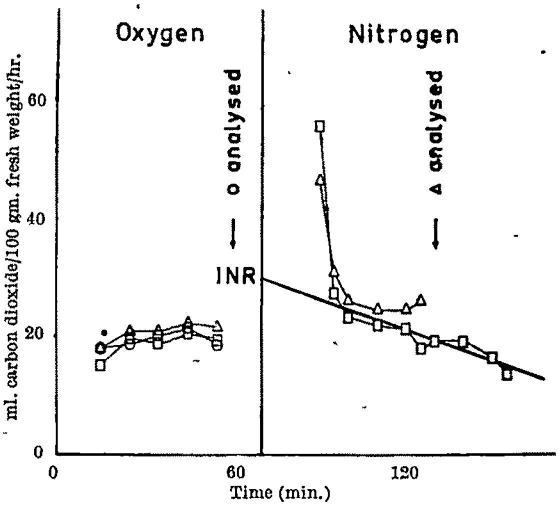

Fig. 1. Rate curves of respiration and fermentation of mature peas, showing the sampling periods for estimate of phosphate fractions. Dickens–Simer apparatus; 25° C. Each experiment utilized twelve seeds, each sample of two seeds. At the arrows, sample(s) were removed for the determination of phosphate fractions

It is difficult to know how to estimate the initial rate of fermentation. The very high initial values for production of carbon dioxide in nitrogen have been shown to be correlated with the initial low carbon dioxide partial pressure in the vessel, and may be due to rapid decarboxylation under these conditions. As the respiration measurements are made in the presence of baryta, it may be better to use these high figures. For the time being, however, we have extrapolated the rates measured in nitrogen to zero time in nitrogen, neglecting the initial high figures obtained within 30 min. after transfer to nitrogen (Fig. 1). These extrapolations will give minimum figures for initial rate of fermentation and, therefore, for the Pasteur effect. The value of the ratio of initial rate of fermentation to carbon dioxide production varied

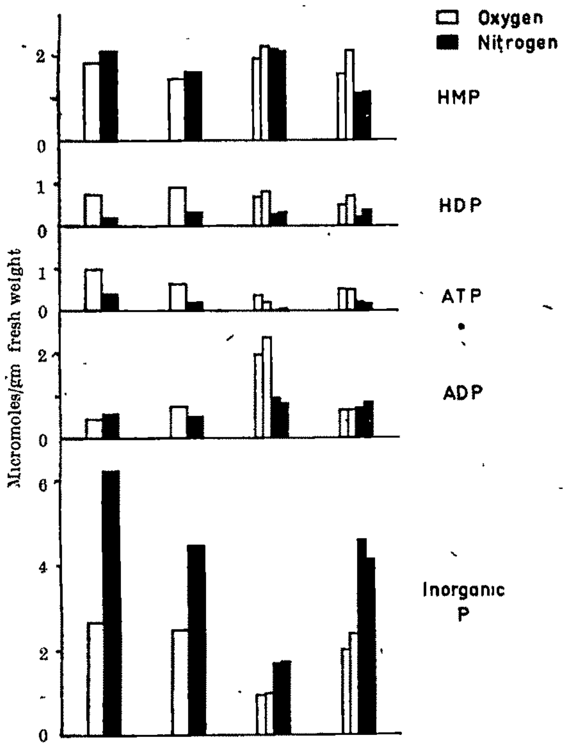

Fig. 2. Results of experiments of the type illustrated in Fig. 1, showing the change in phosphate fractions on transference from oxygen to nitrogen

when so measured from 1 to 1·6. H. G. Wager (private communication) has found that in the first three hours after transfer of pea seed to nitrogen, ethanol, equivalent to about 40 per cent of the carbon dioxide, was produced and, in addition, some acetaldehyde and lactic acid were formed in mature peas. It seems reasonable, therefore, to assume that the high values for this ratio indicate the existence of a Pasteur effect; its extent in these preliminary experiments cannot be measured.

Table 1

Experiment	Adenosine diphosphate / Adenosine triphosphate Oxygen	Nitrogen
1	0 4	1·4
2	1 2	2 3
3	7·6*	18·2*
4	1·3*	4·0*

* Mean of two extractions.

Fig. 2 and Table 1 show the analytical results of all experiments in which tissue was transferred from aerobic to anaerobic conditions. The concentrations of adenosine triphosphate and hexose diphosphate fell consistently in all experiments; inorganic phosphate and the ratio of adenosine di- to tri-phosphate increased. These changes occurred within 1 hr. (in one experiment within 30 min.) of the transfer to nitrogen gas, and their rapidity is of interest when it is remembered that the hypothesis of oxidative anabolism (resynthesis of glycolytic product[8]) is only valid if the transfer to anaerobiosis involves no rapid change in the rate of glycolysis.

These changes of concentration might stimulate the following reactions in glycolysis and starch breakdown:

$$\text{Starch} + P_i \rightleftharpoons \text{glucose 1-phosphate}$$
$$\text{Glyceraldehyde 3-phosphate} + \text{DPN}_{\text{ox.}} + P_i + \text{ADP} \rightleftharpoons \text{glycerate 3-phosphate} + \text{ATP} + \text{DPN}_{\text{red.}}$$
$$\textit{Enol}\text{pyruvate 2-phosphate} + \text{ADP} \rightleftharpoons \text{ATP} + \text{pyruvate}$$

The results reported are consistent with the hypothesis that on transfer from oxygen to nitrogen there is a rapid increase in concentration of inorganic phosphate and of the ratio of adenosine di- to tri-phosphate. This could give rise to an increased glycolysis, and so explain the Pasteur effect. Further work is envisaged on plants in which this effect is lacking.

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Tripping, Crossing and Selfing in Lucerne Strains

There is some controversy on the proportion of lucerne flowers which set seed without tripping; but all investigators have agreed that tripping is essential for high yield of seed. Insect-tripped florets bring about cross-pollination and normally cross-fertilization, while seed setting without tripping or due to automatic tripping results usually in self-pollination and self-fertilization. The population of wild bees, although playing a most effective part in tripping and crossing, is inadequate. The importance of honey bees in tripping has been one of the most controversial subjects; but a number of investigators[1-3] showed that pollen-gathering bees caused a high percentage of tripping and nectar-gathering bees caused only accidental tripping.

There is no evidence as to whether the different strains vary in the amount of florets tripped, either self- or cross-fertilized, or in the number of pods and seeds set under comparable conditions. These aspects and the influence of weather and insects on them have been studied at the National Institute of Agricultural Botany (1953–55) in a number of strains planted as single-spaced plants in the field. Pilot investigations in 1953 showed that early strains (Eynsford, Du Puits, Chartrainvilliers and *W*.268) had a higher number of florets per raceme and, under natural conditions, a higher percentage of florets tripped and pods formed than in mid-season strains (Provence and New Zealand Strain *B*) and in late strains (Grimm and Rhizoma). The early strains also had a higher percentage of self-fertilized florets than mid-season or late strains under cover (my classification[4]). As the number of tripped florets was recorded and calyces marked each day, it was possible to correlate the

Table 1

Strain and treatment	Total florets	Tripped florets (%)	Pods formed			No. of seeds per pod
			Total	% of tripped florets	% of total florets	
Early						
Eynsford						
A	916	81	433	57	47	3·9
B	950	100	362	38	38	2·0
C	995	100	872	87	87	6 9
D	956	—	67	—	7	1·5
Du Puits						
A	928	78	414	56	44	4 0
B	962	100	386	40	40	1·9
C	935	100	758	81	81	7 0
D	945	—	66	—	7	1 5
Mid-Season						
Provence						
A	703	54	131	34	18	3·7
B	781	100	253	32	32	1 7
C	820	100	684	83	83	6·9
D	753	—	28	—	3 7	1 4
Late						
Grimm						
A	719	53	146	38	20	3 8
B	700	100	254	36	36	1·9
C	788	100	668	85	85	6·8
D	763	—	37	—	4·8	1 5

40 racemes were used in each treatment.
(*A*) Under natural conditions—open to all pollinators. (*B*) Artificial tripping and selfing. (*C*) Artificial tripping and crossing. (*D*) Under cover, selfing—no insects.

results with daily weather records. Correlations derived from the means for each strain for ten to fourteen days were highly significant.

More detailed investigations were carried out during 1954–55 with Eynsford, Du Puits, Provence and Grimm strains. Some results for 1955 showing the main differences between strains are given in Table 1.

The number of florets tripped and pods and seeds set under natural conditions in (*A*) treatment was similar for Eynsford and Du Puits. Also, the difference between Provence and Grimm was small; but the difference between them and the early strains was highly significant. Eynsford and Du Puits had the highest number of florets per raceme, percentage of tripped florets and number of pods formed. They also had a higher percentage of self-fertilized florets under cover (*D*) than Provence or Grimm, but this difference was small in treatment *B*. The difference in percentage of pods and seed per pod set under artificial tripping and crossing (*C*) between strains is negligible, but it is considerable between early strains and Provence or Grimm in the actual number of pods and consequently total number of seeds set. In Provence and Grimm the percentage of tripped florets under natural conditions (*A*), artificially selfed florets and pods formed in (*B*) and artificially crossed florets and pods set in (*C*) are in agreement with the figures obtained by Pharis and Urau[4] for similar treatments on an unspecified strain. When the number of seeds set per pod in treatment (*A*) is compared with that obtained in either treatment (*B*) or (*D*), a 2 to 1 ratio is obtained. This is similar to the ratio stated by other investigators[5,6] under similar conditions. However, none of these investigators used early strains or indeed specified the strains used in their experiments; whereas the present investigation shows that the greatest difference is between early strains and mid-season or late strains. I observed when doing artificial tripping and crossing that the early strains tripped more easily than mid-season or late strains. The ease with which they tripped is possibly the most important factor governing the greater number of pods set, as the other pollinating agencies, for example, honey bees, sun and wind, could trip a higher proportion of florets.

My own observation on honey bees was that they work in great numbers on lucerne, taking nectar from the side of the flower, as Reinhardt[2] showed, but causing accidental tripping on other florets on which they landed. They might also cause the cross-pollination of some automatically tripped or wind-tripped florets. The part played by other small insects mentioned by some investigators[3,6,7] should not be under-estimated. They are probably responsible for the fact that I and also others[3,7] found a much higher number of pods formed on selfing in the open than under continuously covered conditions. In the present investigation the range of the number of seeds per pod set under cover (*D*) was only 1–3 and none of the pods produced a full spiral, whereas in the open (treatment *B*), it was 1–5 and a few pods had 2–3 spirals formed. This would support the hypothesis of small insects helping in cross-pollination.

The report on this investigation will be published in full elsewhere.

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Fixity in Chromosome Number of Plants

Studies on the chromosome behaviour of a large number of vegetatively propagating plants have revealed certain interesting facts. The investigations have mainly centred around members of the Aroideae, Liliaceae, Amaryllidaceae and Dioscoreaceae, including the ornamental ones, especially those with obligate vegetative multiplication[1].

In more than a hundred species of plants so far investigated, no constancy in the chromosome numbers of the somatic cells, even of the same root-tip, was found, and similar results are being accumulated from different groups of plants under investigation. In addition to the normal somatic chromosome number, which occurs with high frequency in the nuclei, irregular numbers of chromosomes are present in numerous cells. No regularity in the sequence of their occurrence was noted and the numbers so far recorded suggest random behaviour. This interesting phenomenon was first noticed in *Caladium bicolor*[1], and on careful scrutiny, the presence of irregular chromosome numbers is gradually being revealed in other species, of which species of *Hemerocallis*, *Haemanthus* and *Crinum* may be cited. In *Hemerocallis citrina* the normal somatic number is 22, whereas complements with 11, 18 and 20 chromosomes also occur frequently in the cells of the same root-tip. Similarly, in *Haemanthus kalbreyeri*, with $2n = 18$ chromosomes, and *Crinum kunthianum*, with $2n = 22$ chromosomes, abnormal numbers, such as 15, $16+f$, 17, $17+f$, $18+2f$, 20, $20+f$, 21 and 10, 12, 13, 14, 15, 17, 18, 20, 23, 24, 25 chromosomes respectively, have been recorded in different cells. The irregularities in these plants not only involve a numerical change but structural alterations are also recorded in cells otherwise showing a normal number of chromosomes. In species of *Hemerocallis*, etc., different individuals of the same species differ in the karyotypes of the normal cells, even if these do not differ in chromosome number. In these groups of plants, where sexual reproduction is ineffective, such variations may lead to speciation through their presence on the growing tips of daughter offshoots[2]. Experimental attempts to secure direct evidence of their role in speciation are yielding promising results.

This peculiarity in chromosome behaviour strongly emphasizes the necessity of an extremely cautious approach when investigating the number and behaviour of chromosomes in plants multiplying by vegetative means. The discrepancies often noted in the reports of chromosome numbers of the same species by different authors are significant in this connexion. It is apparent that the idea of the constancy of the chromosome number in cells is not strictly applicable to all plants.

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Some Problems associated with determining Iron in Plants

It is well known that the total iron content of leaves determined by chemical methods seldom reflects the true iron status of plants. In instances of lime-induced chlorosis in fruit trees[1] or metal-induced iron-deficiency in crop plants[2], the iron content of chlorotic leaves is often reported to be similar or even higher than that of green leaves.

Various workers have shown that the iron determined by leaf analysis is considerably less after washing the leaves either in water containing a detergent or in dilute hydrochloric acid[3]. This difference has been assumed to result from the removal of iron contamination on leaf surfaces, although it has not hitherto been determined whether or not iron is leached from the tissues during leaf washing.

We have found that iron is a serious contaminant on the leaves of tomato grown in a glasshouse, and that it may be removed readily by washing the plant in water containing 0·3 per cent detergent.

The effect of duration of leaf washing on the iron content of tomato 'tops' was investigated as follows: The tomato plants, nine weeks from seed, were cut at approximately 6 in. above soil-level and immersed and well agitated in 0·3 per cent 'Teepol' in distilled water, drained for 5 sec. and then rinsed in distilled water. The results are shown in Fig. 1; half of each time interval was used for the detergent wash and the remainder for water rinsing. Significant amounts of iron were removed during the first 20-sec. washing period, but additional treatment did not further reduce iron. The manganese content of the plants, which is similar to their iron status, was unchanged by the washing treatment. Potassium, which is more readily leached than other nutrients, was also unaffected by this treatment. That the iron is remove from the external surfaces only is shown by the fac that the iron content of leaves of tomato plant grown in a dust-proof chamber remained unchange after washing, and their iron content was comparabl with that of washed leaves of plants grown in th open glasshouse.

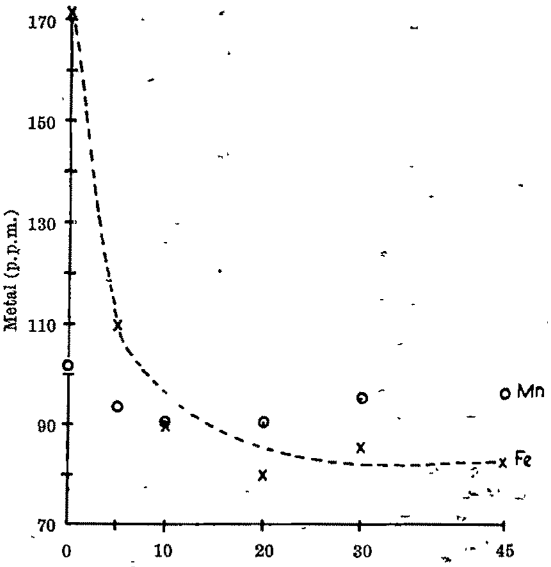

Fig. 1. Iron and manganese contents of tomato leaves after washing them for various periods in 0·3 per cent detergent and distilled water

The following experiment was carried out wit radioactive iron to determine whether iron was los from the plant tissues during washing: Tomat plants, var. Market King, were grown from seed i a complete culture solution containing 1 mgm. c iron labelled with 4 μc. of iron-59 per litre. Si nine and twelve weeks after seed germination th tops were washed, dried and the iron content of th wash solutions and the plants determined by chemica and tracer methods. The results are given in Table I

Washing the plant 'tops' for between 30- an 90-sec. periods in detergent and water resulte in a large loss of iron from the external surfaces but there was no appreciable loss of iron from th plant tissues, as is clearly shown by the low radioactive assay values for iron-59 in the wash solution The greater amount of tracer iron in each initia wash may have been caused by abrasion of glandula hairs.

In other experiments the iron content of dried an ground sub-samples of washed leaves were found t be less variable than those of unwashed specimens suggesting that the unequal distribution of iron contamination on leaf surfaces was the main cause o the variation noted.

It has been suggested that the adsorption of iro on silica and the formation of soluble iron complexe during acid digestion interferes seriously with iro analysis of plants[4]. In our experiments, however tracer and non-radioactive iron were recovered full when added at various stages during nitric an perchloric acid digestion of different dried plan materials, which are specially chosen to represent a range of silica contents[5]. Further, in tomato plant containing radioactive iron there was no indicatio

Table 1. Effect of Washing with Detergent and Water on the Removal of Iron from Tomato Plants

Leaf washing procedure: sequence and duration	(1) μgm. iron leached from plant 'tops', determined by the tracer method	(2) (1) as percentage of total iron in plant 'tops'	(3) μgm. iron in the wash solutions, determined by chemical methods (surface iron)	(4) (3) as percentage of total iron in plant 'tops'
Experiment 1 (6 weeks after germination) 0·3 per cent Detergent in distilled water (10 sec.)	0·24 ± 0·05	0·2	87	51
Distilled water (10 sec.)	0·10 ± 0·08			
Distilled water (10 sec.)	< 0·01			
Experiment 2 (9 weeks after germination) 0·3 per cent Detergent in distilled water (20 sec.)	0·37 ± 0·06	0·3	86	33
0·15 per cent Detergent in distilled water (20 sec.)	0·27 ± 0·05			
Distilled water (20 sec.)	0·09 ± 0·06			
Experiment 3 (12 weeks after germination) 0·3 per cent Detergent in distilled water (30 sec.)	0·68 ± 0·08	0·6	74	31
Distilled water (30 sec.)	0·25 ± 0·07			
Distilled water (30 sec.)	0·17 ± 0·06			

that the iron content of acid digests of plant 'tops' determined chemically by α-α-dipyridyl was less than that determined by the tracer method, thus demonstrating that soluble iron complexes, even should they be formed during acid digestion, did not interfere with the determination of iron in tomato.

A full account of this and related work will appear elsewhere.

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A New Type of Male Fructification referable to *Glossopteris*

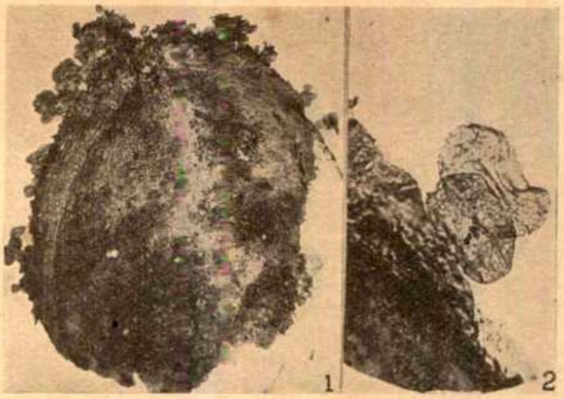

Fig. 1. Photomicrograph showing a dehisced pollen sac liberating numerous Lower Gondwana *Pityosporites* type of pollen grains. × 30

Fig. 2. Photomicrograph showing a pair of characteristic Lower Gondwana *Pityosporites* type of pollen grains on the dehisced wall of the pollen sac shown in Fig. 1. × 260

In a recent communication[1], I described several types of pollen sac containing typical *Pityosporites* type of pollen from some Raniganj (Upper Permian) coal, Lower Gondwana, India. For some years now, the members of the Lower Gondwana *Pityosporites* have been assumed to be the pollen of *Glossopteris*, because both the genera occur profusely and in close association throughout the system[2]. If such a relationship between *Pityosporites* and *Glossopteris* is acceptable, naturally, therefore, the sacs containing the *Pityosporites* should be regarded as the male fructifications of the *Glossopteris*. If this proposed relationship is established, the morphological value of the male fructifications described here, and in a previous communication[1], may have some bearing in determining the systematic position of *Glossopteris*, since considerable doubt now exists as to the structure of the male fructifications of the genus.

A new type of sac containing *Pityosporites* type of pollen (Figs. 1–2) from coal of Karharbari stage (Lower Permian) of the Lower Gondwana, India, has now been found. This differs from those previously described[1] in (1) the manner of dehiscence, and (2) its general shape and structure. It is thus a new member of the previously reported group of male fructifications referable to *Glossopteris*.

The new type of pollen sac is free and occurs singly in maceration residues, exannutate, apparently sessile, more or less oval with the base broader than the apical region (which is a very short and slightly raised cylindrical structure), unilocular, dehiscing regularly along a median line of dehiscence from the apex in a longitudinal direction; as a result the sac splits into two equal halves which are attached towards the base and thus liberates typical pollen of *Pityosporites* type (Figs. 1–2). The cell structures of the sac are mostly destroyed; in some places, however, they are faintly visible (but not reproducible photographically). The cells along the line of dehiscence are linear, with mostly irregularly and laterally thickened walls (Fig. 3) where the sac bursts, and the cells become progressively shorter and broader away from the region of dehiscence and thus usually appear as rectangular structures (Fig. 4). The whole pollen sac measures 1,440μ × 1,100μ. A structure of this size can easily be accommodated in the sorus-like body borne by a *Glossopteris*[4].

The pollen grains are typically Lower Gondwana type of *Pityosporites* previously described by many authors. Each grain is provided with two lateral reticulately marked bladders placed on opposite sides of the thickly rimmed more or less elliptical body, which consists of a number of horizontal stripes

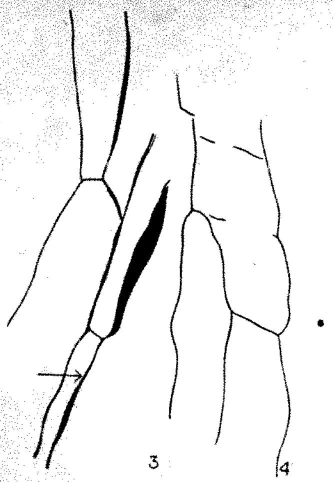

Fig. 3. Camera lucida sketch of some characteristic cells of the line of dehiscence (shown by an arrow head) of the pollen sac with irregular thickening in the walls, mostly restricted towards the actual line of dehiscence. × 425

Fig. 4. Camera lucida sketch of some characteristic cells of the pollen sac wall away from the line of dehiscence. × 425

(Fig. 2). The size varies from 58μ to 80μ (from bladder tip to bladder tip).

Such different types of fructifications—as described here with longitudinal dehiscence, and others previously described[1] with primarily transverse mechanism of dehiscence—do not usually occur in the same genus. However, the tendency towards longitudinal dehiscence as a secondary adaptation for pollen dispersal after the first clear transverse dehiscence is quite clear in some of the pollen sacs described previously[1]. These may be regarded as intermediate forms. It is now time to question whether *Glossopteris*, possibly bearing pollen sacs of characteristically different nature as discussed here and previously[1,4], is a well-knit genus. The ovulate fructifications are also not of the same type[5].

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Effects of Cyanide on the Roots of *Vicia faba*

Mottram[1] claimed that cyanide ions had a considerable effect on the radiosensitivity of *Vicia faba* as measured by growth-rate reactions. Read[2] was unable to confirm this, and Thoday found (unpublished results) no effect upon chromosome breakage (which is often correlated with growth reactions[3]).

During the course of experimental work designed to investigate this apparent discrepancy, significant effects of cyanide independent of radiation have been discovered. The experiments involved four conditions. Roots were immersed in water or in $5 \times 10^{-4} M$ potassium cyanide at *p*H 7 for 30 min., and at the same time nitrogen or oxygen was bubbled through the vessel. At various intervals after such treatments, the lengths of the roots were measured and tips were fixed for cytological examination.

The measurements of length revealed significant effects of cyanide, primarily in the presence of oxygen. There is a similar effect on the progress of mitosis. Mitotic index (proportion of cells in metaphase, anaphase or telophase) is temporarily reduced after the period in nitrogen, and the reduction may be increased very slightly by cyanide. Oxygen alone produces little effect. Cyanide and oxygen together, however, produce a greater and more prolonged inhibition of mitosis.

Examination of anaphases revealed that the roots treated with cyanide in the presence of oxygen contained a much higher frequency of chromosome aberrations than those that received the other treatments (Table 1). There is no evidence of any effect of oxygen in the absence of cyanide or of cyanide in the absence of oxygen.

Table 1

Treatment		Time elapsing between treatment and fixation (hr.)										
		1½	3	6	9	10½	12	14	16	24	36	48
Nitrogen + water	Anaphases		100	100	100	100	100	100	100	100		
	% Abnormal		5	1	2	0	1	1	2	0		
Nitrogen + pot. cyanide	Anaphases		100	100	100	100	100	100	100	100		
	% Abnormal		0	4	1	2	0	0	0	0		
Oxygen + water	Anaphases	200	200	200	200		200		200	200	200	200
	% Abnormal	1	0	1	1		1		2	0	1	1
Oxygen + pot. cyanide	Anaphases	200	200	148*	46*		81*		96*	59†	200	200
	% Abnormal	15	23	10	39		26		21	29	14	2

* The low mitotic index at these times reduced the anaphases available below the 100 per root aimed at.
† Only one root examined as in the nitrogen experiments.

Other effects of cyanide have been reported, which may be of interest in considering the present experiments. Cyanide and azide are known to cause mutations[4,5]. It has been suggested that these substances cause the accumulation of peroxides by the inhibition of catalase[5] and that these peroxides may be involved in chromosomal disturbances[6]. It is known that cyanide and azide both inhibit the cytochrome system, and this inhibition may channel more of the aerobic respiration through the cyanide (azide)-insensitive flavoprotein system which can produce hydrogen peroxide[5,7]. Further, King *et al.* suggested that in high oxygen tension the flavoprotein systems have greater activity and more hydrogen peroxide may be formed.

It is possible, therefore, that the chromosome aberrations reported above are caused by peroxide, the formation of which may be partially influenced by oxygen tension.

The relation of cyanide to breakage is, however, complex, for when X-rays are used in conjunction with the other treatments, the effect of cyanide with oxygen disappears. Instead, there is an effect with cyanide in the absence of oxygen. These irradiation results will be the subject of a later report.

This investigation was carried out in Sheffield and was aided by a grant from the Department of Scientific and Industrial Research to one of us (L. J. L.), then in the University of Sheffield Department of Botany.

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Living and Fossil Pollen from Macquarie Island

THE use of palynology to investigate the ancient floras of antarctic and subantarctic regions and to aid in explaining the present distribution of the living florula has been largely ignored. Auer[1] made use of pollen analysis to describe the fluctuations of forest and steppe vegetation in Tierra del Fuego in postglacial time. Cookson[2] described the pollen occurring in the tertiary lignites of the Kerguelen Archipelago. So far as I am aware, no workers have undertaken similar studies in any other part of this zone.

Macquarie Island (lat. 54° 30′ S., long. 158° 57′ E.), volcanic in origin, dates back to Early Tertiary or Middle Mesozoic time. It has been much reduced in size by block faulting and has undergone extreme glaciation during the last Ice Age. Fluvio-glacial deposits, considered by Mawson[3] to be postglacial in age, are fairly common and include well-developed bands of lignite.

While a member of the 1951 Australian National Antarctic Research Expedition based on Macquarie Island, I was able to obtain a series of lignite samples for examination. By extraction of pollen by the acetolysis method of Erdtman[4] and by comparison of the types discovered with those of the existing vascular flora (some thirty-eight species of grasses and small herbs), it has been possible to show an apparently complete disaffinity between the past and present vascular floras of the island. This finding strongly suggests that the lignites represent the remnants of a preglacial flora. Altogether seventeen main fossil pollen types were found, and it is of interest that these did not include *Nothofagus* or Gymnosperm-type pollens.

During the Ice Age, when the area of land in the vicinity of Macquarie Island was much greater than it is to-day, it is probable that, notwithstanding the severity of the glaciation, parts of the land mass were capable of supporting plant life. Such conditions exist at present in several parts of the subantarctic zone. With the recession of the ice sheet, it is reasonable to assume that the limited plant life began to colonize the freshly exposed land-surface. At the time when faulting and subsidence were practically complete, it is probable that small plant communities were able to survive in more favourable sites on the now much smaller land mass. Those communities may have formed the bands of lignite still preserved at Macquarie Island.

With the land mass greatly reduced in size, a reversal of conditions might readily result in complete extinction of the remnant flora. That such a reversal may have taken place is indicated by the fact that the lignites were found to be covered with considerable layers of fluvio-glacial rubble. Should this explanation be correct, then the fossil pollens may be closely related to the Tertiary floras of the Antarctic.

It is of interest that no definite affinities could be found between the fossil pollens of Macquarie Island and those described by Couper[5] from New Zealand. Although he has recorded compositous grains in deposits ranging from Miocene to Recent in age, without detailed descriptions it is not possible to decide whether any of these are identical with those occurring in the lignites of Macquarie Island.

A search of the available literature[4,6] has shown that the pollen of many species of the antarctic vascular flora has not been described. Until such descriptions become available, the identification of recent fossil pollen from this zone must remain uncertain.

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A Direct Method for the Measurement of Cerebral Blood-flow

THE blood-flow through the rostral and parietal parts of the heparinized cat's brain has been measured by cannulating the sagittal sinus. This flow has been correlated with the systemic blood pressure and the electroencephalogram.

After longitudinal craniotomy in the midline, the sinus was ligated at its caudal end. On the rostral side of the ligature a thin polyethylene catheter was introduced into the sinus. The blood was directed to an electric drop recorder, connected with an 'ordinate recorder' which operated a galvanometer. The blood was then returned to the animal by intravenous drop infusion. The craniotomy interrupted the most

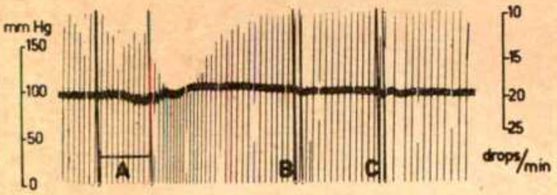

Fig. 1. Cat, 4·5 kgm. 'Nembutal' (40 mgm./kgm.). Vagus, cervical sympathetic trunk and the sinus nerve divided bilaterally. Blood pressure (thick line) from the femoral artery. Blood-flow from sinus sagittalis superior (vertical lines). Each drop of blood from the sinus rapidly carries the spot of the mirror galvanometer to the base of the figure, from which it returns at slower speed so that a steeply rising line is recorded. The length of these lines is directly proportional to time-interval between drops. By joining the upper ends of these lines one obtains a curve inversely proportional to blood-flow (cf. calibration on the right). The record is interrupted every 30 sec. (*A*) 10 per cent carbon dioxide in the inspired air; (*B*) twisting the pinna; (*C*) pinching the paw of the right foreleg. Note, large transient increase of blood-flow in *B*, slower increase in *A*, transient decrease of flow in *C*

important anastomoses between the sagittal sinus and the diploic veins. Ringer solution was injected through the catheter into the sinus in order to show that no larger anastomoses still existed between the sinus and other veins. Intravenous injections of a solution of indian ink and gelatine showed that the drainage was restricted to the rostral and parietal parts of the brain and did not include extra-cerebral areas. Even the jugular bulbs are known to hold only 2·6 per cent extra-cerebral blood[1].

The systemic blood pressure was recorded in the femoral artery by a strain-gauge instrument. The electroencephalogram was led off bipolarly from the middle suprasylvian or the cruciate gyrus.

This method has made it possible to demonstrate that variations in the cortical blood-flow may occur even when the systemic blood pressure is constant. Smaller changes in the blood pressure may be completely without effect on cerebral blood-flow. A larger change in blood pressure, on the other hand, was usually followed by a passive increase in the cerebral blood-flow. The well-known vasodilating effect of an increased concentration of carbon dioxide could easily be demonstrated (Fig. 1,*A*). Cerebral vasomotor reactions, reported to appear during changes in the electrical activity of the cortex[2], were likewise revealed in a very direct fashion. Thus, for example, in the lightly anæsthetized preparation, nociceptive stimuli, twisting the pinna and electrical stimulation of the reticular activating system produced transient changes in the cortical blood-flow. There was a latent period of about 2–5 sec. and a duration which paralleled the concomitant change in the arousal reaction of the electroencephalogram (Fig. 1,*B* and *C*).

Doses of adrenaline and noradrenaline which gave identical rises in the systemic blood pressure were found to produce different effects upon the cerebral blood-flow, the effect of adrenaline being the larger. Ergotamine, in most cases, was found to elicit an increase in the cerebral blood-flow. This effect will be described in detail elsewhere.

Deep anæsthesia abolished all kinds of vasomotor reactions in the cortical vessels. The vascular resistance, which in such circumstances remains constant, makes the cerebral blood-flow a direct function of the systemic blood pressure. Ether paralyses the cerebral vessels in the dilated state, while under barbiturates they are paralysed in a state of constriction. To judge by the electroencephalogram, the resistance of the vessels to anæsthetics corresponds roughly to the level of activity of the cortical neurones.

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Action Potentials from Internal Laryngeal Muscles during Phonation

ELECTROMYOGRAPHY of the internal laryngeal muscles has been applied in the diagnosis of laryngeal palsy by Weddell, Feinstein and Pattle[1]. In a study of phonation, Katsuki[2] recorded action potentials from the m.crico-thyreoideus externus in a case with partial resection of the larynx. In the present study, action potentials were recorded by means of concentric needle electrodes inserted in the m.thyreo-arytaenoideus internus (m.vocalis), crico-thyreoideus externus, inter-arytaenoideus transversus and crico-arytaenoideus posterior (m.posticus) of normal subjects and of patients with laryngeal paresis. In addition,

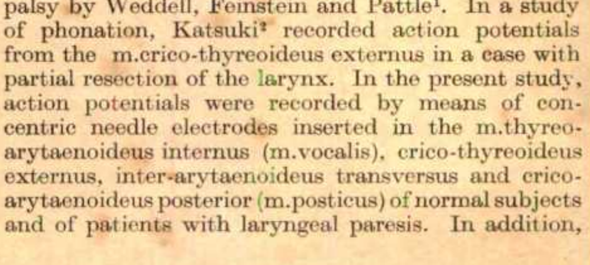

Fig. 1

(*A*) Subject A. H., 64 years; left m.thyreo-arytaenoideus internus, intonation of 'e', frequency 265 c./s. (*a*) Directly recorded action potentials; (*b*) mean action potential amplitude; (*c*) voice recorded on microphone

(*B*) Subject C. S., 55 years; right m.thyreo-arytaenoideus internus, intonation of 'e', frequency 285 c./s.; first with small, then with large intensity. (*a*) Directly recorded action potentials; (*b*) mean action potential amplitude; (*c*) voice recorded on microphone

(*C*) Subject A. J., 44 years; left side paresis of n.recurrens, intonation of 'e', frequency 263 c./s. (*a*) Directly recorded action potentials in left m.crico-thyreoideus externus; (*b*) directly recorded action potentials in left m.thyreo-arytaenoideus internus; (*c*) mean action potential amplitude in left m.thyreo-arytaenoideus internus; (*d*) voice recorded on microphone

(*D*) Subject F. B., 47 years; left crico-arytaenoideus posterior, intonation of 'a', frequency 200 c./s. (*a*) Directly recorded action potentials; (*b*) mean action potential amplitude; (*c*) voice recorded on microphone the action potential amplitude was averaged electrically and recorded as an expression of the degree of activity. The subject spoke into a condenser microphone, the output of which was amplified and recorded simultaneously with the action potentials.

An increase in activity occurred in the m.thyreo-arytaenoideus internus, crico-thyreoideus externus and inter-arytaenoideus transversus 0·3 sec. before any signal was observed on the microphone (Fig. 1,*A*, *B*,*C*). The degree of muscle activity increased greatly with increasing pitch as long as this obtained without change in register. Increase in tone volume had scarcely any effect on the degree of muscle activity (Fig. 1,*B*). As in other voluntary muscles, the increase in activity was due to an increase in the number of activated muscle fibres and in their frequency of discharge. In cases of laryngeal paresis it was possible to follow the increase in frequency for a single motor unit potential (from 10 to 50 per sec., Fig. 1,*C*). The activity was maximal before and in the very first period of intonation. Then it remained on a slightly lower level until intonation stopped. Activity was simultaneous in the m.thyreo-arytaenoideus internus, crico-thyreoideus externus and inter-arytaenoideus transversus.

The activity in the m.crico-arytaenoideus posterior was greatly inhibited during intonation (Fig. 1,*D*). The inhibition occurred 0·3 sec. before a signal appeared on the microphone.

If the subject was asked to prepare an intonation without voice production ('silent speech'), the initial burst of activity was still observed.

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Role of the Terminal Pigment Spots of the Starfish, *Asterias forbesi*, in Light Orientation

IT is generally stated in standard reference and text-books of zoology that, in species where such bodies are present, the terminal pigment bodies (or 'eye spots') are necessary for light orientation. In two early studies, Romanes[1], in the "starfish", and Preyer[2], in *Asterina gibbosa* and *Asterias glacialis*, found that these spots were essential in the positive light responses of these starfish and that without these pigment bodies such responses were lacking. On the other hand, several contradictory reports have also appeared[3-5] which emphatically state that positively phototropic responses persist even after the excision of all the eye spots of each ray of *Echinaster crassispina*, *Pentaceros reticulatus* and *Asterias forbesi*. I therefore undertook to check the role of these pigment bodies in light orientation of the common starfish of the North Atlantic coast of North America south of Maine, *A. forbesi*, as well as to establish a possible chemical basis for light perception.

To this end two different sets of study were undertaken; observations were made of the ability of 'eyeless' and intact starfish to orient to light and concomitantly the absorption spectra were studied of extracts of pigments from these terminal bodies as well as from the dorsal skin of individuals of this species.

In the first case, the pigment body was removed from each of the rays of twenty starfish (about one and a half inches across, in size) by simple transverse cutting about one half-centimetre from the tip. These were then placed, together with an equal number of intact starfish of similar size, in a tank with running sea water, which was so illuminated by the light from a 100-watt Burton lamp (placed 18 in. from the end of the tank) that one side of the tank was illuminated by a narrow shaft of light parallel to the long axis of the tank. After all the starfish had been permitted to distribute themselves freely throughout the tank the number of normal and 'eyeless' animals to be found in the dark zone was counted. After each such observation all the starfish were replaced into the darkened (approximately $\frac{7}{8}$) portion of the tank and allowed to redistribute themselves for at least three (usually 10–12) hours before a subsequent tally was made. The following represents the results of such observations over a six-day period:

Trial No.	Intact starfish in dark zone	'Eyeless' starfish in dark zone
1	10	5
2	15	6
3	11	8
4	9	9
5	6	9
6	19	6
7	6	5

Although facilities for studies involving various portions of the visible light spectrum were not available, a second similar set of observations was made upon 26 eyeless and 26 normal starfish (1½–2 in. across) exposed to a similar narrow shaft of light from a Westinghouse 50-watt red safety lamp under otherwise identical conditions as above. In one case twelve normal and six eyeless, in a second observation five of each type of starfish were found in the dark part of the tank. Clearly, the eye spots are not essential for positively tropic responses by this species to light of this quality and intensity.

An obvious assumption from the above observations is that the skin of the species in question is sensitive to light. To establish a chemical basis for such sensitivity to light, extracts were prepared, directly as well as indirectly (through phosphate buffer followed by petroleum ether extractions), into a 2 per cent digitonin solution, from the eye spots and adjacent dorsal skin segments from animals of this species, previously dark-adapted in running sea water for at least sixteen hours. All preparations were made in the dark and comminution of tissues effected at 0–5° C. Spectral analyses of such extracts revealed an absorption spectrum with a sharp peak at close to 320 mμ and a secondary, broader and lower plateau at about 450–500 mμ, for each of the sets of extracts studied. Also, a minimum of thirty minutes exposure of each of these extracts to cooled, white light (from a 100-watt Mazda lamp), placed twelve inches from the cuvettes containing these extracts, resulted in a significant decline in the optical density thereof; this indicated the presence of a photosensitive pigment.

Obviously, therefore, both the skin and pigment bodies of this species possess a similar photosensitive chemical component which suggests that both have a common function in gross light perception, especially in the positively phototropic responsiveness of this animal. There remains, however, further clarification of the role of these pigment bodies in terms of possibly higher sensitivity than those of the dorsal skin to light of the same wave-lengths or in terms of possibly greater (if not specific) sensitivity to particular bands of the spectrum. What is contemplated is an additional behavioural study of the responsiveness of this species to various parts of the spectrum as well as concomitant spectral analyses of the extracted pigments before and after exposure to each of several bands of the light spectrum.

This work was carried out at the Woods Hole Marine Biological Laboratory Department of Physiology Laboratories; I am indebted to Dr. Daniel Mazia for making such facilities available for this study and to Dr. George Wald of Cornell University for his valuable suggestions concerning the chemical aspects of the work.

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Failure of Enforced Hibernation to inhibit Breeding in the Frog (*Rana temporaria*)

IT is well known that the frog (*Rana temporaria*) is extremely tolerant of cold, and may continue to breed when ice covers or encrusts the sides of the ponds. Warmth, or a small transitory rise in temperature, however, may be necessary for breeding to be initiated.

Dr. M. Smith[1] suggests that the variability in time of spawning (apart from temperature) may be due to the phosphate content of the water and to the availability or otherwise of food for the tadpoles. The amount and the intensity of light are also thought to be important.

In view of these accepted facts, it seems worth while recording the following.

A group of male and female frogs, captured in East Anglia in late September 1954, were subjected to enforced hibernation in a domestic refrigerator early in October of the same year.

The thermostat in the refrigerator was set so that the temperature was maintained at 38° F. A maximum and minimum thermometer was put into the refrigerator and the temperature checked twice each day.

The animals were stored in a shallow enamel tray containing $1\frac{1}{2}$ in. of tap water and covered by a piece of hardboard drilled with several $\frac{1}{2}$-in. holes. The water in the tray was changed on alternate days. There was no pilot light in this particular refrigerator.

In mid-May 1955, $7\frac{1}{2}$ months after enforced hibernation had started, amplexus occurred in four pairs of animals and spawn was laid.

Spawn continued to be laid at intervals until early July. During this time, however, the animals were not always in amplexus. The spawn was removed from the refrigerator and put into shallow trays; some contained tap water and one contained rain water. The spawn in the rain water developed and the spawn in the tap water did not. By August 1955 the froglets from this spawn were approximately $1\frac{1}{2}$ cm. long and beginning to take adult frog laboratory food.

When the adult frogs spawned it is estimated that they had been exposed to light of average indoor intensity for half a minute on alternate days for $7\frac{1}{2}$ months, and warmth for the same period. They had, however, been exposed to cold tap water also on alternate days. Due to the large surface area, the water would probably only take 15–30 min. to attain the temperature of the refrigerator, that is, 38° F. It is probable that the phosphate content of the water varied little, and certainly there was no food available either for the adult frogs or for any potential tadpoles. It is noteworthy that not all the female animals spawned, and that the onset of breeding was substantially delayed in the others.

It is possible, and indeed probable, that there was a gradual build-up of the hormones necessary for breeding to occur; but it must be generally agreed that the external stimuli usually considered necessary for this to occur were minimal.

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Status of *Protobatrachus massinoti*

THE history of the Amphibia Salientia can readily be traced back to the Jurassic when it appears that, skeletally at least, they were already typical, modern Anura. The pre-Jurassic history of frogs, however, was completely unknown until 1937 when Piveteau[1] described *Protobatrachus massinoti* from the lower Trias of Madagascar. To accommodate *Protobatrachus*, Piveteau defined a new order, the Proanura, differing from the Anura chiefly in possessing a tail but no urostyle and with the tibia and fibula, radius and ulna, unfused.

In excluding *Protobatrachus* from the Anura, Piveteau strongly emphasized that no analogy exists between the tail of modern frog tadpoles and the 'true' tail of *Protobatrachus* since, in the former, no vertebræ develop but only the notochord with its sheaths and enveloping skeletogenous layer. In a recent survey of anuran larvæ, however, I have examined tadpoles of the pelobatid *Megophrys major* and found that, from early larval stage, they possess about seventeen ossified caudal vertebræ—a condition that, so far as I am aware, has not hitherto been described for any other anuran larva. In the light of this discovery it seemed pertinent to re-examine Piveteau's statement and the status of *Protobatrachus*.

If *Protobatrachus* is regarded as an adult form two problems of functional morphology are posed. First, the animal possesses ilia, femora, tibiæ and fibulæ which, although relatively not as elongated as in the adults of modern frogs, are, nevertheless, clearly salientian adaptations and, consequently, a sacral articulation would be expected. But no sacrum appears to be present. Two vertebræ with backwardly directed ribs lie between the iliac arms, but they are quite free of the pelvic girdle; while, mesial to the heads of the ilia, where articulation normally occurs, the single vertebra present is unexpanded and unspecialized. How, then, can the salientian trends so clearly shown in the hind limbs and girdle, and which are so essentially concerned with transmission of thrust against the vertebral column, be correlated with the absence of a functional sacrum ? Secondly, as Piveteau appreciated, and as the nature of the caudal vertebræ suggests, the tail was much longer than the remains described by him. How can such an organ, so clearly incompatible with the salientian features listed above, be considered to have combined with them to form an efficient locomotory system ?

These morphological enigmata can logically be resolved by regarding *Protobatrachus* as a tadpole in the later stages of metamorphosis. The tail with its ossified vertebræ is now explicable as a larval, locomotory organ destined for resorption at metamorphosis as in the case of *Megophrys major*. This view can also account for the moderate lengths of the ilia and hind limb bones and for the absence of a sacrum, for these elements complete their development and are knit into a functional unit only towards the end of metamorphosis when, after the resorption of the tail, they form the locomotory organ of the adult. It may explain, too, the paucity of the anterior cranial elements for, at this stage, they would not be ossified to any degree.

A detailed account of the structure and development of the vertebral elements in *Megophrys major*, with a discussion on anuran phylogeny, will be published elsewhere.

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Effect of Supplementary Choline and Methionine on the Response of Chickens to Folic Acid

The wide range of folic acid requirements of chickens reported by various authors[1] is partly explained by considerations of dietary and genetic factors known to affect requirements. Excess intake of choline[2] and glycine[3] has been shown to depress growth or produce anæmias which can be prevented by feeding supplementary folic acid. In experiments at this Station, the effect of choline on folic acid requirements has been confirmed, and supplementary methionine has been shown to have a similar effect.

Two experiments, observing the effect of supplements of 0·2 per cent *dl*-methionine and 0·066 per cent choline (providing an equivalent quantity of labile methyl groups as 0·2 per cent methionine) on the response to supplementary folic acid, have been completed using White Leghorn chickens up to six weeks old. The basal diet contained crushed wheat, meatmeal and whey powder. Dietary supplements and results are summarized in Table 1.

The response to methionine added as the sole supplement or together with folic acid in experiment 1, and in the presence of both choline and folic acid in experiment 2, shows that the diet was deficient in methionine and that the response was independent of the role of methionine as a methyl donor.

In experiment 1, the absence of response to folic acid alone, and the response following addition of folic acid to the diet supplemented with methionine, indicate that the chicken's requirements of folic acid were higher following methionine supplementation. In experiment 2, the growth depression following supplementation of the diet with choline and the effect of addition of folic acid in reversing this response suggest that the methionine – folic acid interaction observed in the first experiment was due to the labile methyl group in the molecule. These results indicate that folic acid is required for the catabolism of excess methyl groups as well as in transmethylation processes. As glycine also provides labile methyl groups[3], the effect of folic acid in reversing the toxicity of glycine further confirms this role of the vitamin.

Table 1. Effect of Methionine and Choline Supplements on the Growth Response of Chickens to a Folic Acid Supplement

		Supplements to basal diets		
Exp 1	Nil	4·4 p.p.m folic acid	0·2% *dl*-methionine	4·4 p.p.m. folic acid + 0·2% *dl*-methionine
Relative weights at 6 weeks (difference for significance $P <$ 0·05, 5 per cent)	100	98	112	120

		Supplements to basal diets		
Exp 2	Nil	0·066% choline	0·066% choline + 4·4 p.p.m folic acid	0·066% choline + 4·4 p.p.m folic acid + 0·2% methionine
Relative weights at 6 weeks (difference for significance $P <$ 0·05, 5 per cent)	100	83	101	106

Further details of these experiments will be published elsewhere.

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Science Babel

While agreeing with the points made in the editorials of November 5 and 19, I may perhaps say that you reveal more than I think you were aware of when writing "a nation using . . . a minority language cannot escape bilingualism if it desires to attain high standards of culture and scholarship". If the sentence is understood as referring to the use of minor languages for publishing, it is indisputable ; but all too frequently it turns the other way—scholars within the major language groups neglecting the literature outside their own language. In fact, if we take into consideration languages read as well as written, no language group can to-day avoid even trilingualism if it wishes to attain the highest standards of culture and scholarship.

To illustrate this point I have made a small survey of world scientific literature within a comparatively narrow field, so that the authors have had the theoretical possibility of drawing from the same, rather well-circumscribed scientific heritage. Two botanical journals were used from each country or group of countries[1], one with a background of ecology, the other more general. The most recent issue(s) was (were) used, and at least ten papers were analysed. No issue was older than 1952.

The idea was that, whereas it is difficult to calculate how much scientific material is presented in different languages, it is comparatively easy, by studying the reference lists at the ends of the papers, to find out what is really utilized by fellow scientists.

Table 1

Country	No of papers	No. of titles in reference lists	Percentages								
			English	German	French	Russian	Scandinavian (coll.)	S European (coll.)	Latin	Dutch	Others
Britain	39	618	78	15	3	—	3	—	—	1	—
France	22	1,000	42	14	42	—	+	1	1	—	+
Germany	26	413	22	69	7	½	½	½	—	+	—
Scandinavia	25*	554	63	19	4	1	10	½	2½	—	—
Switzerland	30†	701	24	60	13	—	1	+	2	+	—
United States	38	679	84	11	4	—	+	+	—	+	?
U.S.S.R.	33	392	16	10	1	73	+	—	—	—	—

* 23 English, 1 German, 1 Swedish.
† 29 German, 1 French.

The results are given in Table 1. Its shortcomings are obvious, but the fact that the percentage figures from each pair of journals (from one country or area) were practically identical, may serve to give it more emphasis. The only exception was the Swiss pair, which showed considerable discrepancies.

That our Soviet colleagues know more about 'Western' literature than the reverse is nothing new; but it is deplorable. New to many others besides myself may be the high standard of polyglottism exhibited by the French literature. That the English and even more the American literature should emerge as the narrowest is scarcely unexpected, but it should be remembered that in this case the 'home' language is undoubtedly also the dominating one within the pool, which accounts for a double effect (one of the Swiss journals also had 80 per cent 'home' language).

The main lesson to be learnt from the table is what a waste it is to publish in anything but the three great languages (and even the inclusion of French among them may be questioned). There is to-day the possibility of publishing primary scientific material in a large number of different languages; but there is also the overwhelming possibility that anything published in a minor language will pass unrecognized and never enter the common pool of world scientific knowledge.

Because I have more than twenty years experience in publishing scientific material in two languages not my own, I think I may safely protest against the accusation that compulsion to write in a foreign language curtails the possibilities for intelligent communication. Admitting that there are exceptional brains, for which no rule can be laid down, I am convinced that a brain that has the capacity for scientific work has also the capacity to learn so much of at least one foreign language as to be able adequately to express scientific ideas in it.

It is a waste, and it is also inconsiderate, to publish primary scientific material in a minor language. Notwithstanding the fact that important works have been published in other languages, it is a fact that the great majority of those papers that are worth reading have been published in the three major languages—and in some branches of science also in Latin. Very few are born to more than one of these languages, the other ones have to be acquired: so far as reading goes, the difference between members of the great and small language groups is the difference between learning two or three foreign languages sufficiently well to use them. That is theory; I fear that practice may differ. The learning of a foreign language, even if it is not as formidable a task as some persons seem to consider, certainly does demand an intellectual effort, and one cannot expect anybody but the very few to be willing to take up more than the two or three essential ones. It is interesting to note, however, from the table that the question whether two or three Western main languages must be learnt does not seem to upset the tendency to learn other languages besides. It may be that very much excellent science is at present published in other languages; but as long as these languages are, and cannot but be, inaccessible to the majority of those who would otherwise have been potential readers, this body of knowledge does not exist to all intents and purposes.

Those who belong to a major language, and who perhaps have, or perhaps have not, taken the trouble to acquire a reading knowledge of two other languages, should show indulgence towards those who have been obliged to learn enough of a third one to be able to write it—which is something quite different. I have a personal reason for this appeal. Some years ago I, together with a Danish colleague, published a book (170 pages) in English, which was reviewed in *Nature*[2]. It was a very kind review, but the reviewer expressed his regrets that the English (which had, incidentally, been checked by two English colleagues) was not good enough. At my request the reviewer very kindly furnished me with a list of his grievances. They were, in all, twenty-eight, of which seven were misprints, two referred to a Latin word, one was rejected for being American, and four were new words we had to construct because no such word existed in English—they were all misunderstood, perhaps they were badly constructed. Three cases were disputable (usage accepted by the Concise Oxford Dictionary), and there remained eleven cases of more or less awkward usage. No expression was so awkward that it interfered with intelligibility.

I mention this at some length, not to give vent to any personal feelings against a deceased colleague, but because it is an excellent example of what should not be done. Nothing could be better calculated to scare people away from using the great languages than just this kind of purism. It may be maintained that French purism has destroyed French as a universal language. If English is to go the same way, the outlook for future scientists is very gloomy indeed.

KNUT FÆGRI

Botanical Museum,
University of Bergen.

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[1] Britain: *J. Ecol*; *New Phytol.* France: *Ann. Sci. Nat., Série Botanique*; *Rev. générale de Botanique.* Germany: *Ber. deutschen bot. Gesell.*; *Planta.* Scandinavia: *Bot. Notiser*; *Oikos.* Switzerland: *Ber. schweiz. Bot. Gesell.*; *Jahrebericht geobot. Forschungsinstitutes Rübel in Zürich.* United States: *Ecol.*; *Amer. J. Bot.* (In American literature there was one reference from the Quran and one from Talmud, but I doubt if they were in the original language.) U.S.S.R.: *Bull. Main Botanical Garden in Moscow*; *Botanicheskii J.*

[2] Fægri, Knut, and Iversen, Johs, "Text-book of Modern Pollen Analysis" (Munksgaard, Copenhagen, 1950) (*Nature*, **168**, 309; 1951).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 20

British Society for the History of Science (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. Gordon Manley: "Contributions to Instrumental Meteorology before 1800".

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "Ultrasonics in Industry". Talk by Mr. C. F. Brocklesby (with films and demonstrations).

Society of Chemical Industry, Pesticides Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. Carmichael: "Recent Advances in the Use of Insecticides in Animal Health".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. W. C. Price: "Spectroscopy in Science and Technology" (Inaugural Lecture).*

Manchester Literary and Philosophical Society (at the University, Manchester), at 5.45 p.m.—Prof. Clifford Holliday: "Anuradhapura, Sacred City of Ceylon" (Percival Lecture).

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Dr. D. J. Crisp: "The Changing Climate of Northern Europe".

Tuesday, February 21

Society of Chemical Industry, Agriculture Group (in the Large Chemistry Lecture Theatre, Royal College of Science (Imperial College), Imperial Institute Road, London, S.W.7), at 10.30 a.m.—Symposium on "Some Cultural and Chemical Aspects of Crop Production".

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Kathleen Lonsdale, F.R.S.: "Crystals, Temporary and Permanent: (1) Ice".*

Scientific Film Association (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Mr. A. J. Speakman: "The Film and Work Study".

Oil and Colour Chemists' Association (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. H. T. Bone: "Instrumentation and Automatic Control with Applications to Resin and Varnish Manufacture".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. C. McIntyre: "Design of Low Landing Speed Aircraft".

Wednesday, February 22

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. W. F. Bewley: "The British Glasshouse Industry".

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. G. J. Chamberlin: "Kippers, Cocktails, Confectionery and Colour"; 5.15 p.m.—Prof. M. Richter (Berlin): "Colorimetric Work in Germany".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. L. C. King: "A Geomorphological Comparison between Eastern Brazil and Africa" (to be read by Dr. F. Dixey); Mr. C. Downie: "Microplankton from the Kimmeridge Clay".

Society of Chemical Industry (joint meeting of the Food and Corrosion Groups, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Control of Corrosion in the Dairy Industry".

Thursday, February 23

Royal Society (at Burlington House, Piccadilly, London, W.1) at 4.30 p.m.—Mr. C. H. Gallagher, Mr. J. D. Judah and Mr. K. R. Rees: "The Biochemistry of Copper Deficiency. 1: Enzymological Disturbances, Blood Chemistry and Excretion of Amino Acids. 2: Synthetic Processes"; Mr. J. Green: "Variation in the Hæmoglobin Content of *Daphnia*".

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. H. Burley and Mr. E. J. Perry: "Modern Trends in Dairy Refrigeration".

Physical Society, Acoustics Group (at the National Hospital, Queen Square, London, W.C.1), at 5.30 p.m.—Dr. D. E. Broadbent: "Physiological and Psychological Effects of Noise".

Friday, February 24

Institute of Metals (at the University, Edgbaston, Birmingham 5), at 10.30 a.m.—Informal Discussion on "Furnace Refractories for the Use of the Non-Ferrous Metal Industries".

Institution of Mechanical Engineers, Industrial Administration and Engineering Production Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 2.30 and 5.30 p.m.—Discussion on "The Productivity Report on Industrial Engineering".

Field Studies Council (at Goldsmiths' Hall, Foster Lane, London, E.C.2), at 4.30 p.m.—Annual General Meeting. Prof. S. W. Wooldridge: "On Understanding a Piece of Country".

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. F. Bianchi di Castelbianco: "The Crossing of the Messina Straits with 230-kV. Double-Circuit Overhead Transmission Line".

Royal Institute of Chemistry (at Norwood Technical College Knights Hill, West Norwood), at 7 p.m.—Dr. J. B. Firth: "The Chemist in the Detection of Crime".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. N. Tinbergen: "The Activation, Extinction and Interaction of Instinctive Urges"

Saturday, February 25

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Marian W. Smith: "The Swaixwe—a Social Dance of the American Indians of the Pacific Coast" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Secretary (graduate, preferably between the ages of 35 and 45, with a general knowledge of the content, organization and administration of technical education in this country, and preferably with experience in industry)—The Acting Secretary, National Council for Technological Awards, Ministry of Education, Curzon Street, London, W.1 (February 22).

Assistant Experimental Officer (with G.C.E. advanced level in chemistry or biology and one other science subject and an interest in biochemistry; if over 22 a pass degree, higher national certificate or equivalent) in the Department of Scientific and Industrial Research, Food Investigation Low Temperature Research Station, Cambridge, to assist in studying the chemistry and microbiology of spoilage in poultry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.29/6A (February 25).

Senior Lecturer (with a good honours degree, together with teaching experience, and preferably with industrial or research experience) in Inorganic Chemistry at the City College of Technology, Liverpool—Director of Education, 14 Sir Thomas Street, Liverpool 1 (February 25).

Lecturer in Organic Chemistry—The Principal, Royal Holloway College, Englefield Green, Surrey (February 27).

Senior Research Fellow (with an honours B.Sc. degree in chemistry or biochemistry and research experience) in the Department of Biological Chemistry—The Secretary, The University, Aberdeen (February 29).

Assistant Bacteriologist (science graduate) in the Regional Bacteriological Laboratory, Raigmore Hospital, Inverness—Secretary and Administrative Medical Officer, Office of the Northern Regional Hospital Board, Raigmore, Inverness (March 3).

Assistant Lecturer or Demonstrator in Pathology—The Registrar, The University, Manchester 13 (March 3).

Assistant Lecturer (with special qualifications in applied mathematics) in Mathematics—The Registrar, The University, Manchester 13 (March 3).

Deputy Librarian—The Registrar, The University, Sheffield (March 3).

Lecturer (preferably with a higher degree) in Physics—The Registrar, King's College, Strand, London, W.C.2 (March 9).

Simson Chair of Mathematics—Secretary of University Court, The University, Glasgow (March 9).

Lecturer or Assistant Lecturer in Mathematical Statistics—The Registrar, The University, Manchester (March 10).

Research Assistant (with a degree in biology or a closely allied subject, and preferably with experience in histology) in the Department of Biomechanics and Surgical Materials at the Country Section, Royal National Orthopaedic Hospital, Stanmore, Middlesex—The Dean, Institute of Orthopaedics, 234 Great Portland Street, London, W.1 (March 10).

Professor of Textile Technology in the University Alagappa Chettiar College of Technology, Guindy—The Registrar, University of Madras, Madras 5, India (March 12).

Chair of Physics—The Secretary, The University, Exeter (March 15).

Chemists (3) (with a good honours degree in chemistry, and for one of the posts at least 2–3 years research experience in organic chemistry) for work in a new research group being established in the University of Exeter for investigations of chemistry of tobacco smoke, with particular reference to its possible influence on incidence of cancer of the lung—The Vice-Chancellor, The University, Exeter (March 15).

Air Pollution Engineer (with a university degree in chemical technology or equivalent qualification and about twelve years experience in chemical engineering or allied activities) in the City Engineer's Department, Durban—Messrs. Webster, Steel and Co., 3 St. Helen's Place, Bishopsgate, London, E.C.3 (March 16).

Chair of Prehistoric European Archæology at the Institute of Archæology—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

Chair of Veterinary Medicine—The Registrar and Secretary, The University, Bristol (March 23).

Chair of Philosophy—The Registrar, University College, Leicester (March 24)

Chair of Physical Chemistry at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, March 28).

HEAD (with high academic qualifications, considerable research experience and established administrative ability) OF THE BOTANICAL DIVISION of the Rubber Research Institute of Malaya, Kuala Lumpur—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (March 26).

DIRECTOR (with proved high scientific attainments, preferably in fields related to soils or crops, combined with administrative experience either as head or deputy in the organization and running of a research institute or university department) OF THE COCONUT RESEARCH INSTITUTE OF CEYLON—The Chairman, Coconut Research Board, Department of Agriculture, Peradeniya, Ceylon (March 31).

LECTURER (with a degree in mining engineering, or equivalent, from a university or university school of mines, and either operating or research experience in ore or mineral dressing) IN MINING ENGINEERING at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 31).

SENIOR LECTURER (with a higher degree in psychology) IN PSYCHOLOGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 31).

ASSISTANT CONSERVATOR (with a university degree in forestry) OF FORESTS in Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/15/04.

ASSISTANT LECTURER IN SOCIAL ANTHROPOLOGY—The Secretary, London School of Economics and Political Science, Houghton Street, London, W.C.2.

BIOCHEMIST in the newly equipped Clinical Research Laboratory—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

CHIEF MATERIALS ASSISTANT (under 40, with a wide experience of laboratory work on soils, bitumen, concrete and other building materials, and preferably with a B.Sc. degree or H.N.C. or other similar qualification in physics or engineering) in the Public Works Department, Kenya, to check and control all test results reported by soils, bitumen and building material laboratories, under the direction of the Chief Materials Engineer—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.112/7/036/CI.

LECTURER IN BOTANY (Assistant Grade B)—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

MASTER TO TEACH PHYSICS at least to advanced level together with some Mathematics—The Head Master, Westminster School, 17 Dean's Yard, London, S.W.1.

MEDICAL PHYSICIST (preferably with previous experience)—Group Secretary, War Memorial Hospital, Scunthorpe.

OPERATIONAL RESEARCH OFFICER (with a good university degree in mathematics, science, engineering or economics, and previous operational research experience) to study factors effecting productive efficiency throughout the Corporation—Head Office Personnel Officer, British European Airways, Keyline House, Ruislip, Middlesex.

PHYSICAL CHEMIST (with a first- or second-class honours degree or equivalent qualification in chemistry) at a Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to study rheological properties of solid systems based on visco-elastic polymers and to assist in formulation of such polymers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.77/6A/AA.

RESEARCH ASSISTANT (female, with a degree in chemistry and an interest in the physical chemistry of biological systems)—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey.

RESEARCH PHYSICIST (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

SENIOR LECTURER (with an honours degree in mathematics, and preferably with research experience) IN MATHEMATICS—The Principal, West Ham College of Technology, Romford Road, Stratford, London, E.15.

SENIOR LECTURER (with experience in some field of applied physics (for example: electronics, solid state physics, vacuum technology, applied heat)) IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

TECHNICAL ASSISTANT (with a pass degree or equivalent in chemistry, biochemistry or physiology) to assist in biochemical research into certain aspects of diabetes—Professor of Physiology, The Medical School, King's College, Newcastle-upon-Tyne 1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Cast Iron Research Association. Services to the Ironfounding Industry. Pp. 20. (Alvechurch, Birmingham: British Cast Iron Research Association, 1955.) [612

Scottish Home Department. Freshwater and Salmon Fisheries Research Series. No. 9: A Review of the Literature on the Biology of the Atlantic Salmon (*Salmo salar* Linn). By K. A. Pyefinch. Pp. 24. (Edinburgh: H.M. Stationery Office, 1955.) 4*s*. net. [612

Memoirs of the Geological Survey of Great Britain. Palaeontology, Vol. 4, Part 1: Fossil Plants of the Carboniferous Rocks of Great Britain (Second Section). By Dr. Robert Crookall. Pp. iv+84+24 plates (London: H.M. Stationery Office, 1955.) 60*s*. net. [612

Aero Research Technical Notes. Bulletin No. 154: Structural Features of the Fokker "Friendship." Pp. 6. Index to Bulletins 60–144. Pp. 8. (Duxford: Aero Research Limited, 1955.) [1312

Bulletins of Marine Ecology. (Formerly Hull Bulletins of Marine Ecology.) Vol. 4, Nos. 29 and 30: Continuous Plankton Records—The Decapod Larvae in the North Sea, 1950–51. By Dr. C. B. Rees. List of Records, 1953–54. By K. M. Rae. Pp. 69–84+plates 13–18. (Edinburgh: Scottish Marine Biological Association, 1955.) 10*s*. [1312

Building Research Station Digest. No. 82 (November, 1955). Building Mastics. Bonding New Concrete to Old. Pp. 5. (London: H.M. Stationery Office, 1955.) 3*d*. [1312

Society for the Promotion of Nature Reserves. Handbook, 1955. Pp. 60+3 plates. (London: Society for the Promotion of Nature Reserves, c/o British Museum (Natural History), 1955.) 5*s*. [1312

British Electrical and Allied Industries Research Association. Technical Report L/T317: On the Thermal Excitation of Trapped Electrons in Ionic Solids. By J. H. Simpson. Pp. 18+3 figures. 12*s*. 6*d*. Technical Report L/T318: Gas Temperature in Argon Spark Channels. By R. D. Craig. Pp. 4. 6*s*. (Leatherhead: British Electrical and Allied Industries Research Association, 1954.) [1312

Forestry Commission. Report on Forest Research for the year ending March, 1954. Pp. vi+177+8 plates. (London: H.M. Stationery Office, 1955.) 6*s*. net. [1312

Other Countries

New Zealand Society of Soil Science. The Role of Soil Science in New Zealand Problems By N. H. Taylor. (First Presidential Address.) Pp. 12. 1*s*. (Reprinted from *Trans. Roy. Soc. N.Z.*, 82: 961–71, 1955.) Proceedings of the First Conference. (Held as Section M of the Eighth New Zealand Science Congress, Auckland. May 17th to 21st, 1954.) Pp. 32. 4*s*. (Wellington: New Zealand Society of Soil Science, 1955.) [612

New Zealand: Department of Scientific and Industrial Research. Geophysics Division. Geophysical Memoir 3: Aeromagnetic Surveys in New Zealand, 1949–1952. By V. B. Gerard and J. A. Lawrie. Pp. 20+6 maps and 3 Profile Sheets. Amberley Observatory. Magnetic Results for 1953. Pp. v+58. (Wellington: Government Printer, 1955.) [612

Building Research in Canada, Vol. 2, No. 1 (30 June, 1955). (A Progress Report of the Division of Building Research.) Pp. 32. (Ottawa: National Research Council, 1955.) [612

International Union of Testing and Research Laboratories for Materials and Structures (RILEM). Proceedings of the International Symposium on Nondestructive Testing of Materials and Structures. Vol. 1: Pp. x+1–208. Vol. 2. Pp. ii+209–404. (Paris: International Union of Testing and Research Laboratories for Materials and Structures.) 2000 francs. [612

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes Rendus de Recherches. No. 1 (Novembre, 1955): Travaux de la Commission de Recherches pou l'Étude des tuyanteries à vapeur (Première Partie) Pp. 84. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifiqu dans l'Industrie et l'Agriculture, 1955.) 95 francs. [61

Institut Royal Météorologique de Belgique. Bulletin de la Statio Ionosphérique de Lwiro—Congo Belge, de l'Institut pour la Recherch Scientifique en Afrique Centrale (IRSAC). Vol. 1. Février 1952 Juillet 1953. Pp. 216. (Uccle, Bruxelles: Institut Royal Météoro logique de Belgique, 1955.) [61

Sudan Government. Wellcome Chemical Laboratories, Medica Services, Ministry of Health. Annual Report of the Governmen Analyst for the year 1954–55. Pp. 16. (Khartoum: Ministry o Health, 1955.) [131

Administration Report of the Director of National Museums, Ceylon for 1954. Pp. 21+2 plates. (Colombo: Government Publicatio Bureau, 1955.) 75 cents [131

Bulletin of the American Museum of Natural History. Vol 107 Article 2: Marine Mollusks Collected during the *Askoy* Expedition t Panama, Colombia, and Equador in 1941. By Leo George Hertlei and A. M. Strong. Pp. 159–318+plates 1–3. (New York: America Museum of Natural History, 1955.) 2 dollars. [131

Commonwealth of Australia. Commonwealth Scientific and Indus trial Research Organization. Seventh Annual Report for the yea ending 30th June, 1955. Pp. 265. (East Melbourne: Commonwealt Scientific and Industrial Research Organization, 1955.) [131

West African Maize Rust Research Unit. First Annual Repor 1953. Pp. 48. (Ibadan: West African Maize Rust Research Unit London: Crown Agents for Oversea Governments and Administratio 1954.) 9*d*. [131

Tanganyika. Records of the Geological Survey of Tanganyik Vol. 2, 1952. Pp. ii+66+10 plates. (Dar-es-Salaam: Governmen Printer, 1955.) Shs. 7 50. [131

Northern Rhodesia. Department of Geological Survey. Bullet No. 2: The Geology and Mineral Resources of the Big Concessio Mumbwa District. By R. T. Brandt. Pp. 56+4 plates+1 geologic map. (Lusaka: Government Printer, 1955.) 14*s*. [131

Annals of the New York Academy of Sciences. Vol. 61, Article 4. Biology of Poliomyelitis. By Karl Habel and 53 other Author Pp. 737–1064. 5 dollars. Vol. 63, Article 2: Nutrition in Infection By W. A. Wright and 26 other Authors. Pp. 145–318. 4 dollars. Vo 63. Article 3: Psychotherapy and Counseling. By L. K. Frank an 16 other Authors. Pp. 319–432. 3.50 dollars. (New York: Ne York Academy of Sciences, 1955.) [131

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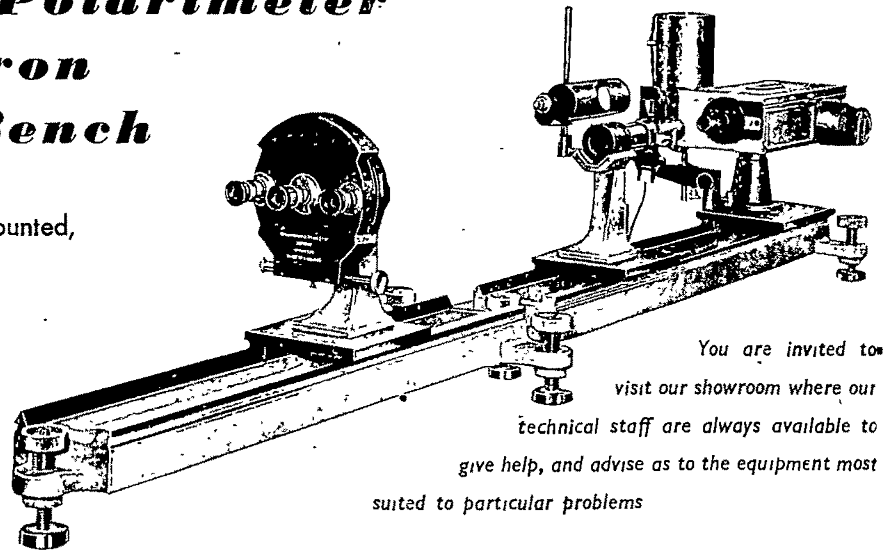

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EDUCATION AND THE RHODES TRUST

THE record of the first fifty years of the Rhodes Trust and the Rhodes Scholarships which has been compiled in connexion with the jubilee of the Trust* is intended primarily for domestic consumption by former Rhodes Scholars, to whom it is being presented. Informal and episodic and admirably produced, its composite authorship does not disturb the unity of the book but rather testifies to the unifying power of the ideal which men of such varied outlook, ability and temperament as Lord Elton, Sir Francis Wylie, Sir Carleton Allen and Frank Aydelotte (American Secretary during 1918–52) have sought to promote. It does not, indeed, claim to be a history of the Rhodes scholarships, still less of the Rhodes Trust. Lord Elton, writing of the Rhodes Trust, endeavours to provide the background against which the personal reminiscences of the Rhodes Scholars in Oxford by Sir Francis Wylie and Sir Carleton Allen, which constitute the core of the book, and Frank Aydelotte's account of the American Scholarships and their administration, may be read. Lord Elton's contribution, in particular, contains shrewd comments and observations on educational issues of the day. A foreword written by Mr. L. H. S. Amery, who died while the volume was in the press, rightly suggests that the story told in its pages has a close bearing on wider educational issues, even if it gives no convincing answer to the question: What did Cecil Rhodes hope to produce by his Foundation? There are, it is true, answers, in some measure, to two other questions noted by Mr. Amery: What has Rhodes's benefaction enabled Oxford to give to those for whom it was intended and to the world outside? And what has Oxford, as a University, itself gained from that benefaction? That those answers are incomplete adds to, rather than detracts from, the value of the book. For it is not only a readable and lively if informal historical record, but also a timely contribution to live issues in higher education to-day. It is timely for the sufficient reason that the record makes it quite clear that generations are required to judge the full effect of experiments in education.

Such a reminder is timely when Britain is faced with the imperative need to expand its system of technological and technical education. It is not always fully appreciated that there is no time to experiment with a technological university—if by that is meant that full expansion must wait until the lessons can be drawn years hence from the results of that experiment. The decision as to what form the expansion of technological education in Britain should take must be based on the abundance of existing experience, and the argument for a technological university rests, in part, on the possibility that a new departure in the British context might yield fresh experience and unexpected results. There is always room for variety in education, but the report on the Rhodes Trust, while testifying to that truth, is equally a warning against committing limited resources excessively to a new departure before we are clear where it will lead.

The warning is needed in other fields besides technological education, and there is another warning to be found in these pages. Even in these fifty years the setting of the Rhodes Trust and of the Rhodes Scholars has changed. Oxford is not to-day the Oxford that Cecil Rhodes knew. As Lord Elton points out, "in the Founder's day, the clamant demand for knowledge as such, the paramount emphasis upon research as the primary duty of a university, was virtually unknown. Mr. Rhodes pictured his Scholars drinking deep of the humanities and rubbing shoulders with their coevals in the College common-rooms and quadrangles rather than as enlarging the sum of human knowledge over a laboratory retort". While to-day the fervour for research is still increasing all over the world, the much wider social strata on which, with economic changes, Oxford now draws has made the University yet more unlike the University of fifty years ago.

These changes have set problems in the administration of the Trust; nor are they altogether avoidable. In deciding education policy which may shape educational institutions for decades ahead, care therefore should be taken to ensure flexibility. It is not merely that the needs of the society which the institutions exist to serve may change, that some functions may become obsolete, that new needs may arise and require service: the nature of society itself may change, and institutions admirably adapted to one form may consort ill with the new one. We need to keep room for manœuvre and for putting more ideas and methods to the proof, and to avoid committing irretrievably the nation's resources into one form which may either fail to fulfil its initial promise or, in unforeseen and changing circumstances, prove less suitable and efficient than was expected.

This is, of course, precisely the argument for the independent institution as the growing point of society in education, no less than in research. This record, moreover, shows the value of the independent and unofficial institution in another respect. The effect of the increasing place which research has come to hold in the life of the university has already been noted, and it has been hinted that this has raised problems for the Rhodes Trustees. Even in 1929, however, the relative advantages of honour schools and postgraduate research were being debated at a conference of members of the selection committees and university officials, most of whom held that Rhodes Scholars should continue to take the undergraduate course at Oxford, as the best and most characteristic teaching which Oxford offered. Most of them also agreed that the importance of higher degrees and research work as a method of education was largely over-estimated. Nevertheless, in his subsequent memorandum to selection committees, Lord Lothian made it clear that a growing proportion of the ablest men could not be expected to compete for Rhodes Scholarships unless adequate facilities for postgraduate study were developed at Oxford.

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* The First Fifty Years of the Rhodes Trust and the Rhodes Scholarships, 1903–1953. Edited by Lord Elton. Pp. xiv+268+19 plates. (Oxford: Basil Blackwell, 1955.) 27s. 6d. net.

Seven years later, in 1936, when recommending the Trustees to contribute £100,000 to the projected University of Oxford Appeal, Lord Lothian pointed out that no university could keep in the front rank unless a considerable proportion of its leading figures were actively engaged in extending the limits of human knowledge, rather than in imparting to successive generations of students the body of learning which they themselves had inherited from their predecessors. In making this gift of £100,000, the Trustees expressed the wish that it should be used to support research in social studies with special reference to "the problems of modern government in the British Commonwealth and the American Republic". Oxford had indeed been chosen by Rhodes because he regarded the study of Greek culture and Roman law as invaluable for young men who were likely to be called upon to practise the art of government.

Education for management and administration and for the art of government was clearly in the mind of the founder of the Trust—or, as perhaps it might be better put to-day, education for leadership. The selection of Rhodes Scholars has obviously been guided by the desire to choose those best fitted by character and intelligence to develop as leaders of their generation in the various walks of life and progress most towards that end by the opportunities which Oxford offers. Nevertheless, there are two important points which any reading of this survey in such a context suggests need fuller consideration.

So far back as 1927, Lord Lothian had expressed doubt whether an increasing tendency then becoming apparent among Rhodes Scholars from the Commonwealth to study the sciences rather than the arts was an advantage from the point of view of Mr. Rhodes's larger ideals. The founder, he argued, had selected the University of Oxford largely because he believed that the type of education given there, with its outlook on the civilization of Greece and Rome, its interest in philosophy, history, law and political science, would develop in his Scholars those attitudes which would specially assist them in the discharge of public duties in after-life. It is not under-rating the value of a scientific education at Oxford or elsewhere to suggest that this point of view should be remembered in the current debates on general education and education for management and leadership.

Sir Carleton Allen makes a specific point in this connexion. He knows of no place where the use of the English language is more sedulously disciplined than at Oxford. "Looseness, verbosity or vulgarity of expression are of all things anathema, and it is, or ought to be, an axiom of tutorial instruction that bad style is bad thinking." If Rhodes Scholars take nothing else from Oxford, they will be in her debt, he suggests, if they have learned to weigh their words before committing them to speech or paper.

Oxford's special strength may well lie, as Sir Carleton suggests, more in its tutorial system than in its supervision of research, and even in the natural sciences, where the research technique of Oxford is most highly developed, there is danger that a Rhodes Scholar may become so tied to his laboratory that he is alienated from the more miscellaneous but educative activities of student life. We may accept, too, that the man who is living in college and working under a good tutor is more likely than the specialist to get the characteristic flavour of Oxford and enter into the main current of its life, and that not every Rhodes Scholar will profit more by postgraduate work than by a 'final honour school'. If, however, a scientific discipline fails to impart precisely that care in the use of the English language which Sir Carleton lays down as characteristic of Oxford, there is something wrong with the teaching of those disciplines. It is not that science is not worth study by the Rhodes Scholar, but that the teaching of science should be on a par with the teaching of those other disciplines in which Oxford has been pre-eminent.

This is an important point, for we cannot expect the Rhodes Scholar to take the place in the world of to-day and to-morrow that the founder of the Trust envisaged unless he is equipped to understand the forces which are moulding it and the way in which they work. An understanding of science and its method is as essential a part of the equipment of the administrator or statesman to-day as the ability to weigh his words and communicate his ideas clearly and concisely. It is also true that the Rhodes Scholars are unlikely to exert their full influence on the world of to-day unless a reasonable proportion of them enter the world of science; and this does not appear to be happening, at least on the evidence provided by the records and statistics collected by Sir Carleton Allen.

Among the Commonwealth Rhodes Scholars, the proportion studying sciences has increased from 54·2 per cent before the First World War to 68·1 per cent between 1918 and 1925, but fell to 35 per cent in 1954; among American Rhodes Scholars the corresponding figures are only 12·2, 14·7 and 16 per cent. While the roll includes such names as those of Dr. Wilder G. Penfield, Sir Howard Florey and Sir David Rivett, the analysis of vocations of former Rhodes Scholars reveals only six who pursued agriculture and animal husbandry, 46 chemists (chiefly industrial), 79 engineers, 19 foresters, 15 geologists and geophysicists, 171 medicals, 66 other scientists, mainly physicists, besides 3 anthropologists and one archæologist who could possibly be included under science, a total of 406 out of the 2,571 Scholars elected up to 1949 whose careers are recorded by Sir Carleton Allen. It does not, however, take account of the 138 scientists included in the 618 Scholars who adopted an academic vocation.

Sir Carleton Allen also notes that postgraduate work is attracting an increasing proportion of Rhodes Scholars, the percentage of those reading for research degrees ranging from 30 to 41 between 1947 and 1953, and of these nearly one-half are engaged in one or other of the natural sciences. Nevertheless, it is more than doubtful whether, however carefully the Rhodes Scholars continue to be selected, they will make in the future the powerful contribution to the national life of the countries from which they come or in which they elect to spend their professional life, unless something more than a fifth of them on average have studied the sciences. It would be fatal to that influence in an age in which nuclear physics is placing such immense possibilities for good or evil in the hands of men if the impression prevailed that, as a class, the Rhodes Scholar usually lacked first-hand acquaintance with the forces that are shaping the world.

Admittedly, science is not the only force involved, but it cannot be ignored and it can only be guided if understood. We need more than ever that influence upon the outlook on intellectual and moral problems which Rhodes Scholars have exercised upon all the professions they have taken up. That influence, derived essentially from Oxford, is described by Mr. L. H. S. Amery as one of the most important services rendered by the Rhodes Scholar; and he concedes, too, that the practical needs of the Rhodes Scholars have steadily reinforced the growing recognition of the importance of research, of the fact that a great university cannot live merely by transmitting an existing body of knowledge and ideas but must make its contribution to the body of knowledge. The Rhodes Scholars must therefore keep in the full stream of modern life and represent and interpret not merely the best traditions of the past and aspirations of the present but equally the forces that are shaping the future.

There is one point noted by Lord Elton in discussing the influence of the scholars and the scholarships which has its bearing on the problems of higher technological education and the general education of both the scientist and the arts graduate in Great Britain. Lord Elton believes that the care taken in selecting Rhodes Scholars for their possession of character as well as of intelligence makes the Rhodes scholarships an even more important influence for good in the life of a university. Until recent years, the tendency in our general scholarship system to concentrate exclusively on the possession of intellectual qualifications has been largely offset by the fact that a high proportion of those obtaining scholarships came from Public Schools, in which emphasis has always been laid upon the training of character. These schools no longer supply the same proportion either of 'open scholars' or of the general body of undergraduates, and at the same time the life of a university is also impoverished by a decrease in the numbers of those, adequately industrious and intelligent, but whose independent means enable them to take a more active part in the social and athletic life of college and university.

This is a trend of which due account should be taken in expanding the provision for higher technological education in Britain, and in our plans to meet the impending 'bulge' in university students in the 'sixties. We cannot rely entirely, even at Oxford, on the beneficial influence of the Rhodes Scholars. But at the least, this inspiring account of the translation into practice of a great ideal is a reminder of the importance of vision and flexibility where educational institutions are concerned, of the need to avoid hasty judgments and preconceived ideals, and of allowing for more ways than one for achieving our purpose before we take decisions which may affect the welfare and service of the State not merely to-day but for a generation or more to come. The Rhodes Trust and the Rhodes scholarships are a supreme demonstration of the truth of Sir Ernest Barker's words in "Age and Youth": "I had always felt that much of what was great and fine in the history of my country —much in its religious life, much in its system of education, much in its development overseas into a Commonwealth of free nations, much in its system of parties and in its general system of self-government—was ultimately based on my countrymen's habit of doing things together for themselves in voluntary co-operation".

FOOD PROBLEMS IN THE UNITED STATES

Handbook of Food and Agriculture

Edited by Fred C. Blanck. Pp. vii+1039. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 100s. net.

THIS is a remarkable book. It is a collection of twenty-six chapters, each by separate authors, of whom there are twenty-nine: it runs to more than a thousand pages of about five hundred words to a page, and it deals with almost every aspect of food production, processing, packing and delivery, especially with the last three items. The section on production is the lightest, consisting of four chapters only, dealing respectively with soils, soil fertility, soil microbiology and fertilizers, covering altogether less than a hundred and fifty pages. Within the limits of space thus imposed, the accounts are good and include most of the subjects recently investigated in America. There are few references to work done outside the United States: in the account of the fixation of nitrogen by leguminous plants, no mention is made of H. G. Thornton's classical investigations; and in describing composts, the need for adding a source of nitrogen such as calcium cyanamide to feed the bacteria and thereby hasten decomposition, which was demonstrated by H. B. Hutchinson and E. H. Richards at Rothamsted in 1921 and formed the basis of the 'Adco' patent, is attributed to an American investigator in 1948. Nor in the fertilizer section is any reference made to the Rothamsted experiments or to the need for proper statistical control of the design of the field experiments and the discussion of the results.

The book must be read, therefore, as principally a statement of American results, and from this point of view it is a mine of interesting and valuable information. Thanks to the friendly co-operation between the soil workers in Britain and in the United States, the material in the chapters on soil is pretty well known to experts in the former country. Some of the information on fertilizers, however, will be new to many readers. Soil conservation activities in the United States have raised the consumption of liming materials from 3·3 million tons a year in 1935 to 13·1 million tons in 1940 and 26·5 million tons in 1950. Prior to 1900, organic manures supplied more than 90 per cent of the nitrogen added to the soil; since 1950 they have supplied less than 4 per cent, the rest being from chemical fertilizers. These supply more than a million tons of nitrogen a year, much of it in the form of ammonium sulphate, but a large and increasing use is made of free ammonia, for which special appliances have been designed. Slow-acting nitrogenous fertilizers based on urea are coming into use, and promise to solve some of the grower's difficulties; it is interesting to note that for this purpose urea has to be imported. As in the United Kingdom, American farmers show a decided preference for mixed fertilizers over single ones; the general formula has changed in the same direction: prior to 1915 the ratio $N : P_2O_5 : K_2O$ was 1 : 4 : 1; it is now approximately 1 : 2½ : 2. There is a tendency also to use more concentrated fertilizer, but granulation is not as usual as in Britain. A very informative chapter on pest control agents includes some pages of constitutional formulæ of the more common organic substances used for this purpose and made on an increasingly large scale—a triumph of modern chemical technology. The need for these control agents is growing: the damage done annually in the United States by insects is roughly estimated at 4 thousand million dollars, by plant diseases at 3 thousand million dollars, and by weeds at more than is done by insects and all plant and animal diseases put together. The authors state that the apple grower "has to compete with 200 infectious diseases and 100 insect pests in order to produce a marketable crop"; it is not surprising the United States Department of Agriculture has a list of thirty thousand pesticidal formulations.

Most of the book is occupied by the processing, storage, packing and transport of foods; these chapters are a rich mine of interesting and sometimes intriguing information. Wheat is made into a number of different foods, in all of which it can be recognized. But maize can be used in making a surprising number of products of the most diverse character: foods for man and beast, antibiotics, cosmetics, chewing gum, explosives, rayon, tobacco, paper, soap, ice cream and various other things. The book ends with some useful chapters dealing respectively with control of quality in food, the disposal of food-plant wastes, and the use of chemicals in food. Altogether, it is an interesting volume.

But it is dear. Its price in Britain is £5—a reflexion, no doubt, of the high cost of production in the United States, but all the same hard on a British buyer. E. JOHN RUSSELL

THE EXTRA PHARMACOPŒIA

The Extra Pharmacopœia (Martindale)

Vol. 2. Twenty-third Edition in two volumes. Pp. xxxi+1501. (London: Pharmaceutical Press, 1955.) 57*s.* 6*d.*

THIS book, which is the latest reincarnation of the second volume of the famous work by Martindale and Westcott, contains a large amount of compact information. The two volumes of the twenty-third edition together contain more than 2,850 pages. The first edition was published in 1883 and contained only 313 pages, and the book grew slowly at first and then rapidly between 1900 and 1910. Since then it has grown at a fairly steady rate, but the interval between editions has increased from two years up to eleven or twelve, so that the amount of matter added with each edition has increased. It is a pity that the interval has grown so long, but the labour involved must be enormous.

In this Vol. 2 about 450 pages are devoted to analytical addenda to Vol. 1—the methods by which the pharmacists ensure that the drugs we use contain the proper ingredients and nothing more. Sections are devoted to *p*H, oxidation potentials, polarography, indicators, ion-exchange resins, chromatography, spectrophotometry, fluorimetry, the microbiological assay of vitamins, food analysis, water analysis, sterilization, disinfectants, radiotherapy, electrotherapy, nutrition, hæmatology, clinical biochemistry and various other topics which come within the wide range of subjects which the pharmacist understands.

The section on the nomenclature of organic compounds has developed gradually through several editions, and will now be very valuable to those who have to try to understand organic structures without being organic chemists. It is a pity, however, that there seems to be no clue to the meanings of the prefixes such as *cis* and *meso* mentioned on p. 768, and surely *nor* means "N ohne radikal" and not "the next lower homologue".

There is a stimulating section on what the Americans call SAR (structure action relationships), but sulphanilamide was not the first useful drug the action of which was traced to its close resemblance to a natural metabolite (p. 780). The theory that some drugs act in this way had been widely discussed in connexion with eserine, atropine, ephedrine and other drugs for many years before it was applied to sulphanilamide.

Enough has perhaps been said in this review to show that the book not only gives much information, but also provokes thought. It is a worthy successor to a long line of famous forerunners.

J. H. GADDUM

ANTHROPOMETRY AND HUMAN ENGINEERING

Anthropometry and Human Engineering

A Symposium on Anthropometry, Human Engineering and Related Subjects conducted by the AGARD Aeromedical Panel on 3 and 4 May 1954 in Scheveningen, The Netherlands. (AGARDograph No. 5.) Pp. iv+123+3 plates. (London: Butterworths Scientific Publications, 1955; published for A.G.A.R.D.) 21*s.*; 3 dollars.

THIS publication originated from a symposium conducted by the Aeromedical Panel of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, and shows a well-defined grouping of related papers. The various approaches by the different authors add considerable interest to what could be a heavy subject. Its scope is wide, and it should be of interest to the aeronautical engineer and applied psychologist. Indeed, the latter may be impressed by the scope and importance of the work in his field introduced in this volume. Basic concepts of instrument display and design are explained in a lucid manner. It is apparent that controversial issues are developing rapidly, and there is a great need for more fundamental research along these lines. In this respect, the topics introduced by the various specialists in aviation medicine and psychology point out shrewdly the future trends. Anyone concerned with instrument design outside the aviation industry might well take heed of these aspects of human engineering which have a universal application.

The papers devoted to anthropometry indicate the impetus given to statistical work of this nature by aviation in general. In the man/aircraft combination, the work space is critical, and approximately one-third of the book is devoted to this subject, which includes a large-scale survey of body measurements carried out in the French Air Force. Research and applications carried out for the Royal Air Force are summarized in an excellent manner and point out to the engineer his responsibility in this field.

The third part of the book, dealing with related subjects, is essentially the general medical application of the previous concepts to aviation. For example, a paper on somatotyping by P. M. van Wulfften Palthe (Netherlands) usefully supplements the French statistical survey. It is suggested that anthropometric studies may be linked with psychological profiles drawn up by air-crew selection boards according to the principles developed by Kretschmer and Sheldon. Altogether, the book should arouse wide interest and appeal to many not directly concerned with aviation. F. LATHAM

SERVO-MECHANISMS AND CONTROL SYSTEMS

Engineering Cybernetics

By H. S. Tsien. Pp. xii+289. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 46*s*. 6*d*.

WHEN a new book arrives on my desk nowadays, I am always hoping that it may not be yet another book on servo-mechanisms and control. Usually it is the mixture as before: a few hackneyed phrases to be written about the ever-growing need for more automatic control in industrial processes; the need for a sound mathematical background; the wide interpretations of the concept of feedback; the accelerated growth of a new science, etc. For the market is flooded with books on the subject. When I saw the title of the volume under notice, "Engineering Cybernetics", my fears were roused, and I must admit to approaching the work with a sense of irritation and in an antagonistic mood. The author has done himself a great disservice in choosing such a misleading means of introducing his book; for a glance at the contents and the preface shows it to be confined strictly to the field of mechanism, making no reference to biological matters or sociological affairs.

But if the title was a frightening thing, the contents were a soothing balm—for this book turned out not to be the same old medicine. Regarded strictly as a text upon the theory of servo-mechanisms and control systems, and nothing else, it is honest and excellent. A great deal of material will be found which is not readily available, to my knowledge, in any other collected form. It can be recommended to the attention of fairly advanced students of servo-mechanism theory, feedback and control processes. In his preface the author excuses the title on the grounds that it denotes ". . . an engineering *science*. whereas servo-mechanism engineering is an engineering *practice* [italics his]. . . . No gadget is mentioned". But I protest: gadgets are mentioned. The book is full of them—diagrams and sketches of springs and dashpots, amplifiers and air-foils, relays and rockets; and a good thing too, for such intellectual prudery is quite out of place. Further, one excellent point of this volume is the great number of fully worked examples—really practical ones.

The author has succeeded well in presenting the essential mathematical techniques, methods and concepts, with explanations and illustrations drawn from a great variety of engineering mechanisms. The introductory sections perhaps serve little purpose, being bare facts about Laplace transforms, lists of operations, and rapid surveys of the mathematical elements; this is a fault which seems very common in many American text-books of this type. Either the reader must know his elements already or he must study them seriously, and at laborious length; he will gather little understanding from the sort of distillations so frequently seen. But this book very soon gets down to work. After a few chapters presenting what is by now the classical treatment of feedback mechanisms, more modern material is introduced. Systems with several controlled quantities are studied, with their interactions; and the need for new stability criteria is considered, with representation of such system behaviour by transfer-function matrices. A small criticism is that several electrical engineering terms, such as 'carrier', 'filter', are used without explanation. Would not a few words help mechanical engineers?

Systems having statistical inputs are taken next, after a good introduction to random process theory: averaging, correlation, power spectra, moments. Then relay servos are treated, their stability being examined by a modification of the well-known Nyquist criterion. This continuity of concept, with extension as proves necessary, is a most commendable policy adopted here. The student can hang on to reality a long while in terms of his existing mental images; and it becomes very clear when, and why, such images fail utterly and must be abandoned.

The work continues with the general properties of non-linear systems, and then with systems having variable coefficients, at which point the classical transform approach must be abandoned. Later chapters deal with the design of specific systems by perturbation theory; here, almost the entire work centres around one class of practical problem—the design of guided missiles to follow prescribed trajectories, or to seek a prescribed target—and the author reveals his own specialization. This problem is carried to great lengths, and includes allowance for the effects of atmospheric variations, for missile manufacture tolerances, etc. Both analysis and synthesis are studied.

There is a good deal of valuable descriptive material, besides the formal mathematics, in this book, giving some notion of purpose, of design difficulties, reasons for choice of methods and other matters so commonly omitted from such books—perhaps not being understood by the theoreticians writing them. But I would beg the author to change the title before a second edition. COLIN CHERRY

Gas Dynamics of Cosmic Clouds

A Symposium held at Cambridge, England, July 6–11, 1953. Edited by H. C. van de Hulst and J. M. Burgers. (International Union of Theoretical and Applied Mechanics and International Astronomical Union. I.A.U. Symposium Series—No. 2.) Pp. xii+247+12 plates. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1955.) 19 Dutch florins; 38*s*.

THE forty-four chapters in this book are mainly amended texts of papers and edited versions of discussions which took place at a symposium in Cambridge two years ago, and they were up to date in the summer of 1954. The meeting was the second of its kind, the first having been held in Paris in 1949. The report of the 1949 meeting, published under the title "Problems of Cosmical Aerodynamics" (Dayton, Ohio: Central Air Documents Office, 1951), gave the impression that the dynamics of cosmic clouds was a well-understood subject and that, for example, one needed only conventional turbulence theory, correctly applied, to explain the spiral structure of our galaxy and the motion of interstellar material.

The present report is quite different. There are many problems left after all. To take a few: Has our galaxy got spiral or circular arms and can present methods of observation ever tell us unambiguously? Do interstellar clouds sometimes condense to form new bright stars? If so, what happens to their angular momentum? Does uneven heating by these stars cause the irregular motion of the gas clouds? Do the clouds really move at Mach five, or even ten? What kind of theory applies to this type of turbulence?

The aerodynamicists at the symposium tried to help with reports of theoretical and practical studies, but contact was not really made: the phenomena to be explained are still a little too complex. However, the book makes stimulating reading and contains some very fine pictures. Even the reports of the discussions are worth looking at, for that is where many of the best remarks were made.

F. D. Kahn

Papirová Chromatografie

Edited by Dr. I. M. Hais and Dr. K. Macek. Pp. 720+10 plates. (Praha: Nakladatelstvi Československe Akademie Věd, 1954.) Cena brož, 136 Kčs.; vaz, 142 Kčs.

AS this book is written in the Czech language and is evidently intended mainly for workers in Czechoslovakia, any detailed comments would not be of interest to most readers of these columns; but it may be pointed out that the book provides Czech workers with a guide to all aspects of paper chromatography that is as useful as any which has been published outside that country. Among many valuable features are the detailed discussions of the applications of paper chromatography in structural studies of proteins and polysaccharides and of the applications of polarographic methods in quantitative work, topics which have not always received the attention they deserve in the books on chromatography.

The bibliography contains well over four thousand references and covers the literature up to 1953. As the title of each reference is given in full in its original language, this bibliography is of universal value and is probably the best source for Czech, Hungarian and Russian references. Another feature of general interest is the systematic list of a large number of reagents for detecting substances on chromatograms and of buffer systems used in paper electrophoresis. These directions can be fairly well followed even without a knowledge of Czech. It is to be hoped that copies of this treatise will be made available at least to the larger science libraries in countries outside Czechoslovakia.

R. Consden

Elementary Introduction to Molecular Spectra

By Børge Bak. Pp. x+126. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1954.) 9 Dutch florins; 18*s*.

A BOOK on molecular spectra as concise as this one deserves serious consideration. Excellent monographs which treat in detail of various aspects of the subject exist, and their number is added to year by year, but there remains a real need for a balanced introductory book to give the range and feel of the subject. The author has been bold enough to attempt this in the limit of 125 pages.

The result is not entirely satisfactory. Experimental matters are dismissed so superficially that the reader will scarcely form any useful idea of what the techniques are like, and he is never made to come to grips with a spectrum, so that the problems of analysis must remain unreal. There is a discussion (pp. 24–58) of the theoretical basis of the subject which occupies a disproportionately large space, but which will yet be of small help to a beginner. The emphasis, too, will not meet with acceptance everywhere; this is laid on the measurement of wavelength, and there is little talk of intensities. Justice is scarcely done to the vast body of work on quantitative ultra-violet absorption spectroscopy.

The book was prompted by a sound idea, and there is some good stuff in it—good enough, indeed, to make one hopeful that a revised edition will approximate more closely to what is wanted. The price is high: the language sometimes distinctly odd.

R. F. Barrow

Introduction to Theoretical Mechanics

By Prof. Robert A. Becker. (International Series in Pure and Applied Physics.) Pp. xiii+420. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 57*s*. 6*d*.

THIS book provides a straightforward and extremely competent introduction to the subject of theoretical mechanics. It may be said roughly to cover the three years of an honours physics degree-course in Britain; it starts with a chapter mainly devoted to vector analysis, and leads, through the usual topics in mechanics, to subjects such as accelerated reference systems, motion of a rigid body in three dimensions, generalized co-ordinates and vibrating systems.

It is definitely a work for physicists. The physics of each problem is clearly stated, and the mathematics introduced is shown to be the most suitable for the purpose concerned; there is no mathematics for mathematics' sake. The practical nature of the book is emphasized by the provision of problems at the end of each chapter; these are carefully chosen to provide all grades of difficulty so that both the average and the good student can test their abilities on them. Altogether, the book can be recommended as a reliable, workmanlike and carefully presented introduction to theoretical mechanics.

MARINE SCIENCE IN THE PACIFIC AREA

THE growing needs of marine research have brought to the United Nations Educational, Scientific and Cultural Organization many appeals for help from a wide range of projects, and the Director-General has felt the need for an advisory committee. Having received the necessary authority from the General Conference of 1954, he discussed the usefulness of such a proposal with a representative group of oceanographers meeting in 1955 after the Food and Agriculture Organization meetings in Rome, and after consulting that body and the International Council of Scientific Unions, he nominated an Interim Advisory Committee, with nine members and provision for regular changes in membership. Clear emphasis was given to the need for good working relations with the United Nations and its Specialized Agencies, and with the international scientific unions and regional bodies which are concerned with oceanographic and fishery research.

The Interim Committee met for the first time during October 24–25 and, on the invitation of the Japanese Government, the meeting was held in the International House of Japan in Tokyo. Symposia on oceanic circulation bearing on the biological resources of the Pacific Ocean, oceanographic instruments and exchange of information were held just before the meeting, and these followed a regional gathering of representatives of marine laboratories and the sixth session of the Indo-Pacific Fisheries Council.

The Advisory Committee started with a general discussion of trends and progress in marine research; it is not easy to summarize this without the full record, but some of the main features can be outlined. It was emphasized that there is still plenty of room for exploratory and descriptive work, especially in the Indian and South Pacific Oceans; but there was also clear insistence that much more than this is needed before the scientific studies can be applied successfully to the practical problems. It was emphasized that the problems are now of such a calibre that they need the attention of physicists, mathematicians, chemists, biologists and geologists who have proved outstanding in their own fields, and it was considered that applications of recent advances in these sciences to the study of the oceans have already proved sufficiently rewarding to interest specialists in applying their ideas to the ocean.

In physical oceanography new techniques and the methods of mathematical physics are beginning to revolutionize our understanding of ocean currents and waves. In marine chemistry such advanced techniques as mass spectroscopy, radiochemistry, emission spectroscopy, chromatography and biological assay are adding fresh significance to studies of substances present in very small concentrations and doing much to further the study of biogeochemical cycles. In biology new applications of genetics, biochemistry, population dynamics, physiology and bacteriology have furthered problems of great importance in the sea, and it seems very desirable that they should go hand in hand with future work on taxonomy, life-histories, morphology, zoo-geography and ecology. There was, however, some feeling that progress in marine research might suffer if the detailed studies, especially some of those using marine animals, are made without keeping the wider problems of the sea, particularly those of the deep ocean, in mind. In submarine geology the techniques of geophysical exploration and the latest methods of physical and chemical analysis would have to be used, as well as echo sounders and the older methods, to study the morphology of the sea floor and the character of the sediments.

There was some general discussion on the kind of laboratory needed for marine research. No one seemed to have much enthusiasm for an international laboratory entirely dependent on contributions from a number of countries. One of the objections was that marine research cannot be planned so nicely that each country would feel that its own interests and problems were receiving a fair share of attention. The difficulties might be less if the programme included the short-term examination of a number of immediate problems, but it seemed very doubtful whether the atmosphere of a joint laboratory, which had to justify itself continually to a joint administration, could be conducive to long-term research. Even in fisheries research, where knowledge of the life-histories, growth-rates and natural fluctuations in numbers of the principal food fishes is of obvious importance, joint ownership had not proved itself very sympathetic to a systematic approach.

There seemed to be a general feeling that support from private funds was conducive to stability and freedom for research, and that there were real advantages in making a relatively modest start centred on some local enthusiasm, emphasizing one aspect, probably marine biology, with later expansion into the other fields as additional funds became available for staff, ships and shore facilities.

For the more developed countries, the Committee considered that progress depends to a large extent on national centres for the marine sciences, at least partly supported by government funds. It was maintained that recent experience has shown that such centres should include men with special training and interests in applied mathematics, theoretical and experimental physics and geophysics, chemistry (geochemistry, biochemistry and analytical chemistry), geology, meteorology and biology (both experimental and ecological). Although the growth and outlook of a new laboratory depend to a large extent on personalities and local conditions, it seems essential to employ more than a certain number of permanent scientists (probably about ten) and to provide for adequate support in facilities and technically trained assistance. There was a general feeling that the research centre should be closely associated with a university.

The need for better facilities for the study of the deep ocean was specially emphasized, and although fairly serious difficulties are foreseen, a study of the feasibility of operating an international research vessel, to work primarily in little-explored areas, was considered well worth while. It was argued that the marine sciences are a natural and invigorating field for international collaboration, and that there is much in the study of the seas and marine animals to enrich human life culturally as well as economically.

Although it was not the business of the Interim Committee to decide the position of a Unesco Advisory Committee on Marine Sciences in relation to other organizations, particularly the International Council of Scientific Unions and the Food and Agriculture Organization, the question was often mentioned and there seemed to be a general feeling that the new committee would do useful work without wasteful overlapping. None of the scientists seemed to think a precise definition was needed, since each authority must obviously interest itself in the work and aims of the others while arranging its own meetings, grants and other activities with its own primary object in mind. The Food and Agriculture Organization has a primary duty to see that the best practical use is made of new and established methods and knowledge to find more fish and improve the supply, and to achieve this it must further education in the less-developed countries and support research in more-advanced countries to find improved techniques and a more effective understanding of the basic biological and physical processes. The International Council of Scientific Unions is concerned primarily with the development of the science; and although it is interested in seeing that all countries share in new developments and advantages, it must concentrate on invigorating the efforts of the most successful scientists. Unesco also has to encourage the new advances as, for example, by its generous treatment of the scientific unions; but its primary concern is to spread the science and its cultural advantages as widely as possible, taking special care of the less-developed countries.

The need to ensure that the relatively small international funds available for furthering marine research are used most efficiently was always in the forefront of the deliberations. The expense of administration and travel was lamented, but the importance of using them as energetically as possible to communicate enthusiasm, ideas and results was fully recognized. There can be no doubt of the value of the meetings in Tokyo. There was a good representation of Japanese scientists, a fair number of representatives from other marine laboratories in the Far East and a few American and European scientists, including representatives of the U.S.S.R.

Marine Science in Japan

The International Directory of Oceanographers, published by the Allan Hancock Foundation, lists only 129 names for Japan as against 195 for the United Kingdom; but in view of the number of laboratories and ships devoted to marine research in Japan, it seems likely that a rather different method of selecting names was used. Among the research institutions are the Japanese Hydrographic Office, under the Maritime Safety Board, seven regional fishery laboratories, the Central Meteorological Office and its four subordinate marine observatories, the Tokyo University of Fisheries, the Disaster Prevention Research Institute in Kyoto University, the Transportation Technical Research Institute and Whale Research Institute, and a number of university faculties devoted to fisheries and geophysics. This is by no means a complete list, since active research is also being carried on in laboratories devoted to basic sciences such as the Institute of Chemical Research, Kyoto University, and many other university departments. They are assisted by eighty ships, not counting vessels less than 20 tons, and although these are not entirely devoted to research they are actively engaged fully or part time in oceanography.

Such exceptional interest in the sea can be explained only by Japan's need to use marine resources to the full, and to take the most effective safety measures she can against the hazards of the typhoons and submarine earthquakes by which she is continually threatened.

Much of the work in marine physics has been related to the needs of navigation, meteorology, coastal engineering and the fisheries. The Japanese say they made their first sounding in 1872; but they have now very extensive programmes of coastal and oceanic surveys being made with the most modern methods. One of the most detailed surveys, of the strait between Honshu and Hokkaido, was made with the help of a portable set of Decca Navigational Aid, and it is claimed that a horizontal accuracy of ± 10 metres was obtained as far off as fifty miles from the stations. They have made extensive studies of the marine sediments, and have located several coal- and oil-fields on the continental shelf. Tidal observations have been made at more than a thousand places, and a new 42-component Légé tide-predicting machine is being installed. Particular attention is paid to the tidal streams, and a number of types of ingenious continuously recording meters are in regular use. Wave recorders are being used for studies of coast erosion, and tide recorders for research on seismic surges (tsunami) and storm surges (takashio). The marine meteorological research is primarily aimed at better understanding of the processes of energy exchange between ocean and atmosphere, and prediction of the water temperature; but the Central Meteorological Observatory has biologists and chemists as well as physicists in its oceanographic section, and initiates studies of the distribution of microplankton and macroplankton in relation to the water masses as well as variation of sea conditions, current boundaries, etc.

The fisheries research is aimed primarily at finding and improving the exploitation of fishing grounds and attempting to foresee fluctuations in distribution and numbers of mackerel, sardine, squid, herring, salmon, shipjack, tunas and whales. The work includes extensive ecological surveys of spawning and nursery grounds, and detailed studies to improve the understanding of variations in the principal currents, particularly the Kuroshio and Oyashio. It includes research cruises to the Bering Sea and more than half-way across the Pacific Ocean.

As in other countries, there is no obvious or logical division between the basic and applied research; but there seems to be a tendency for the initiative in the basic work to be with the universities, though they do not lack active collaboration from the government and regional laboratories devoted to hydrographic, meteorological and fisheries research. In marine physics there are energetic studies of wave generation and propagation, beach currents and shore-line changes, and a co-operative programme between the oceanographers and the Shipbuilding Research Association has recently been commenced. Forecasting of waves and swell is being studied and special attention paid to conditions of dangerous wave interference associated with typhoons. Theoretical and observational research on long waves, seismic and storm surges includes studies of the effects of dispersion, reflexion and refraction. Natural oscillations in lakes, bays and harbours are being investigated in connexion with harbour construction. Basic studies are being made of tidal oscillations, with particular attention to conditions in rivers, straits and shallow seas. A start has been made with studies of turbulence associated with the streams. Some experience has been gained in the use of electronic analogues. Statistical studies at the Earthquake Research Institute show that there is a tendency for the monthly mean sea-level to drop sharply before the large earthquakes.

Theoretical work on oceanic circulation presents many difficulties due to lack of information about actual velocities and mixing processes, and to the rapidly increasing complexity of the reasoning as the basic assumptions are made more and more realistic. The output of the Japanese workers in this field, largely owing to the influence of Prof. Hidaka, is enough to set ideas and conclusions running ahead of the observations and experiments. Marine research in Japan is likely to become remarkably productive if the theoretical workers are more actively helped and invigorated by the physicists, engineers and ships. There is a good measure of co-operation, but the practical facilities voted for attacks on obvious practical problems have to be devoted largely to methods which have been proved. This often means that the theoretical workers have to spend too long with pen and paper before they can put new ideas to work, and have their work stimulated, intensified and improved by practice and closer inquiry. This is a universal problem, but anyone attempting to survey marine science in Japan cannot fail to be impressed by the great wealth of observations, some of which have to be dealt with in fairly general terms, and by a similar wealth of theoretical work, some of which has to seek rather hard for the measurements that it believes most significant. The Japanese scientists lose no opportunity of checking measurements with hydrodynamical theory, and are well aware of the need to devote as much of the practical effort as possible to basic studies; but they might be able to do more if the responsibilities and burden of some of the practical requirements were shared by academic and technical workers in a laboratory in which both were well represented.

Some twenty Japanese scientists are making active contributions to the chemistry of the sea, including the development of new analytical methods and studies of variations in oxygen, carbon dioxide, nitrogen, phosphorus and other nutrients in relation to productivity, water movements and sediments. Attention is being paid to the elements in minor concentrations and to the geochemical implications of the work. Measurements of radioactivity near Bikini atoll have been used for studies of diffusion.

Japan has twenty marine biological stations, each with a staff of two to five full-time research workers as well as technical assistants and facilities for working in coastal waters. They lie between 33° and 43° N. over a very wide range of exposure and water conditions. In some the investigations are mainly physiological, without much immediate application to ecological and oceanographic problems. The local faunas are described, though not as completely as for some European laboratories. For work in the open ocean they rely on co-operation from the hydrographic, meteorological and fisheries laboratories, and active work is being done on productivity, indicator species, and the general character of regional faunas in relation to oceanographic factors. They emphasize the need for more taxonomic studies.

The Japanese instrument makers arranged an exhibition in connexion with the Unesco meetings, and it was apparent that they are keeping pace with new developments in marine research.

The International House of Japan was an ideal house for the meetings. The lecture hall will seat two hundred, and the dining hall and adjacent lounge could be combined to accommodate about the same number. There are forty-two bedrooms, single and double, and the service and meals were excellent. It is a non-profit organization, made possible by £100,000 collected in Japan and a grant of £125,000 capital expenditure and £25,000 a year for the first five years from the Rockefeller Foundation. It was formally opened in June 1955, and its activities aim primarily at promoting and sponsoring the international exchange and co-operation of intellectual leaders and creative artists, though some of its programmes are planned for students and the general public. The Japanese writer and lawyer Shigeharu Matsumoto is its managing director.

G. E. R. Deacon

RESISTANCE OF INSECTS TO INSECTICIDES

On January 9 the Association of Applied Biologists and the Society of Chemical Industry held a joint symposium in London on the subject of the resistance of insects to insecticides. The morning session was devoted to a discussion of the changes in resistance that can occur naturally before any kind of selection has occurred. The afternoon session was chiefly concerned with a discussion of the resistance that may develop following the use of insecticides.

The first paper, by C. Potter, dealt with the variations in resistance to insecticides that normally occur throughout the life-cycle of an insect and of the effect that differences in nutrition may have on resistance. It was pointed out that, in practice, insecticides are usually applied to kill a particular instar of a pest and it is important to choose the most susceptible instar for attack. Furthermore, since there can be variation of resistance with the age of the instar, detailed knowledge of the extent of these changes is desirable if control measures are to be put on a rational basis. Examples were then given to show the extent of the changes in resistance to insecticides that can occur throughout the life-cycle of an insect and also those that can occur during the development of a single instar. The changes throughout the life-cycle may be large; in one example quoted, it was more than 250 times. Smaller changes are found to occur within the instar, but even these can be appreciable, an example of a difference of more than sixteen times being given.

The examples given by Dr. Potter served to show that the extent and direction of the changes in resistance depend on the insecticide used, the species of insect and the conditions of treatment. It follows from this that not only may the absolute toxicity of any one insecticide differ with the stage of development, but also that the relative toxicity of any two insecticides is likely to differ also. There appears to be no information on the reasons for the differences in resistance between instars, and they are likely to be complex. Differences in resistance within an instar have been correlated with morphological and physiological changes that occur during its development, but these changes are not necessarily the cause of the differences. Examples were given to prove that the diet of the insect may affect its resistance to insecticide. This was shown to happen both by changing the constitution of artificial diets and by changing the host plants of insects that feed on living plants. The amount of food administered and the period when it was administered were also shown to affect resistance.

A. H. McIntosh then discussed the effect of temperature on the toxicity of insecticides. He stated that a change in the temperature at which insects are kept after treatment with poison nearly always affects the kill. If the kill increases with temperature, the temperature coefficient of kill is positive, and vice versa. In contact tests on grain beetles, the size of the temperature coefficient depends on the particle size used if the poison is a solid. If the temperature coefficient is negative, it is always bigger for colloid than for crystals; this happens with DDT and some of its analogues, rotenone and endrin. But if the temperature coefficient is positive, it may be bigger for colloid than for crystals, as with dieldrin, or bigger for crystals than colloid, as with 2-bromomercurithiophen.

The time elapsing between treatment of insects and counts of kill may sometimes affect the size and sign of the temperature coefficient. Thus, the temperature coefficient of dieldrin by injection into mealworms did not change as time passed (one to four days); but with rotenone the coefficient was negative if counts of kill were made up to about a day and a half after treatment, and after this it was positive. At the higher temperature, the percentage kill increased as time passed, but at the lower temperature the insects recovered from the effects of rotenone. The size and sign of the temperature coefficient may also depend on the dose, the method of application, the insect species and the range of temperatures used. The most that can be said about any one poison is that its temperature coefficient is usually positive or negative, as the case may be. Differences in temperature are certainly one cause of differences in both relative and absolute toxicities found by different workers.

K. F. Goodwin-Bailey then read a paper on behalf of J. M. Holborn on the susceptibility to insecticides of laboratory cultures of an insect species. The results of tests of the comparative resistance of strains of *Tribolium castaneum* (the rust-red flour beetle) and of strains of *Calandra granaria* (the granary weevil) were described. None of these strains had been exposed previously to insecticides, yet they showed consistent differences in resistance to the test poisons. A laboratory strain of *C. granaria* was found to be between three and a half and six and a half times as susceptible to pyrethrum powders as a wild strain. There was little difference in susceptibility when pyrethrins synergized with piperonyl butoxide were used. Several strains of *T. castaneum* developed from cultures from different laboratories were tested against γ-BHC, the pyrethrins and the pyrethrins synergized with piperonyl butoxide. The strain showed marked differences in susceptibility to γ-BHC and the pyrethrins, but the differences were less marked with the synergized pyrethrins.

The most resistant strain was four times as resistant to γ-BHC and three times as resistant to the pyrethrins as the least resistant strain. There is evidence that these natural differences were inherited through at least six generations. The differences in susceptibility found are thought to be due to differences in vigour. The results also show that the factor of synergism can differ greatly with the different strains. With the species examined, the synergist appears to be most effective against the most resistant strains, thus tending to diminish the differences found with the pyrethrins alone. The data presented in this paper provide evidence that considerable differences in resistance to insecticides can exist between strains of the same species, before any treatment with a poison has taken place; that is, that insecticide resistance is not always acquired by selection.

The first paper in the afternoon was read by J. R. Busvine, who discussed the occurrence and status of insecticide-resistant strains. He listed twenty-one species recorded since 1940 as having insecticide-resistant strains in the field. Only those records were listed which at the same time were substantiated with good supporting evidence for the existence of insecticide resistance. The criteria to be adopted in judging whether or not a resistant strain had been produced in the field were then discussed, and it was pointed out that the factors of natural high resistance, faulty insecticide or inefficient application, the elimination of parasites and predators and natural fluctuations in the insect population, should first be excluded. These factors make the field assessment of resistance difficult, and it should therefore be confirmed in the laboratory by a quantitative comparison with insects of the same species that have not been exposed to an insecticide.

The necessity for adequate standardization of the method of assessment of resistance was stressed, since errors can occur due to lack of standardization of the insect material, and different results may be given by varying the method of test. In general, high resistance is associated with flat probit/regression lines. The probit lines for resistant strains are nearly always flatter than for normal strains. Where two techniques of measurement are used, one may show a bigger difference between resistant and normal than the other; it generally occurs that the technique showing the bigger difference has the flatter probit line.

Dr. Busvine then considered the types of resistance that occur and concluded that the more important forms of resistance which result in the failure of control measures are characteristically specific to one type of insecticide. The grouping of the insecticides into types on this basis may indicate that they have a similar mode of action. The biochemical basis of resistance has been studied by some workers, and it has been shown that resistant strains have an increased capacity to detoxify DDT, although this alone is not sufficient to account for the degree of resistance that occurs. It was pointed out that there is some evidence of increased metabolism of the insecticide with strains resistant to γ-BHC, chlordane and toxaphene. Studies on the genetical bases of resistance have yielded very conflicting results, and there appears to be no general agreement. Dr. Busvine ended his talk with a plea for further research on this subject.

The next speaker, F. R. Bradbury, then gave a paper on the absorption and metabolism of benzene hexachloride in normal and resistant houseflies. The pick-up and absorption of vapours of γ-BHC and of its non-toxic α-, β- and δ-isomers by the housefly *Musca domestica* have been studied by confining susceptible and resistant strains over treated filter papers; labelling with carbon-14 and chlorine-36 has facilitated analysis. The general picture of resistance to γ-BHC deduced from the data broadly parallels that currently held for DDT. Resistant flies pick up and absorb less poison and perform a more rapid conversion to excretable metabolites with both the toxic and non-toxic isomers of BHC and, probably, there are differences in the distribution of the poison in the bodies of the susceptible and resistant strains. Resistant strains also convert a greater percentage of the absorbed dose in the earlier stages of storage.

By reversed-phase chromatography it has been established that the carbon tetrachloride extracts of flies treated with γ- and δ-BHC contain mainly unchanged BHC. No dehydrochlorination products have been detected in these extracts, and evidence that metabolism is accompanied by dechlorination was presented. The problem of the identification of the metabolic products is complex. In the metabolism of the four common isomers of BHC, water-soluble compounds are produced most readily from the α- and γ-isomers and much less readily from the δ- and β-forms. Two-dimensional chromatography has revealed eleven well-defined compounds from both γ- and α-BHC; these have not been identified, but there is evidence from paper electrophoresis that eight of the eleven compounds from these two stereoisomers are the same. It is unlikely that all the metabolites are trichlorobenzene derivatives, and it is possible that benzene derivatives (by dechlorination) are intermediate stages in the production of some of these metabolites. Comparative tests on a number of insect species have shown that even normal houseflies are exceptionally able to convert γ-BHC to excretable, water-soluble metabolites, and this factor may predispose this insect to the acquisition of insecticide resistance.

It is concluded that the reduced absorption and the increased amount of metabolism are not alone sufficient to explain the increased resistance. These two factors give at the most a sixfold difference in BHC content between normal and resistant flies, while resistance has increased by a factor of one hundred. However, it is possible that a combination of reduced absorption, increased metabolism and redistribution of the poison in the insect might provide the explanation.

The concluding paper in the afternoon was given by F. P. W. Winteringham on biochemical factors in the natural and acquired tolerance of insects to insecticides. It was pointed out that, when an insecticide is applied to an insect, it may be attacked by the tissue enzymes with the formation of metabolites which may be more or less toxic than the insecticide itself. An example where the metabolite is more toxic than the original chemical is parathion, which is a poor inhibitor of cholinesterase. Parathion is known to be oxidized by the insect *in vivo* to the oxygen analogue paraoxon, which is a potent inhibitor of cholinesterase. Similarly, it has been established that 'Schradan' becomes oxidized to a monophosphoramide oxide or a compound very much like it. The process occurring in these two examples might be referred to as toxication. The conversion of insecticides to harmless metabolites or detoxification has been demonstrated with DDT and BHC, particularly with insects resistant to these poisons. It has now also been established that the pyrethroids undergo detoxification in the adult housefly, and there is some evidence that the detoxification process is not one of simple hydrolysis.

The increased detoxification of poisons by resistant insects when compared with normal insects might be either a consequence or a cause of the insects' survival, there being evidence for and against either possibility. Extensive detoxification may occur in normal insect strains, and this must be a factor in their normal tolerance. Detoxification may be inhibited by the presence of certain adjuvants applied simultaneously with the insecticide. A complete understanding of the DDT-resistance problem implies a better understanding of DDT action *in vivo*. Recent work indicates that DDT may, in normal strains of insect, interfere with the oxidative formation of the vital tissue substance adenosine triphosphate. The interference was not observed in a resistant strain, and it may therefore be an additional biochemical factor in DDT-resistance mechanism.

When the evidence provided by all the papers given at the symposium is considered, it appears that results are steadily being accumulated on the changes of resistance that occur naturally and that are produced by the application of an insecticide. However, little progress has, as yet, been made in demonstrating the causes for the differences in resistance that are found, and this work is severely handicapped by lack of knowledge of the mode of action of insecticides.

THE 74-IN. REFLECTOR OF THE COMMONWEALTH OBSERVATORY, MOUNT STROMLO, CANBERRA

EARLY in 1947, the Commonwealth Astronomer, Prof. R. v. d. R. Woolley, supported by the then Astronomer Royal, Sir Harold Spencer Jones, and the board of visitors of the Commonwealth Observatory at Canberra, laid before the Minister for the Interior, the Hon. H. V. Johnson, proposals relating to the establishment of a large reflector at Mount Stromlo.

Among the arguments advanced for the placing of such a telescope at Mount Stromlo was the fact that telescopes of 72-in. aperture or more are to be found almost exclusively in the northern hemisphere. Even at the present time, with the Stromlo instrument operating, the situation is still unbalanced, for there are two such instruments in the south as against nine (including those under construction) in the north.

Cabinet approval was given for the construction of the instrument, and in 1948 an order for a 74-in. telescope complete with building and dome was

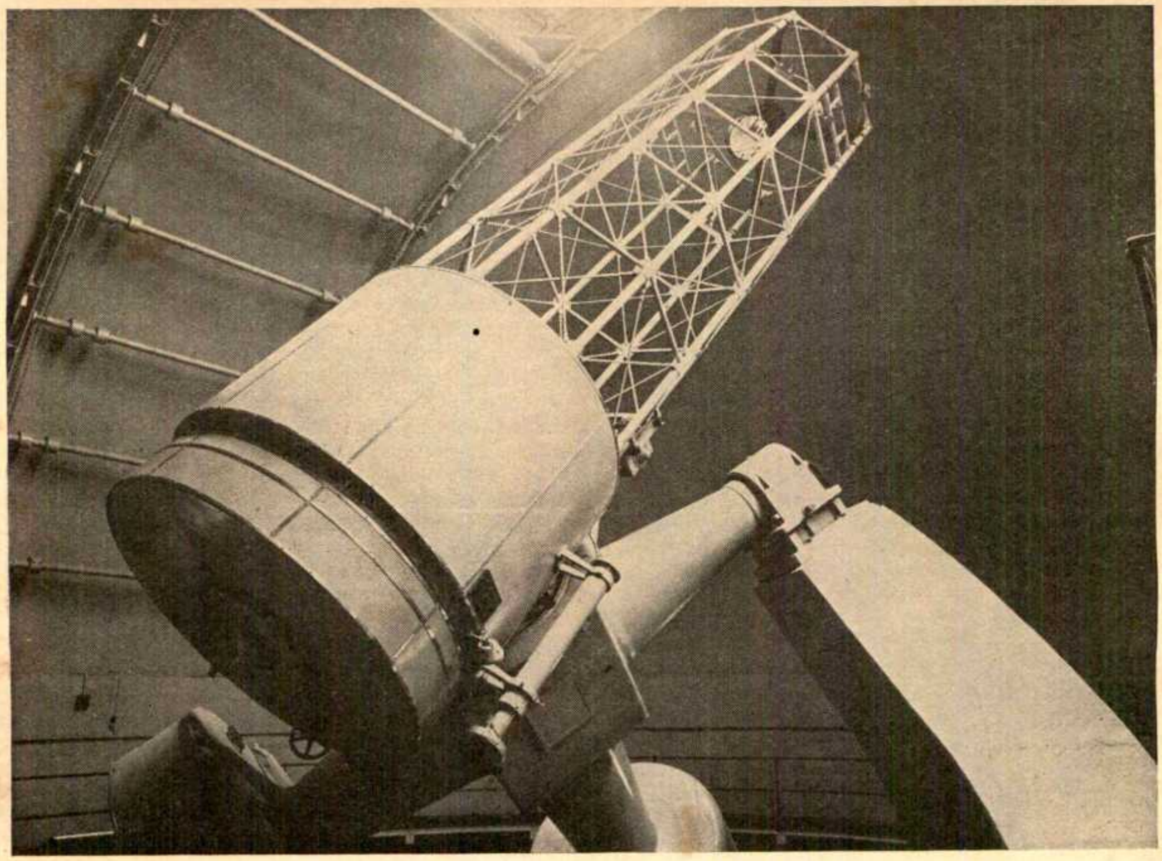

Fig. 1. The 74-in. reflector at Mount Stromlo Observatory. By courtesy of the News and Information Bureau, Department of the Interior, Commonwealth of Australia

placed with the firm of Sir Howard Grubb Parsons, England. The mounting was finished early in 1951 and, after display in the Festival of Britain, was sent to Mount Stromlo. By early 1954 all parts of the telescope and dome were delivered with the exception of the aluminizing plant.

The telescope was formally opened by His Excellency the Governor-General, Sir William Slim, on November 8, 1955. The opening ceremony was held in the dome with the then Minister for the Interior, the Hon. W. S. Kent Hughes, in the chair. Mr. Kent Hughes referred to the labours of the Commonwealth Astronomer in initiating the project and wished him every success in taking up his new post as Astronomer Royal at the Royal Greenwich Observatory, Herstmonceux. Sir William Slim concluded his address by pressing a button, which caused the shutters of the dome to open.

Prof. Woolley then demonstrated the operation of the telescope to an audience of nearly two hundred people, representatives of academic, scientific and departmental activities in Canberra.

The total weight of the moving parts of the new equipment is 40 tons. The main mirror is 74 in. in diameter, 11½ in. thick, and weighs 4,000 lb. The building and dome housing the new telescope provide a controlled ventilation system designed to keep the interior of the dome at as near to night temperature as possible during the day. The dome weighs about 100 tons and can move at a speed of one revolution in five minutes. The rotation of the dome allows any part of the sky to be viewed.

The instrument is designed for use at the Newtonian, Cassegrainian and coudé foci with the respective aperture ratios of $f/5$, $f/8$ and $f/28$. Photographs have also been made at the prime focus for testing purposes, but regular operation in this position is not contemplated. The instrument is arranged on an English-type mounting and access to the Newtonian focus is effected by a platform which moves up and down the opening of the 62-ft. diameter dome.

OBITUARIES

Dr. Sunder Lal Hora

Dr. Sunder Lal Hora, well known to many zoologists in Great Britain, died suddenly on December 8; he was due to retire from his post as director of the Zoological Survey of India this coming June. Hora was born at Hafiazabad in the Punjab in 1896 and educated at the Anglo-Sanskrit High School at Jullundur. Thence he went to Government College, Lahore, where he came under the influence of Prof. John Stevenson and had a distinguished career as a student, obtaining the M.Sc., in part for work on the "Fish of Lahore", and receiving the Maclagan Gold Medal and Purse of the University of Punjab. The same year, 1919, he joined the Zoological Survey of India as a research scholar and less than two years later was appointed to the permanent staff. It was here that he became closely associated with Dr. Nelson

Annandale, of whose help and inspiration he always spoke with affection. In this service he spent the rest of his life, with the exception of 1942–47, when he was director of fisheries for Bengal, returning to the Survey as its director in 1947. He was awarded the D.Sc. of the University of Punjab in 1922 and of Edinburgh in 1928.

Dr. Hora was an indefatigable and careful worker and his many publications cover various fields. He was primarily a systematic ichthyologist and the admitted authority on the freshwater fishes of India and adjacent lands. This statement without qualification could convey a false impression of his breadth of outlook. A number of his systematic papers contain bionomic and ecological observations. The latter aspect induced him to consider the adaptation and the evolution of the adaptive mechanisms of animals to the severe conditions in torrential streams, and his best-known publication in this field (*Trans. Roy. Soc.*, 1930) is mainly devoted to insects.

In trying to comprehend the pattern of the distribution of freshwater fishes in India and Malaya, Dr. Hora was led to consider the past geological history of these areas, and particularly that of the changing river systems brought about by Himalayan tectonic movements, and he put forward an ingenious explanation known as Hora's Satpura hypothesis. From an early stage he became interested in fisheries and means of increasing their efficiency with due regard to conservation. Later, he tackled the pond culture of fish with the view of increasing the food supply. The work and enthusiasm he put into this led to his being invited to open a discussion on the subject at the United Nations Conference at Lake Success in 1949. As fisheries consultant to the Food and Agriculture Organization he recently completed a "Handbook on Tropical Fish Culture".

Dr. Hora's command of Sanskrit enabled him to assess the knowledge of fish and fisheries possessed by the ancient Hindus and so make a significant contribution to the history of Indian science.

Dr. Hora was very active outside his own post and held important positions in various scientific societies and organizations. In recognition of his work he received a number of awards and honours, both in his own country and abroad; but he remained a most approachable and companionable man who willingly placed his knowledge at the disposal of others and, in particular, younger workers, many of whom he encouraged at critical stages in their careers. With his death India has lost a distinguished zoologist and loyal son, and many zoologists in other parts of the world will mourn a friend.

C. H. O'Donoghue

SUNDER LAL HORA's research career was dominated by the materials and concepts he had inherited from Nelson Annandale, and he succeeded in creating new vistas of biological discovery in India. He took Indian ichthyology back to ancient history, prehistory and palæontology, and forwards to a systematized historical understanding continuously related to the material and cultural welfare of the Indian people. His emphasis throughout has been on relationships: from the immediate relationships he described to the larger relations between science, the humanities and politics.

He believed in generalizations based on the growth of intensive specialization into a many-branched unity.

At home he was a kindly patriarch, sometimes looking askance, but tolerantly, at the departures from Punjabi custom of his children; for him the day started with the prayers he had learned in childhood. He was humble, affectionate, considerate, addicted to tabulating routines which never reached the level of work-disciplines, eager for new experiences (he had travelled extensively in most countries), quick to laugh, and quite unable to control his passion for shop talk. On one occasion in London in the autumn of 1953, when he had talked zoology before, through and after dinner, Mrs. Hora whispered to a friend, with a wealth of loving understanding in her voice, "It is always so—nothing but fish!"

He lived a full life, with many sorrows and satisfactions, but remained astonishingly unsophisticated. After his first heart attack, he compromised with decadence by rising at 5.30 a.m. instead of earlier. He could not adjust himself to slowing down, and when I stayed with him in Calcutta a year ago, he made it clear that he would rather die at work than live as a semi-invalid. He died as he wished. He collapsed while presiding over a meeting of the Asiatic Society, but not before calling upon a member to take the chair. It was, characteristically, the last public gesture of a man whose life was distinguished by service and integrity. Cedric Dover

Mr. Frank C. Willcocks

In a few years time Frank Willcocks may become one of those "that have no remembrance", because of his own modesty, and because of his isolation for thirty years in Egypt, yet those of us who had been his colleagues recognized his possession of 'the Darwin touch'.

The influence of Theobald at Wye diverted his intention from farming to entomology, and so to an appointment with the Khedivial Agricultural Society when its eight-room laboratory was founded in 1904, a chemist and a botanist being his colleagues. Within two years he was able to outline the three major pests of cotton in a hundred pages of the Society's Year-book, and this succinct account by a non-graduate student aged twenty-four is still a standard reference.

He remained with the Society until 1930, designing and founding its Cotton Museum as a side-issue, then retired to Bournemouth, whence he moved after the death of his French wife to a bungalow in the woods near Battle. The toil of struggle with his orchard and garden, workshop and housekeeping, lonely except for his friends the cats, led him at last to move to the home of a niece in Gloucester, where he died unexpectedly only a few weeks later on December 18 at the age of seventy-two.

The introduction to his last publication in 1937 (the third volume of "Insect and Related Pests of Egypt") gives a clear impression of his sincerity and quiet wit, his humility towards the specialization of his juniors, and his gratitude for help by lesser men. He was a scientist in grain, the infinite capacity for taking pains being combined with a wide view across the field of his economic problems; he was a pioneer. In that last volume he devotes particular attention to one of his favourite insects, treating the mole-crickets almost affectionately, alternating between the ingenious additions to our knowledge of them which he made and his repeated emphasis on knowledge about them still to be sought. His dealings with the velvety strength of *Gryllotalpa*, burrowing, swimming and flying, showed him to have been a great naturalist.

Willcocks took occasion to investigate patiently some unique opportunities. The invasion of a new scale-insect which destroyed the Lebbek avenues of Cairo was the first of them. Another was the arrival in Egypt of the pink boll-worm, which quickly became the major pest of cotton for many years; arising out of his studies about its queer resting-stage in the seed, he invented the heat-treatment which has for decades been applied as compulsory routine at every ginnery in the country; the credit went elsewhere. His quiet enthusiasm enlisted many willing amateur helpers before professional entomologists became abundant, and his reputation was in no way diminished when the newcomers found that they could accept his fundamental observations.

The Cotton Museum exercised his ingenuity, and his craftsmanship produced some noteworthy exhibits in collaboration with his wife and his artist brother-in-law, A. Morel; there were some witty private fantasies as well. Writing results was a painful necessity, and because his publications were made in Egypt they are little known elsewhere. Unfortunately the three volumes already mentioned weigh more than half a stone apiece, with three-inch page margins, so that their unwieldiness restricts their use.

Willcocks leaves memories of gentle pessimism; of devotion to his friends, whether human, feline or even invertebrate; of industry in spite of recurrent invalidism. It must be a matter for regret that Britain found no means for making use of the latter half of a life from which Egypt had profited so much.

W. LAWRENCE BALLS

NEWS and VIEWS

Photographic Science: Dr. C. E. K. Mees, F.R.S.

BY the retirement of Dr. Kenneth Mees from his position as vice-president in charge of research of the Eastman Kodak Company, industry has lost one of its foremost research directors. While many have the satisfaction of looking back on widely applied technical improvements for which they have been responsible, few can claim to have altered the whole aspect of an industry; Mees is one of them. At University College, Sir William Ramsey dissuaded Mees from an academic career, and in 1906 he joined the firm of Wratten and Wainwright, Ltd., of Croydon, as partner and joint managing director—at a salary of £3 per week! At that time the photographic industry depended largely on empiricism for its advance, and this appointment presented a wonderful opportunity to a trained scientist of exceptional ability. Mees was not slow to take full advantage; he was the first to market panchromatic materials, and by proper application of spectrophotometry was able to produce a comprehensive series of light filters (Wratten filters) which were the first commercially available products in this field. At this time industrial research laboratories were rare; but with characteristic foresight George Eastman decided to establish one at the Eastman Kodak Company's plant at Rochester, N.Y. Mees was invited to organize this development; but he was reluctant to leave his firm, so Eastman purchased Wratten and Wainwright, Ltd., and in 1912 Mees went to the United States to commence his duties. Since that date the work of the laboratory has covered both fundamental and applied research, and has not been confined to subjects of immediate connexion with photography.

In a special division of the laboratories which Mees established for research on photographic emulsions, much of the early development work leading to the great advances in photographic materials has been carried out. Of special importance for science was the working out of a wide range of plates and films for spectrographers and astronomers. Among the other notable contributions to photography made by Kodak during the period when Mees was director of the Research Laboratories were the introduction of panchromatic materials, of 16-mm. (and later 8-mm.) Cine Kodak film and equipment in 1923, and 'Kodachrome' film in 1935. Other activities include the establishment in 1918 of a department for the manufacture of synthetic organic compounds to replace German supplies, which has now become the Eastman Organic Chemicals, and work on molecular distillation, which was applied successfully to the extraction of vitamins from cod liver oil and has resulted in Distillation Products, Inc. Mees's books on photography culminated in his "Theory of the Photographic Process", published in 1942 and completely revised in 1954. His wide interests are reflected in "The Organization of Industrial Scientific Research", written in collaboration with J. A. Leermakers; but his breadth of vision is best illustrated by his philosophical discussion of the history of science in relation to world history—"The Path of Science". He was elected an Honorary Fellow of the Royal Photographic Society in 1921, and received the Progress Medal of this Society in 1913 and again in 1953. In 1939 he was elected a Fellow of the Royal Society, and in 1950, after he became an American citizen, a member of the U.S. National Academy of Sciences.

Dr. C. J. Staud

DR. CYRIL J. STAUD now succeeds Dr. Mees as vice-president in charge of research and development, Eastman Kodak. Staud graduated at the University of Rochester, N.Y., and obtained a Ph.D. degree at the Massachusetts Institute of Technology. He joined the Kodak Research Laboratories in 1924, where his ability gained for him positions of increasing responsibility. In 1931 he was appointed superintendent of emulsion research, and was appointed director of the Research Laboratories in 1947. His energies have been devoted to the internal organization of the laboratories, so that he is not as well known outside the firm as his achievements would warrant. He has an astonishing grasp of the details of the wide activities of the Laboratories, and is outstanding in organizing and inspiring effective and enthusiastic team-work. His managerial skill is supplemented by a keenly inventive mind, and he has been responsible for many of the Company's scientific achievements. Although Dr. Mees's retirement is a sad loss to the organization, and to industry generally, the research activities of Eastman Kodak have been left in capable hands.

Progress Medal of the Royal Photographic Society : Dr. J. D. Kendall

The Silver Progress Medal of the Royal Photographic Society has been awarded to Dr. J. D. Kendall, head of the Renwick Laboratory of Ilford, Ltd., in recognition of his distinguished contributions to research in the chemistry of photographic processes and materials. Dr. Kendall is known for his work in relation to photographic emulsion sensitizers, emulsion stabilizers, colour couplers, developing agents and desensitizers. His discovery, some twenty years ago, of particular *p*-dialkylaminobenzylidene derivatives of compounds having a reactive methylene group activated by carbonyl (the merocyanines) as efficient optical sensitizers for emulsions, was a starting-point for advances of considerable consequence in emulsion technology. In 1935 he proposed an original theoretical principle for relating the chemical structure of sensitizers, desensitizers and developing agents to their respective properties, and his name is now linked with those of Andresen and Lumière in the 'Andresen–Lumière–Kendall rules' for photographic developing agents. Dr. Kendall's relatively recent discovery of 1-phenyl-3-pyrazolidone (phenidone) as a developing agent has led to greatly improved commercial developers and has also initiated a great deal of research on superadditivity phenomena in photographic laboratories throughout the world. Even more recently (1954) he has described, in collaboration with G. F. Duffin, a new class of optical sensitizers, namely, the immazolenine cyanines. The Progress Medal was instituted in 1878, and this is the forty-fourth such award, twenty-two being to persons of foreign nationality ; it is awarded for any invention, research, publication or exhibition which leads to an important advance in photography.

British Broadcasting Corporation : Miss Mary Somerville, O.B.E.

With the retirement in January of Miss Mary Somerville from the B.B.C., one of the links with the pioneering days of 2*LO* has been broken. Miss Somerville joined the B.B.C. in 1925 as assistant to the then educational director, J. C. Stobart, having been attracted to the new field of intellectual adventure through the broadcasts of Sir Walford Davies. Within four years she had taken full charge of the embryonic Schools Department, and imbued by a strong sense of educational purpose, in the eighteen years of her active direction of this Department she carved out a unique place for this activity of the B.B.C. in the educational history of our time ; and this in the face of considerable resistance from the vested interests of the essentially conservative educational world. In 1947 she toured the Commonwealth and on her return became assistant controller of Talks Division, thus entering a field where she could to an even greater extent explore the radio medium as a means of communication. Three years later she took over one of the toughest assignments in the whole B.B.C. organization, that of full controller of Talks Division, and as such became the Corporation's first and only woman controller. With the whole of the Corporation's Talks output under her control, the world of science was not the least of her interests, and the present position of the B.B.C.'s science talks owes not a little to her sympathetic understanding of the problems that face the producer who is presenting science to a mass audience.

Mr. John Green

The new controller of talks, Mr. John Green, also had connexions with science, if in the applied field, namely, agriculture. Mr. Green comes from a Gloucestershire landowning family. He went up to Cambridge, where he was President of the Union, and was afterwards called to the Bar. In 1934, however, he joined the B.B.C. and specialized in the production of agricultural talks, being the Corporation's agricultural liaison officer until he became Miss Somerville's chief assistant a number of years ago. Thus the new controller has risen from the ranks, as it were ; he is familiar with the professional problems concerned with talks production and sees in the producer a public servant with a valuable part to play in bridging the gap between those who have something to say and those who are prepared to listen.

British Iron and Steel Research Association : Dr. J. Pearson

The British Iron and Steel Research Association has appointed Dr. J. Pearson as assistant director of research, to assume such duties as are delegated to him by the director, Sir Charles Goodeve ; Dr. Pearson will continue his present duties as head of the Steelmaking Division and Chemistry Department of the Association. After graduating from the University of London in 1933, Dr. Pearson did some research in organic chemistry, and then joined the Research Department of Tube Investments, Ltd., to carry out work in connexion with the manufacture of steel tubes and allied products. During 1937–46 he was employed in the explosives branch of the Armament Research Department, Ministry of Supply, and obtained his Ph.D. in 1946 for research work on the polarography of organic compounds. After the Second World War he joined the British Iron and Steel Research Association as head of the Chemistry Section of the Swansea laboratories, where he was largely concerned with problems on the disposal of spent pickle liquor. He was appointed head of the Chemistry Department in 1950, assuming the additional duty of head of the Steelmaking Division four years later.

Nuffield Foundation Awards in Dentistry, Biology and the Social Sciences

The Nuffield Foundation is offering a number of fellowships, scholarships and bursaries in the fields of dentistry, biology and the social sciences. The fellowships for dentistry are for persons, aged 25–35 years, with dental qualifications to receive additional training in pure and applied science so as to fit them for an academic career in dentistry, and also to enable graduates in medicine and science to receive training (not necessarily for a registrable dental qualification) so as to undertake teaching and fundamental research on dental health and disease. (It is to be noted that in past years few applications have been made by those eligible in the latter category.) The fellowships are worth £500–800 a year for one to three years, and applications must be received by March 1. The dental scholarships, normally for one year only, are for students at university dental schools in the United Kingdom and cover tuition fees and a subsistence allowance of not more than £200 ; applications must be received by June 30. The Foundation's scholarships and bursaries in biology and the social sciences are for graduates of British universities, preferably within the age-group 22–35 years. The awards in biology are for graduates in physics, chemistry, mathematics or engineering to receive such training in biology as will enable them to undertake research and teaching in the biological sciences in the United Kingdom. The scholarships, which are for those with postgraduate (non-biological) research experience, are worth £500–600 a year, and the bursaries £350 a year; in each case, fees, a marriage allowance of £50 a year and a family allowance of £50 per child will be paid. Applications must be received by April 1. The awards for social sciences are similar to those for biology, except that applications must be received by May 1, and the holder may have a degree in any academic subject other than the social sciences, psychology or the social sciences; subjects suitable for study by holders are political science, social psychology, anthropology, social statistics and sociology generally (but not economics). Applications for all these awards, and further information, can be obtained from the Secretary, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1.

Industry and Nuclear Power in Britain

QUESTIONED in the House of Commons on February 15 as to the Government's policy regarding the utilization by private firms of technical information on the industrial applications of nuclear power, the Lord Privy Seal, Mr. R. A. Butler, stated that it is the policy of the Atomic Energy Authority to encourage access by private firms to such information in order that industry may participate more fully in these important new developments. Steps are being taken to ensure that firms are not enabled to obtain exclusive rights on the basis of information supplied by the Atomic Energy Authority. In reply to further questions, Mr. Butler said he would discuss with the Minister of Fuel and Power, Mr. Aubrey Jones, the question of letting the House have the maximum information which it is in the public interest to disclose on this new phase in the relationship between the State and private industry on Mr. Aubrey Jones's early return to Britain.

Electronic Computers in Molecular Quantum Mechanics

THE importance attached to the use of modern electronic computers in molecular quantum mechanics has been stressed in an International Conference held in Texas during December last. A resolution was passed unanimously, directing attention to the impressive results already obtained by high-speed computers in the calculation of molecular and crystal properties, and claiming that these properties are of extreme importance in chemistry, physics and biology. The resolution goes on to note that "progress of this work is greatly hampered by the fact that, due to their great cost, high-speed computers are unavailable to most scientists in this field"; and therefore it "recommends that governments, industries, foundations and private philanthropists give special attention to the problem of providing more high-speed computing facilities for use in molecular problems". Copies of the complete document are being sent to government and other scientific agencies in Britain, the United States and elsewhere.

This matter is highly important so far as Britain is concerned. It is believed that the University Grants Committee contemplates the provision of a limited number of these computers during the next quinquennium. But it would be a great pity if the number is unrealistically small. For, as Prof. D. R. Hartree and others have pointed out, electronic computers have entirely changed the kind of problem (such as the structure of vitamin B_{12} or a single protein molecule) which can be attacked successfully. As things are now, certain calculations have to be sent from Britain to the United States, since they cannot be dealt with adequately in British universities. One American firm alone expects to have nearly two thousand large computers in use at the end of another eighteen months or so. It is imperative that universities in Britain—and other institutions—should have calculating facilities which such machines alone can provide.

Artificial Rain-making in India

A SYMPOSIUM on artificial rain was held in India in February 1953 under the joint auspices of the Atmospheric Research Committee, Council of Scientific and Industrial Research, and the India Meteorological Department, the purpose of the symposium being to review the present status of rain-making operations, to discuss recent progress and to make recommendations for extending research in India on cloud physics. The proceedings have now been published (pp. 148. New Delhi: C.S.I.R., 1955). Of the twelve papers, six are concerned with the formation and physical characteristics of clouds in different parts of India. It appears that the release of showers by the coalescence of water drops in non-freezing clouds is a common occurrence, and there was some discussion on the possibilities of artificially stimulating this mechanism by spraying the clouds with water droplets. It was concluded that, in India, the possibilities of producing economically significant quantities of rain by artificial seeding techniques are rather limited, largely because of the low frequency of cloudy days without rain in dry areas. In a long paper, Banerji and Mukherji describe their laboratory studies on nucleation and condensation, and also some cloud-seeding experiments which they have carried out near Calcutta. Hydrogen-filled balloons were used for releasing either dry ice, a spray of cold water or a charge of gunpowder impregnated with silver iodide at a predetermined altitude. Unfortunately, the physical reasoning used by these authors is not always sound, and their field experiments, although showing commendable enterprise, were not well conceived. Their observational techniques were also inadequate for a proper assessment of the results. A number of workers gave sober appraisals of the present status of rain-making trials in other countries and very properly stressed the need for more fundamental research in cloud physics and the training of more scientists in this field. The principal outcome of the meeting was a recommendation to the effect that a cloud physics research unit be set up to undertake fundamental research, and a rain research unit be established having aircraft and radar facilities for planning and conducting field experiments. These proposals show not only enthusiasm but also an appreciation of the importance and magnitude of the problem. India has set an example which other countries, with far greater scientific resources, might do well to follow.

Medical Research and its Benefit to Humanity

IN his Stephen Paget Memorial Lecture, "Humanity's Rising Debt to Medical Research", given before the Research Defence Society on November 16, Sir Henry Dale referred to the convincing evidence of the success of inoculation against diphtheria, which has become available since he lectured to the Society in 1931. Systematic inoculation began in Hamilton, Ontario, in 1925, and the death-rate from diphtheria fell so steeply that after 1930 there were no more deaths and after 1933 no more cases. In Great Britain a full-scale preventive inoculation campaign was not inaugurated by the Ministry of Health until 1940 and was not fully under way until 1942. In 1940 there were still in England more than 45,000 cases of diphtheria, and more than 2,400 of these were fatal. As inoculation became effective, in spite of a counter-campaign, the numbers fell steeply and steadily until in 1954 there were only 173 cases; of the nine deaths, six were in children less than fifteen years old, and all in the minority who had not been inoculated. The value of preventive inoculation against tetanus is a more recent discovery, but there were only seven cases among the sixteen thousand wounded in the British Expeditionary Force in fighting its rearguard action to Dunkirk over soil known to be highly dangerous as a source of tetanus infection; these seven cases were all in the 10 per cent minority who had been persuaded to refuse protective inoculation.

Sir Henry also pointed out that the discovery of successful methods for immunizing dogs against distemper and the crippling condition known as 'hard pad' had, too, met a persistent campaign to induce owners to refuse this protection for their dogs. Sir Henry outlined some of the outstanding medical discoveries which had resulted from the experimental method during the past twenty-four years, such as mepacrine, the sulphonamides and penicillin, and the new types of anæsthetics; the use of some of these, such as curare, is still exposed to a cruel, if ineffective, campaign of denunciation and misrepresentation. The Research Defence Society, he said, needs and deserves all the support it can get in combating this attitude of blind obstruction.

Linen Research Association: Report for 1955

The report of the Council of the Linen Research Association for the year ended September 30, 1955 (pp. 20; from the Association, Lambeg, Belfast; 1955), refers to the support forthcoming from all sections of the industry—this in spite of the difficulties of the industry, which has not recovered from the setback of 1952. A special committee has been appointed to put before the Industrial Grants Committee of the Department of Scientific and Industrial Research a statement of the Association's policy and programme for the next five years and of its financial needs, and the Department has agreed to continue the present terms of grant for the first year of the new quinquennium, while raising the contribution needed to earn the maximum grant from £32,000 to £40,000 for the last four years of the quinquennium and the maximum grant itself from £22,000 to £25,000. The Association has experienced increasing difficulty in recruiting new staff, and in its spinning research has given priority to a new servo-drafting control mechanism, which should improve the regularity of dry spun yarns and the dry spinning of flax to finer counts, and to a modified ring system for wet-spinning. A pneumatic tension gauge has been developed for measuring tensions on winding machines and dry-spinning frames, and means have been devised for restricting the size of the yarn balloon when warping linen yarns at high speed. Attention has been given to improved methods of applying vat dyes to linen fabrics and to the application of resins and other polymers to linen fabrics.

In connexion with the difficulties of the linen industry, it may be noted that, replying in an adjournment debate in the House of Commons on January 31, the Parliamentary Secretary to the Board of Trade justified the Government's decision to close the flax processing mills operating in Great Britain. He said that, unless considerable sums are spent on plant and new machinery, many years of operation and research will be required to do more than touch the fringe of the problem, and the Government does not consider that continued expenditure of £500,000 a year from public funds to maintain a small scheme covering 16,000 acres of land is justified.

Capper Pass Awards for Papers on Metallurgy

The following Capper Pass Awards have been made by a joint committee representing the Institution of Mining and Metallurgy and the Institute of Metals for papers published during 1955 in the *Transactions* of the Institution and the *Journal* of the Institute: £100 to Dr. Maurice Cook, C. L. M. Cowley and E. R. Broadfield (use of refractories in low-frequency induction furnaces for melting copper alloys); £100 to P. M. J. Gray (extraction of uranium from a pyritic ore by acid pressure leaching); £50 to W. T. Edmunds and R. C. Lloyd (production of light-alloy drop forgings, their heat treatment, inspection and testing). The Awards are made from a fund given by Capper Pass and Son, Ltd., for the encouragement of scientific and technical papers dealing with processes and plant used in extraction metallurgy and on the subject of assaying, and also papers and processes used in all branches of the non-ferrous metal industry.

City and Guilds of London Institute: Fellowships

The fellowship of the City and Guilds of London Institute has been conferred upon the following past students of the City and Guilds College or of Finsbury Technical College in recognition of their distinguished contributions to industry and the engineering profession: Dr. R. T. Colgate, chief technical works manager and chief chemist, Huntley and Palmers, Ltd., Reading; E. W. Moss, senior partner of Raworth, Moss and Cook, chartered patent agents; J. F. Pain, director of Dorman Long (Bridge and Engineering), Ltd.; B. G. Robbins, secretary of the Institution of Mechanical Engineers; and Dr. F. H. Rolt, formerly superintendent of the Metrology Division of the National Physical Laboratory, Teddington.

Psycho-Analysis and Contemporary Thought

The British Psycho-Analytical Society is arranging a series of six evening lectures commemorating the centenary of the birth of Sigmund Freud; they will be given in the Friends House, Euston Road, London, N.W.1, under the general title of "Psycho-Analysis and Contemporary Thought". The dates, lecturers and subjects are as follows: April 13, Marion Milner (psycho-analysis and art); April 17, Donald W. Winnicott (psycho-analysis and the sense of guilt); April 24, Dr. Roger Money-Kyrle (psycho-analysis and philosophy); April 27, Dr. Elliott Jaques (psycho-analysis and social problems in industry); May 1, Dr. John Bowlby (psycho-analysis and child care); May 8, Dr. Ilse Hellman (psycho-analysis and the teacher). Tickets (4*s.* each lecture or 1 guinea the series) and further information can be obtained from the Administrative Secretary, British Psycho-Analytical Society, 63 New Cavendish Street, London, W.1.

Advanced Courses in Technology

A MOST useful booklet for all in the London area who are interested in advanced technological studies has been prepared by the London and Home Counties Regional Advisory Council for Higher Technological Education. The booklet describes all the courses which are available and which are not announced in college calendars or prospectuses. They are, as a rule, part-time (usually evening) courses; but full-time courses which are specially arranged and are not of longer than three months duration are also included. The courses range from silicone polymer technology to the organization of civil engineering contracts and from advanced archive administration to the industrial applications of servo-mechanisms. The booklet is clearly indexed and gives particulars of the venues of courses, the lecturers, and the approximate fees. Copies can be obtained from the Secretary, Tavistock House South, Tavistock Square, London, W.C.1.

The Night Sky in March

NEW moon occurs on March 12d. 13h. 36m., U.T., and full moon on March 26d. 13h. 11m. The following conjunctions with the Moon take place: March 3d. 15h., Saturn 3° N.; March 11d. 0h., Mercury 7° S.; March 16d. 04h., Venus 1° S.; March 23d. 15h., Jupiter 6° N.; March 30d. 23h., Saturn 3° N. Mercury is too close to the Sun during the month for observation. Venus sets at 21h. 30m., 22h. 15m. and 23h. on March 1, 15 and 31, respectively, its stellar magnitude varying between −3·6 and −3·9 and the visible portion of its illuminated disk decreasing from 0·701 to 0·575; during the month its distance from the Earth decreases from 96 to 75 million miles. Mars rises at 3h. 50m., 3h. 25m. and 3h. on March 1, 15 and 31, respectively, and lies rather low in the constellation Sagittarius, in which it has an eastward movement and is a little south of α Sagittarii on March 23; its stellar magnitude varies between 1·2 and 0·8, and its distance from the Earth between 146 and 122 million miles during the month. Jupiter is visible throughout the night, setting at 6h. 25m., 5h. 30m. and 4h. 25m. at the beginning, middle and end of the month, respectively, and has a westward movement in Leo; its stellar magnitude varies between −2·0 and −1·9, the small decrease in brightness being due to its distance from the Earth increasing from 410 to 435 million miles. Saturn rises at 1h. 10m., 0h. 10m. and 23h. 10m. on March 1, 15 and 31, respectively, and lies rather low for good observation in Scorpius, a little north of β Scorpii; its brightness increases by 0·2 mag. owing to its distance from the Earth decreasing from 909 to 867 million miles during the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: March 18d. 19h. 36·1m., ι Tau. (*D*); March 22d. 23h. 45·9m., κ Cnc. (*D*), *D* referring to disappearance. The Sun enters the first point of Aries on March 20d. 15h. 21m.

Announcements

SIR EDWARD APPLETON, principal and vice-chancellor of the University of Edinburgh, will deliver the Reith Lectures for 1956. The lectures, "Science and the Nation", will be broadcast on the B.B.C. Home Service in the autumn.

THE Countess of Albemarle and the Right Hon. Lord Justice Morris have been appointed additional members of the University Grants Committee on matters relating to academic salaries only.

PROF. J. PIVETEAU, professor of palæontology in the University of Paris, has been elected a member of the Geology Section of the Paris Academy of Sciences in succession to the late Prof. A. Michel-Lévy.

THE Ninth International Botanical Congress will be held in Montreal during the summer of 1959. Preparations for the Congress have been initiated, but the exact date and officers of the Congress will be announced later. For the present all communications should be addressed to the Secretary of the Executive, Dr. A. J. Skolko, Botany and Plant Pathology Division, Science Service Building, Carling Avenue, Ottawa, Ontario.

A MEETING of the Malacological Society of London will be held on March 14 at 6 p.m. in the rooms of the Linnean Society, Burlington House, London, W.1, when "Pelagic Mollusca: Swimmers and Drifters" will be considered. Four papers will be read, and then the meeting will be thrown open for discussion. Further information can be obtained from the honorary secretary of the Society, G. I. Crawford, 18 East Drive, Carshalton, Surrey.

A SHORT course on the elements of radiological protection (that is, personal safeguards against radiation) will be held at the Isotope School, Atomic Energy Research Establishment, Harwell, during April 9–13. The course will consist of lectures and practical work and is primarily intended for industrial users of radioactive isotopes. Application forms and further details can be obtained from the Isotope School and, as the number of places is limited, these should be returned before March 9.

THE Industrial Committee of the Scientific Film Association is organizing a course on "First Steps in Industrial Film Making", to be held during March 5–8 at "Wansfell", Theydon Bois, Essex, a residential college of the Essex Local Education Authority. The course is not for those engaged professionally in the making of films but rather for those in industry who may have occasion to make a film (16 mm. silent or sound) in such fields as work study, the recording of processes or installations, or the simplest forms of illustration for instructional purposes. The course is residential, and the fee is 8 guineas. Further information can be obtained from the General Secretary, Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

THE Ministry of Agriculture, Fisheries and Food is offering the following scholarships for rural workers or the children of rural workers, of seventeen years of age or more: twenty senior scholarships, tenable at universities or colleges, for a degree or diploma in an agricultural subject or veterinary science; thirty junior scholarships and six extensions for existing holders, tenable at farm institutes, for one-year courses. Selection is by interview only. Further information and application forms (to be completed by February 29) can be obtained from the Secretary, Ministry of Agriculture, Fisheries and Food (Room 290), Great Westminster House, Horseferry Road, London, S.W.1, or from education offices of County Councils.

COLONIAL RESEARCH IN THE BRITISH COMMONWEALTH

THE reports for 1954–55 of the Colonial Research Council and of the eight specialist advisory bodies and the Director of the Anti-Locust Research Centre are contained in a substantial publication of more than three hundred pages entitled "Colonial Research 1954–55"[*]. In addition, there are some notes on research matters not covered by the reports of the specialist advisory bodies, and appended is a list of schemes approved for research grants under the Colonial Development and Welfare Acts, April 1, 1954–March 31, 1955. At the end of each of the reports are lists of publications; and, with the membership of the various Councils or Committees and their terms of reference, the publication as a whole gives an impressive picture not merely of the magnitude and range of the effort devoted to research in Colonial problems by Great Britain but equally of the extent to which that effort is interlocked with the research organization generally in Britain whether in the universities or in government establishments. No document better calculated to refute the idea that there is any inherent reproach in the word 'Colonial' could easily be conceived.

The report of the Colonial Research Council points out that with the coming into force of the Colonial Development and Welfare Act, 1955, the provision for 1955–60 calls for an average annual research expenditure of £1,600,000 as against £1,173,381 during the year ended March 31, 1955, and an average of £1,240,000 over the past four years. Expenditure in the several fields of research is at different stages of development, necessitating continuous review of the financial situation, and the Colonial Research Council held the first of such reviews in April 1955 to consider the allocation of the available funds among the various fields of research. The fifty-two new schemes and forty-eight supplementary schemes made during the year, involving grants totalling £533,548, brought the net commitment chargeable against Colonial Development and Welfare Funds since 1940 to £12·5 million. Of the gross allocation of £13·5 million, 32·5 per cent has been for agricultural, animal health and forestry schemes, 15 per cent for medical research, 11·8 per cent for fisheries research, 9·7 per cent for tsetse and trypanosomiasis research, 9 per cent for social science and economic research, 7·9 per cent for insecticides research, 5 per cent for research sponsored by the Colonial Products Research Council, 3·6 per cent for anti-locust research and 5·5 per cent for miscellaneous schemes, including building and road research. About 39 per cent has been for schemes to benefit the East African Territories, 18 per cent for the West African group, 10 per cent for the South-East Asian Territories and Hong Kong, 8·8 per cent for the West Indian Colonies, British Guiana and British Honduras and 5·6 per cent for the Central African Territories.

Much the largest scheme approved during the year was £104,024 for the establishment and maintenance for an initial two years of the East African Scientific and Industrial Research Organization, but £50,000 was provided for the establishment and maintenance of the Colonial Road Research Section at the Road Research Laboratory, Harmondsworth, a supplementary £42,500 for the East African Medical Survey, and a supplementary £37,750 for the maintenance of the Anti-Locust Research Centre and its extra-mural activities. £31,483 was provided for the purchase of buildings at Kabete for the East African Veterinary Research Organization, £22,329 for the establishment of the Agricultural Research Station at Aden, £17,780 for silvicultural research in Nyasaland, and supplementary £16,683 for the Desert Locust Survey, £16,365 for maintenance of the Ebini Livestock Experimental Station, British Guiana, and £14,390 for maintenance of the Colonial Insecticides Research Unit, Porton.

The second annual report of the Colonial Products Council and Colonial Products Laboratory records that the Laboratory dealt with 829 inquiries during the year, and completed eighty-four investigations. Those of major interest included an examination of oil of *Leptospermum citratum*, which indicated a citral content of 40 per cent, and one of the limonene obtained as a by-product in the concentration of sweet orange oil, which showed the limonene to be of good commercial quality. Examination of the oleo-resin collected in an experimental tapping trial from *Pinus caribaea* Morelet in British Honduras was completed and also a second trial distillation on a larger scale. The effects of insect attack on groundnuts were further studied, and five species of illipe nuts that were examined for the agricultural authorities of Sarawak contained 64–66 per cent saturated acids, 33–35 per cent oleic acid and about 1 per cent of linoleic and more unsaturated acids.

Detailed studies were made of the composition of Barbados sugar-cane wax; and a further sample of sisal wax from Kenya gave wax polishes comparable with those obtained by using carnauba wax, but emulsion polishes hardened on standing. A study of the development of acidity in maize under insect attack has been started, and, in further work on the chromatographic resolution of the active principles of pyrethrum flowers, reversed-phase chromatography using silicone-impregnated kieselguhr columns gave a good separation of the pyrethrin I and pyrethrin II fractions. Further progress has been made in building up the reference collection of photo-micrographs of fibres from botanically authenticated plants, and a satisfactory fibre was obtained from experimental yarn produced in a bulk spinning trial on a sample of Nigerian anaphe silk, probably derived from *Epanaphe moloneyi*.

At the Colonial Microbiological Research Institute, Trinidad, a start has been made in following the microbiology of 'microfermatories', and the distribution of free sugars and glycosides in the cacao bean has been studied. Further work on the development of the antifungal antibiotic, comirin, now lies mostly outside the scope of the Institute, but the nature of the antibiotic effect against fungi and yeast has been more closely investigated in an attempt to elucidate the point of attack of comirin on the fungus. The preliminary difficulties encountered at the newly established jute estate near New Amsterdam in British Guiana now seem to have been overcome, and retting dry ribbon no longer seems to be a problem, but the original difficulties point to the necessity for 'seasoning' tanks and using a 'starter'. The Sugar Technological Laboratory, Trinidad, has completed work in connexion with the modernization of the experimental sugar factory, and studies on the variation of cane-juice constituents with plant growth conditions have shown that in the greenhouse a refractory juice can be produced to order by simply controlling the water supply to the cane. Use of sodium fluoride in clarification has been examined critically, and a study undertaken of the thermal conductivity of sugar cane, while a detailed study is being made of the soft fatty fraction obtained as a by-product of wax manufacture.

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[*] Colonial Office. Colonial Research, 1954–55. (Reports of the Colonial Research Council; Colonial Products Council; Colonial Social Science Research Council; Colonial Medical Research Committee; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Insecticides Committee; Colonial Economic Research Committee; Tsetse Fly and Trypanosomiasis Research Committee; Colonial Fisheries Advisory Committee; Director, Anti-Locust Research, and Research Matters not covered by the above Reports of the Specialist Advisory Bodies.) Pp. 316. (Cmd. 9626.) (London: H.M.S.O., 1955.) 9s. net.

Investigations into the production of fibreboard from secondary Colonial timbers continued at the Forest Products Research Laboratory, Princes Risborough, where experimental work on the processing conditions for hardboard from four Malayan timbers has been completed. At the University of Birmingham work continued on the synthesis of cellulose by the organisms *Acetobacter acetigenum* and *Acetobacter xylinium*, and on the characteristics of dextransucrase from *Leuconostoc arabinosaceus*, and the mechanism of the reaction between sugars and amino-acids was being investigated using model sugar–amino-acid systems; the anti-acetylcholine activity of several series of compounds, including antihistamine agents, has been determined, and it was observed that introduction of several halogen atoms in the molecules of three classes of antihistamines modified their anti-acetylcholine activity. At the Royal Technical College, Glasgow, the constitution of the triterpene alcohol, taraxerol, has been determined, and investigations into the nature and properties of the undesirable highly coloured constituents of mangrove tanning extracts continued at the University of Leeds. At the University of Nottingham the Colonial hardwood, rengas, has been shown to contain two pigments, the more abundant being probably 4 : 3′:4′-trihydroxybenzylidene-6-methoxycoumarone, with very small amounts of an isomer, and the quantitative aspect of the production of oligosaccharides from glucose and the purification of Floridean starch have been studied at the University College of North Wales, Bangor.

The eleventh annual report of the Colonial Social Science Research Council, to which are appended reports from the East African Institute of Social Research, the West African Institute of Social and Economic Research, the Institute of Social and Economic Research, University College of the West Indies, the Rhodes–Livingstone Institute, the Educational Research Institute for Fiji and Western Pacific Territories, and the Social Research Unit, University of Malaya, expresses the opinion that, while funds available for research by individual scholars will be severely limited, the new allocation of £525,000 should suffice for a reasonable level of activity by the regional Institutes of Social and Economic Research, provided they can attract funds from other sources. Much time was devoted by the Council during the year to the question of making regional institutes ready for transfer as university institutes to the parent universities and university colleges at the end of their present Colonial Development and Welfare period, but the success of these plans depends largely on matters outside the Council's control. The Council for Technical Co-operation in Africa South of the Sahara has set up an Inter-African Committee for Social Sciences, and the first inter-African conference under the auspices of the Committee was arranged at Bukavu during August-September 1955.

The research section of the Department of Social Welfare in Singapore completed a socio-economic survey of family living conditions in Singapore City and also a survey of listening habits and tastes of Chinese households, while in Malaya the Department of Aborigines undertook some ethnological research, mainly to establish the geographical distribution and to collate material on the political and social organization of aboriginal tribes. Twenty-six volumes of the Ethnographic Survey of Africa had been published by the end of the year, and two further volumes were in the press. The first volume of the North Bantu Borderland Linguistic Survey was also ready for the press. A bibliographical survey of available material on labour productivity in British African Colonies is being made, and the preparation of a Ga-Adangme dictionary was started. A study of Iban agriculture, the last of the anthropological studies in Sarawak, is in the press. At the East African Institute of Social Research, work in Buganda was mainly in connexion with the study of change in patterns of authority and social stratification in Buganda and the North Nyanza district of Kenya. The West African Institute of Social and Economic Research expects in the near future, over and above the research programme for its permanent staff, to assist a five-year programme for a cultural history of Benin and a survey of the groundnut- and cotton-producing areas of Northern Nigeria. Research in progress at the Rhodes–Livingstone Institute covers both urban and rural studies, including a social survey of Livingstone, a study of family economics and nutrition in the copper belt of Northern Rhodesia and field work among the Lungu. Studies by the three Fellows comprising the Social Research Unit, University of Malaya, have included an analysis of land usages and transfers at Parit Sulong, with particular reference to the alleged encroachment of Chinese, and an examination of inter-racial attitudes, their bases and rationale, the relation of Chinese farmers at Sungei Derhaka, in Province Wellesley, to the Malays on whose land they have settled and among whom they work, and the social conditions of the inhabitants of a street in the 'Chinatown' area of Singapore.

Six small schemes, applicable to the tropics, two of which were for home-based work at the Universities of Liverpool and London, were added to the twenty-one established research schemes under the supervision of the Colonial Medical Research Committee at the beginning of the year. The Committee's tenth annual report records five new appointments to overseas research units, two of which were to newly created posts, and states that the Colonial medical research studentships are increasingly filling their purpose. Tribute is also paid to the value of the work of the Sub-Committee on the Sickle-Cell Trait in fostering research in this field, while the Helminthiasis Sub-Committee has recommended that a group of young zoologists should be given basic training under recognized specialists in the varied aspects of malacology, in particular the systematics of the snail, at appropriate laboratories at Glasgow, Liverpool, Reading, London and perhaps in Europe or the United States, and also afforded opportunities to study the infestation overseas. The East African Standing Advisory Committee for Medical Research stresses the need for statistical and demographic studies and for co-operation among agricultural, veterinary and medical workers concerned with nutrition. The East African Council for Medical Research held its first meeting in January 1955, and the West African Council for Medical Research met for the first time in March 1955 at Lagos.

Studies on loiasis in the Cameroons and Nigeria have included the continued study of the population of flies and its infection-rate at Kumba and Sapele; the biting-cycle of *C. silacea* at all levels of the forest up to and above the canopy, using an improved technique for scaling the giant trees in the tropical rain forest, and trial of the use of 'Hetrazan' in controlling the transmission of loiasis. It seems likely that use of 'Banocide' for this purpose may be of practical value in developed areas where the population can be adequately covered and monkeys are not a potential reservoir. Infection of captive monkeys (*Mandrillus leucophaeus*) has now been achieved. In East Africa the Filariasis Research Unit has now been merged with the Medical Survey. In Malaya, blood surveys made by the Filariasis Research Unit at Kuantan, along the Pahang River, revealed a high incidence (60 per cent microfilaria-rate in those aged 4–5 years) in young children, and the results suggest that a very high rate of transmission occurs indoors and that most infections are thus acquired. Experiments to find a practicable treatment by 'Hetrazan' continued on carriers of *W. malayi*, and trappings of mosquitoes with Mangoon (stable) traps confirmed that *Mansoniodes longipalpis* (*longipalpis* plus *bonneae*) is the major vector and that it will feed on many animals and is equally attracted to man or goat.

Investigations on guinea-worm at University College, Ibadan, indicate that *Thermocyclops nigerianus* Kiefer is the most widespread intermediate host in south-west Nigeria and is highly adapted to pond water. Laboratory and field studies on the transmission of vesical schistosomiasis continued in the Gambia and, with its further expansion during the year by a group of World Health Organization workers, the designation of the East African Malaria Unit has been changed to the East African Institute of Malaria and Vector-Borne Diseases, to accord with its increasing scope. Continued examination of 'Dieldrin' as a mosquito larvicide has shown it to be some ten times as lethal as DDT, and the granulated form is a valuable new preparation. The Malaria Control Pilot Project in Western Sokoto, Northern Nigeria, found a surprisingly rapid loss of potency of residual 'Dieldrin', DDT and BHC on the mud walls of human dwellings. In solid form 'Dieldrin' and 'Lindane' were the most effective toxicants against the larvæ of *Aedes aegypti* and *Culex fatigans*; in aqueous suspensions the order of efficiency was 'Dieldrin', 'Lindane', DDT. In Kenya, investigations were initiated on the metabolism of *Plasmodium knowlesi*; using the fluctuation in quantity of the adenosine phosphates as an indicator of the energy resources in the parasite–erythrocyte complex, it was found that the parasite draws upon the energy resources of the erythrocyte during its multiplication in the blood stream, and that the adenosine triphosphate and diphosphate contents vary inversely with the percentage of parasitized cells.

A detailed entomological survey to determine to what degree West African strains of *Aedes aegypti* are domestic species and therefore accessible to larvicidal control measures, and whether this species is the sole or even the most important local vector, has been commenced in and around Ilobi, a typical rain-forest belt village fifty miles from Lagos, while from the results of surveys of yellow-fever antibody in man and monkey made during the past ten years certain epidemiological patterns in south, south-west, eastern and northern Nigeria emerge.

In a study on the relation of the virus to its insect host, the East African Virus Research Institute at Entebbe has concentrated on the genetical and breeding aspect, to elucidate why only some mosquitoes are infectible; other studies at Entebbe concern the relation of virus to host tissues and the behaviour of Rift Valley fever in the mouse, while in collaboration with the Laboratoire Médicale de Stanleyville, Belgian Congo, a survey was made of yellow-fever immunity among forest pigmies. Tests of the Malayan strain of *Aedes aegypti* have shown that under laboratory conditions it is a most effective vector for the transmission of yellow-fever virus by bite. The Trinidad Regional Virus Laboratory, Port of Spain, has given full attention to yellow fever, following the isolation of yellow-fever virus from a patient from a forestal region of Trinidad; immunity surveys have also revealed that dengue is widespread throughout the island and that ilheus is widespread in the lowland high-rainfall–forest–cocoa area. In Malaya sera from six rural communities exposed to different predominant biting mosquitoes were being examined for antibodies to yellow fever and Japanese encephalitis, and a comprehensive clinical and laboratory study of acute febrile illnesses in and around Kuala Lumpur was undertaken to define their etiology and determine the part that arthropod-borne viruses might play in their causation. Study of Japanese encephalitis in Malaya was extended to a search for the natural mosquito vector, and at the Lister Institute of Preventive Medicine, Elstree, the identification of blood-meals of insects continued.

In Uganda the work on the body composition of malnourished African subjects before and after feeding with high-calorific diets of high protein content continued, and the water and protein contents of muscle obtained at autopsy and operation were investigated; studies of the hæmoglobin and serum protein of subjects living in the high (non-malarious) districts and in the lower (malarious) districts of Kigezi led to the tentative conclusion that the high values for gamma-globulin are in part due to malarial infection. Data on the potassium and sodium concentrates in the plasma of infants suffering from kwashiorkor show that plasma potassium values in children who do not suffer from severe diarrhœa are within control limits. At the Hot Climate Physiological Research Unit, Nigeria, a statistically designed investigation was made of certain variables in the standard Harvard pack test. A long series of trials began on the effect of air movement on performance, and also preliminary work on the distribution of body fluid and the composition of the body. An active programme of leprosy work at Singapore included a chemotherapeutic trial of isonicotinic hydrazide, and a study was made of the interrelationship of the Mantoux and Lepromin reactions in an attempt to evaluate the use of B.C.G. vaccine as a prophylactic in leprosy, which indicated that leprosy attacks essentially the Mantoux-negative individuals and that infection with tuberculosis resulted in some resistance to leprosy. A new mass-treatment campaign has been started in Keneba against *Microfilaria bancrofti* infection using 'Hetrazan' in conjunction with an anti-histamine drug. The search for new antibiotic-producing organisms, particularly streptomyces, from Malayan soil continues, and further mosquito infectivity experiments have confirmed that, in patients carrying gametocytes of a proguanil-resistant strain of *P. falciparum*, anopheline mosquitoes can be infected from a person taking 0·4 gm. proguanil daily. Further observations in the Kitui kala-azar area indicate that an anthropophilic species, provisionally designated *Phlebotomus* (*Sergentomyia*) sp. nov. 2, is the most likely vector of the epidemic, and experiments in Fiji indicate that the most effective dosage of 'Hetrazan' for control of filariasis is one 50-mgm. tablet taken on one day per month for twelve months.

(*To be continued*)

FOURTH NATIONAL CLAY CONFERENCE IN THE UNITED STATES

THE Fourth National Clay Conference of the National Clay Minerals Committee, United States, was held in the Department of Mineral Industries of the Pennsylvania State University, University Park, Pennsylvania, and consisted of seven sessions during the three days October 11–13. Approximately fifty-four papers were presented. Participants came from all regions of the United States, as well as seven from overseas: Dr. G. F. Walker (Australia), Dr. W. Dekeyser (Belgium), Prof. U. Hofmann (Germany), Dr. J. L. White and Dr. D. M. C. MacEwan (Great Britain), Prof. T. Sudo (Japan), Prof. J. M. Albareda (Spain). Dr. Hénin (France) was prevented by illness from attending. E. W. Radoslovich (Australia), J. Kulbicki (France), J. Zussman (Great Britain) and H. Heystek (South Africa), who were on extended visits to the Pennsylvania State University, were also present.

With such a wealth of papers, it would be difficult to give a detailed report. The present account concentrates on certain topics which seemed to me to be of importance, and is bound to be coloured by personal interests. It may, however, not be entirely a matter of personal prejudice that the study of interstratified, or mixed-layer clay minerals, appeared to emerge as one of the important growing-points of this branch of science. Their existence was reported many years ago by Alexander and others[1], and, since then, gradually increasing numbers of studies of such minerals have been appearing. At the Pennsylvania meeting, a whole session was devoted to this topic. The use of Geiger-counter recording apparatus for X-ray diffraction allows very extensive surveys to be made in a relatively short time. C. E. Weaver reported on the examination of three thousand sedimentary rocks, his conclusion being that interstratified clays are among the commonest mineral types present in the clay fraction. Systems identified are randomly interstratified illite–montmorillonite, chlorite–vermiculite, illite–chlorite–montmorillonite, chlorite–kaolinite, and regularly interstratified chlorite–vermiculite. A vermiculite–illite system, weathering to a 'chloritic' system (alumina in interlayer positions), was reported from New Zealand soils by T. Tamura. Schmehl and Jackson directed attention to the presence in soil clays of amorphous 'relicts', not giving distinct diffraction maxima, even on heating. T. Sudo reported certain Japanese acid clays which are randomly mixed kaolinite–montmorillonite; some of these minerals show almost no basal reflexions, a phenomenon which has not been satisfactorily explained. Vanadium silicates resembling clay minerals were described by J. C. Hathaway, who reported that they show mixed-layer expanding structures, mica–montmorillonite and chlorite–montmorillonite.

The name 'corrensite' has been proposed[2] for (apparently) a regular 1 : 1 montmorillonite–chlorite, and two occurrences of similar material were described at this meeting by J. W. Early and I. H. Milne. Vermiculite–chlorite systems from soil and shales were described by H. Heystek. D. M. C. MacEwan reported a Fourier-transform investigation of a mica–montmorillonite interstratified system in a Silurian clay from Worcestershire, the system being strikingly similar to the 'Kinnekulle II' clay from Sweden[3]. E. W. Tooker found mixed-layer illite–montmorillonites as stages in the series biotite–illite–montmorillonite (in an extensive paper on altered wall-rocks in the Pre-Cambrian of Colorado).

R. Roy, with his collaborators, has continued his important studies at the Pennsylvania State University on clay synthesis and equilibria, and he reported (with D. M. Roy) on hydrogen–deuterium exchange and the assignment of infra-red frequencies in clays (a caution against a too light-hearted assignment of absorption maxima to certain atomic groupings), and also on thermal transformations in dickite—namely, the formation of kaolinite by hydrothermal treatment of 'metadickite' and 'meta-metahalloysite', these substances being, of course, the analogues of 'metakaolin'. With F. A. Mumpton he has investigated the relation of ionic substitution to hydrothermal stability of montmorillonoids. Saponites are the most stable; the addition of polarizable ions (Zn^{2+}, Ni^{2+}) decreases the stability, as does the substitution of Ga^{3+} for Al^{3+} in beidellite. The interlayer ions also affect stability. Mumpton and Roy have further succeeded in synthesizing both regularly and randomly interstratified minerals.

G. W. Brindley and his collaborators have been continuing detailed structural work on clays. At the meeting, Newnham and Brindley reported on the structure of dickite, a two-dimensional Fourier investigation, which shows the octahedral layer of this mineral to have distortions of the same general type as in gibbsite (the first study of this sort on a dioctahedral mineral of the clay group); and on allevardite, confirming in general the results of Caillère *et al.*[4]. Brindley and Radoslovich have commenced a study of the hydrothermal alteration of single crystals of felspars. In Dr. Hénin's absence, Prof. Brindley also read his paper on low-temperature synthesis of clay minerals.

Other structural studies were reported by J. Zussman and G. F. Walker. Zussman proposes to divide the serpentine minerals into ortho- and clino-chrysotile, antigorite, and a third variety with orthogonal packing. (Whittaker, reporting on these minerals in November to the Mineralogical Society in London, proposed the name 'lizardite' for this variety.) Walker has investigated in detail, using two-dimensional Fourier syntheses, the dehydration mechanism in vermiculite, and his paper may well form the foundation for much future thought on clay–water relationships, replacing the earlier ideas of Hendricks and Jefferson[5]. He recognizes a two-layer stage for the interlamellar water, with octahedral co-ordination around the exchange cations; then a less hydrous stage where the cations migrate to the mineral surface, followed by a one-layer stage; and finally, as more water is removed, the 'collapsed' form without interlamellar water occurs in interstratification with the previous stage.

Walker's paper was read during a symposium on "Clay–Water Relationships", in which H. van Olphen presented experimental evidence for the magnitude of the linking force in pure clay gels (10^{-4} dynes), and the height of the energy barrier for thixotropic gelling in 0·03 N sodium chloride solution (7 kT). In the same session, D. T. Oakes and E. J. Burcik described a method for electro-osmotic charge determination in concentrated suspensions; W. H. Wood, W. T. Granquist and I. M. Krieger described viscosity measurements on very dilute suspensions; W. C. Ormsby, R. M. Witucki and W. A. Weyl reported investigations on the effect of wetting agents on deformation of kaolinite suspensions; and U. Hofmann gave experimental evidence for a relation between surface charge of montmorillonite minerals (determined by chemical analysis) and swelling properties. C. W. Marshall, who was unable to be present, sent a paper on thermodynamic, quasi-thermodynamic and non-thermodynamic methods of investigating the electrochemistry of clays.

Another symposium was devoted to "Thermal Transformations in Clay Minerals". R. A. Rowland, E. J. Weiss and W. F. Bradley reported on the study of mono-ionic montmorillonites (Na, K, Li, NH_4, H, Ca, Mg, Mn), using the 'oscillating-heating' method, which consists in continuously scanning a small diffraction region, while heating the sample. The resulting diagrams illustrate very prettily the onset and progress of reactions. J. L. White described work on the effects of molten salts on layer-lattice silicates, the most striking result being the removal of potassium from (silt- and clay-grade) mica by molten lithium nitrate, giving a montmorillonite-like product. Other papers were on the dehydroxylation of illite (B. W. Nelson), and comparison of natural and synthetic montmorillonites (L. B. Sand and M. S. Crowley).

Advances in the technique of identification of minerals were referred to by E. B. Kinter and S. Diamond, and I. H. Milne and C. M. Wardshaw (preparation of samples for an X-ray diffractometer); and by A. Auskern and R. W. Grimshaw (infra-red spectrography). Aspects of industrial interest included paper-coating by kaolinite (H. H. Murray and S. C. Lyons); green compression strengths of bentonites (W. F. Bradley); and colloidal properties of silica and silicones (E. A. Hauser).

There was no symposium on weathering and alteration of minerals, but several papers were concerned with related questions. In Illinois (H. H. Murray and R. K. Leininger), and in Wisconsin (L. D. Whittig and M. L. Jackson), illite and chlorite have been found to alter to montmorillonoid (montmorin), or vermiculite. B. N. Rolfe described surficial sediments from Lake Mead (Hoover Dam area). B. Osthaus has studied the acid dissolution of montmorillonite and nontronite, and is able to distinguish two first-order reactions in the removal of iron and aluminium (octahedral and tetrahedral co-ordination ?). G. T. Kerr, R. H. Zimmerman and F. H. Wells have found two stages in the degradation of acid hectorite, with the release first of magnesium, and then of silicon dioxide. Anion exchange was discussed by S. J. Buckwold.

The entire series of meetings gave an impressive picture of clay mineral researches in the United States at the present time. It is noteworthy that some fine pieces of research have been done by industrial laboratories, especially those of oil companies. Most of the foreign visitors seemed to find the programme over-full, and would have preferred more time. This conference represented, of course, a year's research in the field. As compared with the diversity of effort in Europe (two meetings a year in Great Britain, France and Sweden; and others in Germany, Belgium, etc.) it showed the great advantages of organization on a continental scale, enabling all the workers on the subject to get together for an intensive discussion. The result was very inspiring. The complete proceedings of the conference will appear in book form, and are at present being edited by Miss Ada Swineford, of the Kansas Geological Survey. Like the second and third conferences, they will be published by the National Research Council, Washington, D.C., as will, so it is intended, the proceedings of subsequent conferences. The proceedings of the first (Bull. 169, Calif. Dept. of Mines, 1955) and second conferences have already appeared and form attractive and valuable records of progress in this field.

D. M. C. MacEwan

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[2] Lippmann, F., *Heidelberger Beitr. Min. Petr.*, **4**, 130 (1954).

[3] Byström, A.-M., *Nature*, **173**, 783 (1954).

[4] Caillère, S., and Hénin, S., *C.R. Acad. Sci., Paris*, **230**, 668 (1950).

[5] Hendricks, S. B., and Jefferson, M. E., *Amer. Min.*, **23**, 855 (1938).

THE METAPHYSICS OF SCIENCE

In the Riddell Memorial Lectures* Prof. R. O. Kapp discusses a question which is, he says, of even greater importance for science than for theology, namely, "whether non-material influences have a real existence or not" (p. 8). Kapp defends an affirmative answer to this question, a doctrine that he calls "dualism", as against the negative thesis which he describes as "monism". This nomenclature is, I think, misleading, because various theorists such as Hegel have advocated a non-material, that is, spiritual, monism. Kapp supposes not only that the two metaphysical theories of dualism and monism are answers to a genuine problem, roughly 'What are the ultimate and irreducible constituents of reality ?', but also that they are the only two possible answers to the problem. These are, of course, very large assumptions indeed, and it is regrettable that Kapp fails not only to defend them but even to state them. He gives no grounds for presenting us with what, to my mind, are equally erroneous doctrines, nor for his assumption that one must vote for one rather than the other.

Kapp regards his problem as raising an empirical issue, namely, whether or not a certain sort of entity exists. The dualism that he defends is a causal hypothesis to account for the existence of 'order' in the universe. In this sense, which we shall see is a somewhat special one, order is explicable only if there exists a non-material cause or causes; of these we are offered a generous selection: "God, the soul, entelechy, élan vitale". The generic name given to these is "diathetes". At various places they are described as "things" (p. 13), "active realities" (p. 12) and "influences" (p. 8), but it seems clear that Kapp thinks of them as entities of a kind, as he is perplexed by the problem "That diathetes, be they called God, life, mind or the soul can be nowhere and yet do things is a most puzzling concept" (p. 53). We are not told whether these "diathetes" are fundamentally one, or whether they are separate; if the latter, then criteria should be given which would enable us to decide how many diathetes there are.

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* "Facts and Faith". By Reginald O. Kapp. Riddell Memorial Lectures. University of Durham. Pp. 63 (Oxford University Press, 1955.) 5*s*.

The argument that is advanced for the existence of diathetes is of the form of a causal hypothesis; they are said to be necessary to account for the existence of 'order' in the physical world. (It is not clear whether Kapp would regard as admissible any more direct attempt to establish their existence.) Only a certain class of physical events is the result of the causal activity of diathetes, those which occur in "living substance"; this notion is contrasted with that of the "rough untouched world of lifeless things", a phrase which recurs with hypnotic regularity. "A diathete can exercise direct control over any living substance and either only indirect control or none over all lifeless substance" (p. 17). A diathete is thus very like the driver of a motor-car—indeed this simile is explicitly used on p. 21. The crux of Kapp's argument is therefore the distinction between random and ordered events; only in living substance, he maintains, is order to be found, which is the result of 'diathetic' activity, while no such hypothesis is necessary in order to understand the processes of inanimate Nature, for these are all random.

What exactly is to be understood by the phrase 'the natural order' is, of course, a problem of the greatest importance for both philosophy and the natural sciences. Kapp recognizes the profundity of this somewhat neglected question; but his own treatment of it, so far as I can understand, is vitiated by a serious confusion. Kapp uses the words "order" and "random" as antitheses, but not always to point the same contrast. Sometimes "random" is used to mean simply "contingent"; for example, he describes the world studied by physics as "one in which anything may happen that is logically possible" (p. 36). From this quite true observation Kapp concludes in most misleading language that such a world is a 'random' one. The bounds of logical possibility are very wide, and include many concepts that are empirically *impossible*; as Russell has pointed out, there is no *logical* absurdity in the idea that the universe was created five minutes ago, complete with memories. Thus from the contingency of all factual propositions it is incorrect to conclude that there are no objective physical laws; logical and empirical necessity are concepts of quite different orders.

In denying that there is any objective order in physical nature, Kapp finds himself faced with the problem of explaining what the physical sciences are all about; if there are no laws in inanimate Nature, what are these sciences investigating? The discussion of this question is carried out with reference to Ohm's Law. Kapp argues, with some persuasiveness, that this principle should be regarded as a tautology, that is, as true by the definition of a resistance. With less plausibility this is alleged to hold true of all the laws of the natural sciences. In proposing a return to the conventionalism advocated by Poincaré some years ago, Kapp does not seem sufficiently aware of the objections that can be made against this view. Some of these are, briefly: (1) the fact that scientific laws can be represented as tautologies that are true by definition does not place them in any special category, for any proposition can be expressed as a tautology if sufficient latitude is allowed to our definitions; (2) if the principles of science are mere definitions, then it is not easy to understand how it is that scientific knowledge enables us to predict and control natural phenomena; (3) how, on such a theory, are we to explain, or even describe, the progress of the sciences? I do not deny that many, and perhaps all, scientific advances involve the re-definition of terms, but it by no means follows from this that the practice of science is to be understood as the invention of definitions.

A different use of the word 'random' can be found in those passages where Kapp contrasts it with the concept of 'ordered' as meaning the result of planning. He is much concerned to omit notions like those of 'consciousness' and 'purpose' because he believes that it is a fallacy to suppose that a diathete can operate only at a conscious level. Nevertheless, he talks as if he wishes to preserve the concept of teleology without having to face the difficulties raised by the idea of 'purpose'. Thus he compares "the extremely precise predictions that can be made in the biological sciences" (a rather paradoxical remark), with the 'predictions' about the product of the assembly line that an engineer can make from blueprints (p. 49). This somewhat special use of the word 'random' is again illustrated by Kapp's remarks about the stimuli that reach the brain. Of these he says: "They are not co-ordinated. They may arrive from anywhere. [I do not know what this means.] They are random events, unselected, most of them the result of pure chance. And yet the response of the brain to these stimuli is not random. Selection, discrimination, guidance, control do occur. Where, when, how?" (p. 20). Here 'random' clearly means 'not subject to guidance, control or selection'; and, of course, there is a perfectly good sense of the word 'chance' which means precisely this. A boy who breaks a window 'by chance' has not broken it intentionally; but this goes no way towards showing that the event in question was a chance or random event in the scientific sense, that is, inexplicable by the known laws of mechanics or psychology. The implicit teleology of Kapp's position may also be seen from the fact that he finds no incongruity in lumping together "houses, machines and living substance" (p. 36).

The concept of 'order', which is not only of great intrinsic importance but also vital to this particular argument, is unfortunately left as obscure as its antithesis 'random'. Kapp rightly believes that the notions of 'law' and 'order' are very closely connected, but he does not notice that there is here a profound ambiguity. The discussion of the conditions of order begins with a reference to human affairs. It is argued, quite correctly, that a necessary condition of order in this sphere is law "of the statute book kind". Certainly, laws of this character, such as those governing the behaviour of traffic, introduce order, in one sense of the word, into human activity. These laws "make for order", to use a phrase which often occurs in these lectures. Kapp now passes to the question whether "the laws of physics are, like those in the statute books, of the kind that make for order" (p. 23). To this question, which I shall try to show is unintelligible, Kapp returns a negative answer, on the ground that, strictly speaking, there are no laws in Nature but only the definitions and conventions established by scientists. "The precision with which experiments are repeatable does not prove that it is in the nature of matter to behave in an orderly manner but only that it is in the nature of scientists to do so" (p. 45). And again: "The place of the laws of physics, we are led to conclude, is not in the world of physical reality but in the world of scientific methodology" (p. 62, Appendix). In passing, it might be observed that from this duplication of 'worlds' one can only conclude that so far as Kapp is concerned, Carnap's "Logical Syntax of Language" and Stebbing's "Philosophy and the Physicists" have been written in vain.

The problem of whether the laws of the natural sciences 'make for order' can arise, it seems to me, only as the result of a failure to recognize the ambiguity of the phrases "law" and "law and order". The traffic laws impose orderly conduct on motorists and others, and sometimes these "statute book laws", to use Kapp's somewhat unhappy phrase, may be difficult to enforce, as in Cyprus at the present time, in which case 'the rule of law' breaks down. But this does not mean that the phenomena in question become in any way unintelligible or unpredictable from the scientific standpoint. The reason for this is that 'statute book laws' are of a fundamentally different kind from those established by the sciences. The former are *prescriptive* rules which coerce human beings to behave in certain ways because sanctions are attached to them. Of an essentially similar kind are social rules and conventions. The laws of science (including, *pace* Kapp, those of biology) are entirely unlike these, for they are *descriptive* of the actual behaviour of the subject-matter in question, whether it be human, animal or material. Hence the laws of science do not 'make for' or impose order, for only prescriptive laws are capable of this; rather, they merely record the orderly relations which obtain between events. It is worth pointing out, incidentally, that in this distinction between prescriptive and descriptive laws, first clarified by Schlick, one can find the solution, or rather the resolution, of the problem of the freedom of the will.

In the seventeenth and eighteenth centuries this issue was somewhat bedevilled by certain theorists who represented the descriptive laws of Nature (often spelt with capitals) as prescriptive laws imposed by God on the Creation. This leads to the idea that the particles of a gas are 'governed' by Boyle's Law in the same kind of way that we are governed by the income tax laws. All this, of course, arises only from a failure to notice the different senses in which words like 'govern' and 'obey' are used. If Kapp had considered this, he could scarcely have employed language like: "Only on the reason why a particle of matter implicitly obeys the laws of physics may there be difference of opinion between a theologian and his atheistic opponent. The theologian might say it was because matter does not possess free will and cannot therefore sin against God's moral law. The atheist might object that the laws of physics were not ordained by God but by Nature and that a particle of matter obeys them implicitly because it is made in Nature's image and cannot do otherwise" (p. 28). The essential point is that the laws of Nature were not ordained by anybody, so that fortunately we do not have to speculate as to what can be meant by saying that something is 'made in Nature's image'. I conclude that Kapp is right in denying that scientific laws are prescriptive, but that his reasons for this are not convincing because he fails to see that there are perfectly good laws of another, that is, descriptive, kind. If this is admitted, then it appears that Kapp's notion of order, as it concerns the natural sciences, is misconceived, and so are his attempts to find its source in 'diathetes'.

C. K. GRANT

CENTENARY OF THE FORMER SCOTTISH METEOROLOGICAL SOCIETY

THE year 1855 saw the foundation of the Meteorological Office and the Scottish Meteorological Society, both as a result of the international conference on the meteorology of the sea held at Brussels in 1853, and the centenary of the Society's foundation was celebrated at a meeting of the Scottish centre of the Royal Meteorological Society held in Edinburgh on October 28. The principal address was delivered by Sir Ernest Wedderburn, honorary secretary of the Scottish Meteorological Society during 1909–20 and now vice-president for Scotland of the Royal Meteorological Society, and a summary of the address has been published in the November number of *Weather*.

Sir Ernest began by pointing out that it was Sir Henry James, then of the Scottish Ordnance Board, who proposed the formation of the Society as the best means of making available for public use the meteorological observations held by the Northern Lights. The first Council included Thomas Stevenson, designer of the Stevenson thermometer screen, and the first secretary, Dr. Stark, organized on a standard basis the work of seventy voluntary observers in Scotland and the subsequent publication of their observations by the Registrar-General. Unfortunately their preparation for publication soon had to be given up and was performed by the Astronomer-Royal for Scotland from 1858 until 1893, when it returned to the Society. In 1860, Alexander Buchan, later famous for his world climatological atlas and his work on the climate of Edinburgh, was appointed secretary, and he soon made his influence felt by arranging in 1864 for the publication of the Society's *Journal*, which flourished until 1920. He represented the Society at the Leipzig conference of 1872 and, with the Director of the Meteorological Office, the British Government at the Vienna conference of 1873 which did much to draw up an international code of practice in meteorological observing.

Interest in observations at high levels began early in the Society's life, and before 1870 three stations were in operation at above a thousand feet. The most famous single work of the Society, the making of observations on the summit of Ben Nevis, was first mooted in 1877; the observatory on the summit was opened on November 28, 1883, and hourly observations were begun and telegraphed to the Meteorological Office in London over a line laid down the mountain. In 1883, too, the Society set up a marine research station at Granton, at which Dr. R. H. Mill began his meteorological career.

Some government grant was received to assist the Society's work, but by the early years of this century the Society had been financially exhausted by the efforts to maintain the Ben Nevis observatory, which had, unhappily, to be closed in 1904. Negotiations with the Government resulted in 1912 in the granting of an annual sum of £350 from the Meteorological Office on condition the Society maintained an office in Edinburgh to provide for public service under the guidance of a committee, of which Sir Napier Shaw, director of the Office, was appointed chairman. Financial difficulties after the First World War led in 1920 to the complete taking over by the Meteorological Office of the Society's office and its public responsibilities, and at the same time an official Meteorological Advisory Committee for Scotland was set up with the director of the Office as chairman and a membership of representatives of the Scottish universities, learned societies and government departments.

The purpose of the Society, to establish meteorological work in Scotland on a permanent and comprehensive basis, having been achieved, the Society amalgamated in 1921 with the Royal Meteorological Society, which since 1944 has had as one of its honorary officers a secretary, more recently a vice-president, for Scotland. The balance of the funds was used to found the Royal Meteorological Society's Buchan Prize for meteorological research. Meetings of the Royal Meteorological Society were held in Scotland in 1921 and 1954, and a flourishing Scottish Centre was formed in 1946. Some famous names in meteorology connected with the Scottish Meteorological Society have been mentioned. To them may perhaps be added that of C. K. M. Douglas, who joined the Society in 1916 and published his first paper, on weather observations from aircraft, in the *Journal* the same year.

INTERNATIONAL REVIEW OF EDUCATION

THE problems of educational theory and practice, of educational psychology and sociology, of education in home, school and society, have become, more than ever before, matters of international concern. National educational systems and national educational ideas can no longer safely be developed without contact with educational thought and action elsewhere in the world. The maintenance of cultural life has ceased to be something to be guided by ideals purely national in scope.

For these reasons a new educational journal designed to provide an international forum and to promote international exchange of information does not require extended justification. The *International Review of Education* has been launched on behalf of the Unesco Institute of Education, Hamburg, and edited by Karl W. Bigelow of New York, Roger Gal of Paris, M. J. Langeveld of Utrecht, Walther Merck of Hamburg and Friedrich Schneider of Munich. Editorial consultants have been appointed in various countries throughout the world and include such well-known names as Prof. C. H. Dobinson, Prof. M. U. C. Jeffreys and Prof. F. J. Schonell.

One aim of the new journal will be to inform readers as to educational theory and practice in various countries. Another—and perhaps the more important—will be to explore the extent to which such ideas and activities have elements of validity that transcend national boundaries. Such exploration will, of course, require continuing discussion and debate.

In pursuance of its aims the *Review* hopes to develop an ever-strengthening chain of contacts with educational research and training centres throughout the world. Systematic attention will also be paid to international educational conferences and congresses, as well as those of more limited scope which possess special international interest. From the torrent of educational publications appearing everywhere it is the intention to select those of outstanding extra-national significance for critical examination.

The first four numbers of the journal have now appeared, and each contains articles in English, French and German; articles in one of these languages contain useful summaries in the other two. Besides articles by leading English educationists, the first volume of the journal contains a valuable account of the reforms in the French educational system since the War; a bird's-eye view of education in India; a description of educational reform and its problems in post-war Japan; two articles of different points of view on nationalism and internationalism; a survey of political education in France, Great Britain, Germany and the United States; a penetrating inquiry into the state of American education and its relation to politics; a comparison between "le français élémentaire" and basic English which suggests the latter may be too basic; and an interesting account of the way vocational training in Germany has been humanized.

SOURCES OF ANIMAL BEHAVIOUR

IN his inaugural address, delivered on May 5, 1955, at University College, London, and recently published*, Prof. G. P. Wells has drawn forcible attention to the importance of spontaneous rhythms in animal behaviour. His analytical studies of the lugworm *Arenicola* over the past twenty years have shown how little the normal behaviour of this worm seems to depend on the reflexes of a passive animal and how much depends on inherent rhythmic activity. Burrowing, feeding, defæcation and respiration are controlled by 'physiological clocks'. There is rhythmic activity originating from the œsophagus, and this itself recurs in outbursts controlled by rhythms of a higher order.

In any species there are many patterns of these rhythms, and the animal may pass abruptly from one pattern to another. These patterns vary with the species; and the different patterns of rhythms are recognizably characteristic of each species, quite as much as are the anatomical characters by which they are distinguished systematically.

To illustrate the generality of rhythmic patterns, Prof. Wells shows that, just as in his *Arenicola*, much recent work on the behaviour of birds suggests that this is governed by a variety of spontaneous rhythms—that is, regular activity not directly related to environmental stimuli. Rhythmic outbursts of song, feeding and reproductive cycles of behaviour recall the spontaneous rhythms of the worms. It is true that bird behaviour differs from worm behaviour in its much greater complexity and in the much greater indirect influence of external stimuli upon the rhythms and their patterns. But the fact remains that much that is most characteristic of the behaviour of both worms and birds depends on highly individual patterns of rhythmic activity apparently of internal origin.

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* The Sources of Animal Behaviour. (An Inaugural Lecture delivered at University College, London, 5 May, 1955.) By Prof. G. P. Wells. Pp. 20. (London: H. K. Lewis and Co., Ltd., 1955.) 2*s*. 6*d*.

The address is stimulating and leads one to many questions. What are these 'clocks' that control rhythmic behaviour? When we consider rhythmic contractility, on one hand, and reproductive cycles, on the other, it is clear that the clocks work on very varied principles. The one common feature is the rhythmic activity of the system whatever its grade of organization. Possibly it is a general character that they are systems in relaxation oscillation. Living organisms are dynamic, and it does not follow that they will naturally tend towards a constant steady state. Indeed, in many cases such steadiness is only achieved by the evolution of elaborate controls—as the proprioceptive machinery of limbs. Systems in relaxation oscillation may arise at many different levels of organization. Once they are there, they may inevitably be built into the behaviour of the organism through the operation of natural selection.

C. F. A. Pantin

USE OF LOGARITHMIC NOTATION IN SCIENCE AND ENGINEERING

By Prof. S. DEVONS, F.R.S.
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FOR the past ten or twelve years I have been using, and encouraging colleagues and students to adopt, a logarithmic system of notation, in place of the conventional arithmetical one, as the normal one in which to express physical magnitudes and relations. Suggestions that logarithmic scales and units be used more widely have been made by numerous writers, and such systems have obvious advantages. The experience gained in the use of a general system of this sort confirms that the advantages are substantial, perhaps more than is generally appreciated, and that they definitely outweigh its drawbacks and are sufficient to justify its more widespread use.

A large proportion of statements in physical science are in the form: the quantity X, as measured (calculated), is n times a specified unit. The number n is not normally integral or exact. It is not arrived at by counting but by computation from primary physical measurements (empirical quantities), and in this process of computation multiplication plays a dominant part. One can see that this is the case by inspecting a typical table in a compilation of physical data, such as fundamental constants[1], electrical resistivities of metals[2], wave-lengths of X-ray lines[3] or abundances of isotopes[4]. One will find, normally, that the numbers are spread roughly uniformly over a limited logarithmic scale: for example, about 30 per cent of the entries will have the first significant figure 1, whereas only 5 per cent will begin with 9. (Even when the primary quantities are not 'logarithmic', the quantities derived after a few multiplicative steps soon tend to be so.)

The fact that most, although not all, of the quantities used in physical expressions and calculations are of this 'logarithmic' sort suggests that the normal notation to be used in expressing them, and numerical relations between them, should also be logarithmic, with some convenient unit of relative magnitude. A very convenient unit that has long been used in several branches of physics and engineering to denote a ratio of powers is the decibel ($10^{1/10}$, or approximately a factor 1·2), and many proposals have been made to adopt it (either with the same or a new name) for wider use. For the quite general use proposed in this article, a simpler and more distinct name and notation is called for. I have used the term 'jot' for the unit, and I have found the notation $x =$ (unit $\pm$ $xyz.ab$) jot, with the word 'jot' normally omitted, to be simple and unambiguous. It readily permits the simultaneous use of logarithmic and normal notation. Thus, for example, electron charge = (e.s.u. $-$ 93·2), velocity of light = (cm./sec. + 104·8), to an implied accuracy of $\pm$ 0·05 jot (or about 1 per cent). No confusion arises in addition, subtraction, etc.; for example, (c.g.s. + 82·1) + (c.g.s. + 86·2). A notation such as this which emphasizes the unit has considerable pedagogic value. Some other advantages of the logarithmic notation are as follows.

Simplicity of calculation. Just as so many of the physical quantities one deals with are 'logarithmic', so, naturally, the arithmetical manipulations in which they are involved are predominantly multiplicative (including roots, powers, reciprocals). These manipulations become, obviously, greatly simplified and far less liable to error if one starts, works and finishes with the quantities expressed in logarithmic notation. Of course, addition and subtraction become more complicated, but since these operations normally involve quantities of the same order of magnitude, whereas multiplication often involves many orders of magnitude, it is advantageous to have the notation suited to the more frequent and important operation.

Economy of notation. As previously indicated, ordinary arithmetical notation does not use all the digits equally when dealing with usual physical magnitudes. Less digits are required, on the average, to indicate a specified accuracy on the logarithmic scale. This, coupled with the simpler notation, makes quantities expressed logarithmically easier to write, remember, and particularly to manipulate mentally. Compare, for example, $m = 1 \cdot 67 \times 10^{-24}$ gm. with $m =$ (gm. $-$ 237·8), which has three less digits, and all the digits are on a similar footing.

Another feature of the logarithmic system is the possibility of 'normalizing' the scale of measurement so that a high accuracy can be expressed with few digits. For example, the specific gravity of a liquid might be expressed as (unity + 0·2), with an accuracy of 1 per cent, whereas normally this accuracy would require three digits.

Simplification of units. An expression such as $a_0 = 5 \cdot 292 \times 10^{-9}$ centimetres (Bohr radius) is clearly both inconsistent and uneconomical in its notation. First, we have a mixture of logarithmic and linear notations: the digits themselves are linear; whereas the decimal, exponent of 10, and the prefix centi- are all logarithmic, and all three doing the same job. With a consistent logarithmic notation such as the one proposed, multiplication even by large powers of ten does not result in clumsy expressions, so that the need for many units differing by powers of 10 is largely obviated.

For example, suppose we are making (mental) calculations to an accuracy of about 10 per cent, so that we work to the nearest jot, with mean individual error of 5 per cent. Then with four hundred three-digit numbers and ± signs we cover the range of magnitudes 10^{80} to 1, sufficient for most purposes. Moderately accurate calculations can be made in any system of units, and the task of memorizing physical data is made significantly easier. For example (to an accuracy of $\frac{1}{2}$ jot), r_0 (classical radius of electron) = (cm. − 126). Using c = (cm./sec. + 105) and year = (sec. + 75), we get r_0 = (light-year − 306), which is scarcely more difficult to deal with than (metre − 146) or (angstrom − 46). With a notation that can express the size of the electron as conveniently in light years as in angstrom units, there is little need for a large multiplicity of units (and especially of length). The use of a single unit in all branches of physical science would not only simplify many calculations, but it would also bring out, most directly, the relative magnitudes of different physical quantities, related and otherwise.

Representation of errors. In logarithmic notation the sign and the number of digits before the decimal point indicates the magnitude; that after, the precision. Without further specification, no digits after the point indicate an average accuracy of ± 5 per cent, one digit ± 0·5 per cent, etc. For normal error distributions, the accuracy can be given directly and absolutely by additional figures (for example, superscripts) giving the size of error in units of last digit written. (The ± sign is redundant, and more than one figure is seldom required.) For example, c = (cm./sec. + $104{\cdot}77^{2}$) would indicate an accuracy of the quoted value of 0·02 jot or about ± 0·4 per cent.

The systematic use of logarithmic notation does involve transcription into this notation of quantities such as meter readings, some numerical constants, and data presented in conventional form. The most frequent of these is the last-mentioned, and this task would be avoided if the notation were generally used and accepted. The incorporation of non-dimensional constants presents no difficulties; for example, the expression 4π(e.s.u. − 82·5) is quite unambiguous and, moreover, displays the nature of the quantities involved very directly. Fortunately, π and powers of 2 can be expressed quite accurately in integral units (jots), and even '137' can be replaced by 21·37 to an accuracy of one or two parts in a thousand! Primary observations fall into two groups: some, such as micrometer or thermometer readings, involve counting and additive operations; others, such as most electrical instruments, do not, and there is much to be said for having the scales of these latter marked in both logarithmic and linear fashion.

To summarize: the use of logarithmic systems simplifies notation and calculation, eases the burden on memory and reduces the need for a multiplicity of units. Whenever I have had occasion to propound the merits of the system, I have generally found ready acceptance of the points made here, and this leads me to propose general use of some such system.

[1] DuMond, J. W. M., and Cohen, E. R., *Rev. Mod. Phys.*, **25**, 707 (1953).

[2] "International Critical Tables", **6**, 136, Table 2 (1929).

[3] Compton, A. H., and Allison, S. R., "X-Rays in Theory and Experiment", Table 2, 784, 785 (Van Nostrand, New York, 1948).

[4] Brown, H., *Rev. Mod. Phys.*, **21**, Table 4, 630 (1949).

SONIC SCATTERING LAYERS OF HETEROPODS

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DURING a nineteen-day oceanographic cruise in April 1955 in Bass Strait, southern Australia, the Fisheries Research Vessel *Derwent Hunter*, using a 14-kc./s. echo-sounder (Kelvin Hughes MS 24*E*), repeatedly detected sonic scattering layers over a large and well-defined area of continental shelf. The layers were diffuse and quite unlike fish traces, and varied greatly in density; they were virtually confined to the top 20 m. of the sea and were generally found in the upper 10 m., by both day and night.

Fig. 1 shows the track of the ship, distinguishing the long echo-sounded portion; the stations at which plankton was collected; and the sections of the track along which the layers were found, which were all east of 145° 15′ E. long. The longest section over an unbroken layer was about seventy miles.

Fig. 2 shows a portion of the echogram record of the densest of these layers, taken just before and during the occupation of one of the stations (No. 1 in Fig. 1), on a calm night.

Vertical bottom-to-surface hauls were made in duplicate with the "Discovery" *N*70 plankton net at each station on the continental shelf, and similar paired hauls from 500 m. to the surface were made at each station on the continental slope. Echo-sounding was done at twenty-seven stations, fourteen at which layers were detected and thirteen at which they were not, and was omitted at fourteen stations (mostly on the continental slope).

The plankton catches were checked to try to identify some organism which (*a*) was present at each station at which a scattering layer was found, and (*b*) was absent at each station at which no layer occurred. No organism completely satisfied these conditions, but three species met them closely: the cladoceran *Evadne nordmanni* Lovén, the lancelet *Paramphioxus bassanus* (Gunther), and the heteropod mollusc *Firoloida desmaresti* Lesueur.

Evadne nordmanni was absent at one station where there was a scattering layer, and present at three stations, including one as far west as 143° 15′ E. long. (No. 4 in Fig. 1), where there was no layer. This species is most unlikely to have caused the echo-sounder traces because it is very small (about 0·5 mm. long) and was not very abundant at any

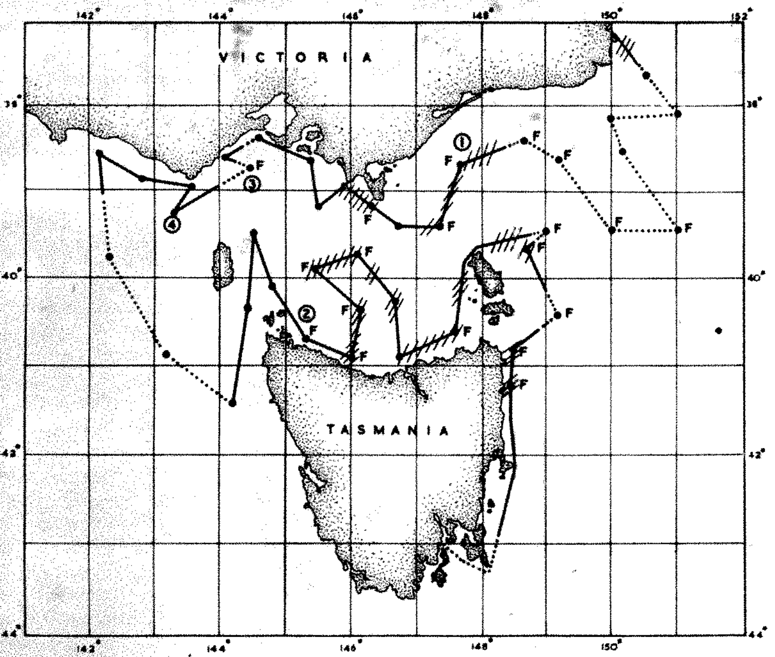

Fig. 1. Chart of the cruise showing the echosounded (——) and un-echosounded (· · · ·) portions of the track, and station positions (●). The occurrence of the scattering layer is indicated by hatching, and of *Firoloida* (in plankton catches) by the letter *F*. For further explanation see text

station. At the station to which Fig. 2 refers, for example, only about two hundred individuals were taken in two vertical hauls.

Paramphioxus bassanus was absent at four stations where there was a layer, including the station to which Fig. 2 refers, and present at three stations where there was no layer. The greatest density was observed at one of the three latter stations, and elsewhere the numbers did not exceed ninety-one for a pair of vertical hauls. The animals were only about 5 mm. long, and as lancelets are benthic forms it is most unlikely that the scattering layer consisted of this species.

Firoloida desmaresti was taken at eleven of the fourteen stations where there was a layer and at one of the thirteen stations at which there was no layer. The best catch, nineteen for a pair of vertical hauls, was made at the station to which Fig. 2 refers, where the scattering layer was densest. The average length of the specimens was about 40 mm., diameter 4 mm., and volume 0·4 ml.

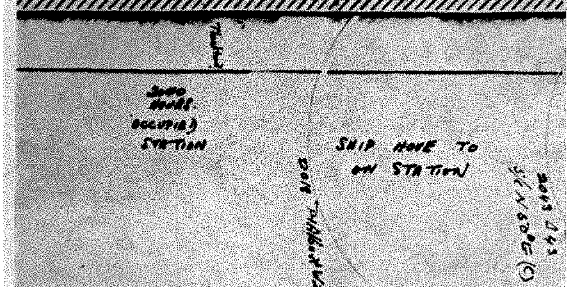

Fig. 2. Portion of echogram showing the appearance of a dense scattering layer before and during the occupation of a station (No. 1 in Fig. 1). Note time scale in minutes above. Depth of water 75 m., with layer confined to upper 20 m.

According to Tesch[1], *Firoloida desmaresti* is given to swarming, and the members of the family to which it belongs, the Pterotracheidae, are active and fast-swimming. This could explain why larger numbers were not captured and why the species was not taken at all at three stations at which a scattering layer was seen: the animals might have avoided the net. Fig. 2 shows some discontinuity of the layer beneath the ship while she was on the station, which could be due to disturbance of the animals by the raising and lowering of nets. A re-examination of the echograms at the three above-mentioned stations showed that the layer was faint or absent at the actual times the plankton nets were used, at two and possibly all three stations.

One specimen of *Firoloida* was taken in two hauls at one station at which the echo-sounder revealed no sign of a layer (No. 2 in Fig. 1); and here, just beyond the western boundary of the general area of the scattering layer, it may be assumed that the numbers were insufficient for the formation of a detectable layer. The same might have been true of another station still farther to the west (No. 3 in Fig. 1), where only one specimen was taken in two hauls, but there was no echo-sounding at this position.

Thus *Firoloida*, by virtue of its size, habits and distribution in relation to that of the scattering layer, is far more likely to have been the constituent of the layer than any other organism sampled by plankton nets. There remains the possibility that the layer consisted of some animal which avoided the nets on every occasion. Such an organism would probably be one of the smaller members of the nekton, such as a small fish or cephalopod. However, the nekton of this region is fairly well known from a study of the stomach contents of the omnivorous pelagic scombroid fish *Thyrsites atun* (Euphrasen), which I am studying, and only one nektonic species apart from *Thyrsites* itself has been found to occur in abundance in Bass Strait at the time of year in question. This is the anchovy, *Engraulis australis* (White), which gives echogram traces of a very different kind. *Thyrsites* itself has not yet been found to give any well-marked echogram trace, and its distribution at the time of year under discussion is generally coincident with that of the euphausian *Nyctiphanes australis* Sars, on which it preys; and *Nyctiphanes*, on the cruise of April 1955, was most abundant to the west of the region of the scattering layer.

The sonic scattering layer described may therefore be attributed to the swarming of the pterotracheid heteropod mollusc *Firoloida desmaresti* Lesueur. The swarming was probably for reproductive purposes, as many females had egg chains.

The work described was part of the research programme of the Division of Fisheries, C.S.I.R.O., Australia. Mr. W. Dall, of that Division, identified the plankton of the cruise. [Oct. 14

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sensitivity of the Mouse Testis to the Mutagenic Action of X-Rays

In making estimates of the damage caused by exposure of human gonads to ionizing radiation, it is essential to take into consideration variations in sensitivity of the germ cells at different stages in their development. In *Drosophila*, this has been done by mating irradiated males to a succession of females and determining mutation-rates separately for successive broods[1]. It was found that spermatids, probably at the stage of transformation into spermatozoa, are the most sensitive stage; mature spermatozoa are one-third or one-fourth as sensitive as spermatids, and spermatocytes are intermediate. Spermatogonia are the least sensitive: a given dose of X-rays produces only one-third to one-half as many mutations in spermatogonia as in spermatozoa.

This last point is of particular significance for estimates of radiation damage in man. In a human population exposed to chronic irradiation, spermatogonia form the majority of treated cells, and it is their sensitivity which in the main determines the genetical effectiveness of the exposure. As extrapolation from *Drosophila* to man seems hazardous, it would be of the greatest value if the 'sensitivity pattern' of the testis could be established for a mammal, for example, the mouse. Unfortunately, the most important comparison—that between spermatozoa and spermatogonia—requires scoring of genetical effects which are not subject to germinal selection during and before meiosis, and this rules out the two most frequent effects in the mouse, namely, dominant lethals and translocations. These can, however, be used for comparing the sensitivity of post-meiotic stages. If the post-meiotic sensitivity pattern of the mouse testis should resemble that of the *Drosophila* testis, we may with some confidence extrapolate to pre-meiotic stages and predict that in mammals, as in *Drosophila*, spermatogonia will be less sensitive than spermatozoa.

Hertwig[2] and Russell *et al.*[3] compared the frequencies of dominant lethals in litters produced during the early and late part of the pre-sterile period; they found significantly higher frequencies in the late litters. This suggests that in the mouse, as in *Drosophila*, X-rays produce more genetical changes in spermatids than in mature spermatozoa. We have carried out a pilot experiment to test this conclusion for translocations.

Five wild-type males from crosses between inbred lines were exposed to X-ray doses varying from 400 to 600 r. Each male was given five females, and every morning females which had copulated during the night were replaced by new ones. All sons which had been conceived during the pre-sterile period were tested for fertility by mating to several (two to six) females which had had litters of seven or more young by untreated males. Sons of treated males which produced average litter sizes of less than nine were suspected of semi-sterility and were examined cytologically for translocations. Twenty separate chromosomal elements seen in at least five metaphase plates of the first meiotic division were taken as evidence for the absence of a translocation. The consistent presence of nineteen separate elements served as indication for the presence of a translocation. Table 1 shows the strong correlation between low fertility and a cytologically detectable translocation.

TABLE 1

Average litter size	No. of males examined cytologically	Translocation present	Translocation absent
0	2	2	0
6	18	18	0
6–6·8	8	2	6
7–8·9	3	0	3

Males with average litter sizes of nine or more were not examined cytologically. This may result in the loss of small translocations which do not cause lethal aneuploidy of the zygote. In fact, one male with average litter size nine, which was examined because it had produced two litters of seven, carried a translocation involving an exchange of minute segments, so that, in one out of six cells examined, nineteen chromosomal elements were present. This case was not included among the translocations, since similar small translocations may have been present in fertile males which were not examined cytologically. One of the highly sterile males carried a complex interchange which was scored as two translocations. No controls were used, for the occurrence of spontaneous translocations in mice must be exceedingly rare. No translocation was found in 248 *CBA* males which one of us (B. M. S.) had examined previously, and none has been reported in the literature.

Table 2. NUMBERS OF TRANSLOCATION HETEROZYGOTES AMONG F_1 MALES

Litter number	Mouse 1	2	3	4	5	Trans.	Total animals	%
1	1/4	1/5	1/5	0/5		3	19	15·8
2		1/3			0/2	1	5	20·0
3	1/7	1/5	0/5	0/2		2	19	10·5
4	0/2	1/4	1/5	0/3	0/3	2	17	11·8
5			0/2	3/4	0/3	3	9	33·3
6	2/2	0/1	2/5	0/1	0/1	4	10	40·0
7	1/6	1/3	1/2		1/5	4	16	25·0
8		0/2	1/2		0/3	1	7	
9					2/2	4{ 2	{ 2 }	25·0
>9			1/7			1	7	
	4/21	5/23	8/33	3/15	3/19	23	111	

In Table 2 the full results are presented. In the last column the overall translocation frequency has been calculated for each litter number, and these figures have been plotted in Fig. 1.

It will be seen that after the fourth litter translocation frequency rises to a higher level, which is more or less maintained to the end of the pre-sterile period. If the slight decrease in the last litters is more than an effect of chance variation, it may be assumed that the sperm used for these litters could be traced back to irradiated spermatocytes, in which

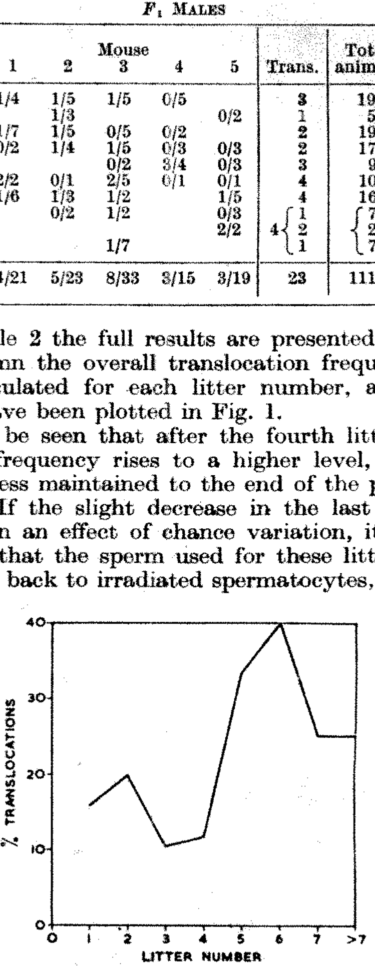

Fig. 1. Translocation frequency in successive litters

germinal selection has started to operate against translocations. Altogether, there were eight translocations in sixty males from the first four litters, as against fifteen in fifty-one males from later litters. The difference has a probability of slightly less than 5 per cent of being due to sampling error. For a more elaborate statistical analysis the present results are too scanty. Confirmation on a larger scale is desirable, but cannot be obtained with our present facilities. We hope to be able to provide it at some later time.

Meanwhile, the results presented here, together with Hertwig's[2] and Russell's[3] previously mentioned findings on dominant lethals, offer presumptive evidence for the conclusion that in the mouse, as in *Drosophila*, spermatids are more sensitive to the mutagenic action of X-rays than mature spermatozoa.

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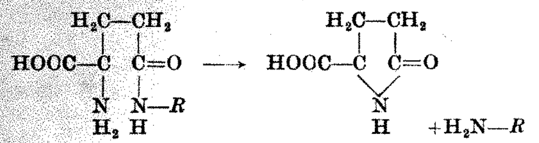
Enzymic Formation of Pyrrolidone Carboxylic Acid from γ-Glutamyl Peptides

Pyrrolidone carboxylic acid has been reported frequently as a constituent of biological systems. Ellfolk and Synge[1] have summarized these reports and clarified the reliability of methods used for its identification. Pyrrolidone carboxylic acid can be formed rather readily from glutamine, γ-glutamyl peptides, and even glutamic acid in non-enzymic reactions, and in some cases this may account for its reported natural occurrence. For example, Woodward and Reinhart[2] claimed that an enzyme from kidney, later characterized as γ-glutamyl transpeptidase[3], caused the formation of varying amounts of pyrrolidone carboxylic acid from glutathione ; but the results of Hird and Springell[4] suggest strongly that the pyrrolidone carboxylic acid isolated by these authors resulted from secondary non-enzymic breakdown of γ-glutamyl peptides under the drastic conditions applied.

In the present work an enzyme has been isolated from liver tissues which does in fact catalyse the formation of pyrrolidone carboxylic acid from glutathione and other γ-glutamyl peptides in accordance with reaction 1 :



(1)

This enzyme is quite distinct from γ-glutamyl transpeptidase. It is very active in rat liver, in which tissue the transpeptidase occurs in traces only ; and when the two enzymes occur together, as in pig liver, they can be separated cleanly by centrifugal fractionation followed by fractionation with ammonium sulphate. Furthermore, highly active preparations of γ-glutamyl transpeptidase, after appropriate purification, fail to produce even traces of pyrrolidone carboxylic acid detectable by the methods used here.

It is proposed to refer to the pyrrolidone carboxylic acid-forming enzyme as γ-glutamyl lactamase. It will be noted that the cyclic lactam is formed by transfer of the γ-carboxyl group of the glutamyl residue from the peptide linkage to new linkage with the amino-group of this same residue. The enzyme has been shown to act upon γ-glutamylglycine, γ-glutamylglutamic acid, γ-glutamylphenylalanine and glutathione—more slowly upon the last two substrates. The enzyme has no action on glutamine or on free glutamic acid.

In all cases tested the γ-glutamyl peptides are converted completely (within the limits of detection) into pyrrolidone carboxylic acid plus the C-terminal amino-acid or peptide. The purified enzyme is devoid of hydrolytic activity and no free glutamic acid appears during its action. No reversal of the reaction shown in reaction 1 can be demonstrated when the enzyme is allowed to act upon pyrrolidone carboxylic acid plus amino-acids, even when they are present in high concentration ; the equilibrium seems to lie far to the right. No pyrrolidone carboxylic acid is detectable when boiled enzyme is incubated with a γ-glutamyl peptide under the usual conditions.

The γ-glutamyl lactamase may be prepared from pig liver in partially purified form as follows : (i) liver tissue, in 3-gm. portions, is macerated in a glass pestle homogenizer in 25 ml. 0·25 *M* sucrose solution ; (ii) the homogenate is centrifuged at 105 × gravity in a 'Spinco' centrifuge (model *L*) for 30 min. at 0° C. ; the supernatant liquid is dialysed against frequent changes of distilled water in the cold ; (iii) the dialysed solution is treated with 2·33 vol. saturated ammonium sulphate solution at *p*H 7·0 and 0° C. (to give 0·7 saturation). After 1 hr. the precipitate is removed and discarded. The supernatant solution is now brought to 0·85 saturation by addition of solid ammonium sulphate. The resulting precipitate is removed on the centrifuge, dissolved in 1/20 of the original volume of water, and the solution is dialysed against distilled water.

During this procedure, a purification of about twenty-fold is achieved. The bulk of the γ-glutamyl transpeptidase is removed in step (ii), and the small amount of this enzyme remaining at the end of step (ii) is removed completely in step (iii).

The action of the enzyme has been studied by chromatography on paper. Samples taken at intervals from enzymic reaction mixtures are killed by heating in boiling water for 1 min. in sealed capillary tubes. (Under these conditions glutamine breaks down to form pyrrolidone carboxylic acid, but no formation of the acid from the different γ-glutamyl peptides used could be detected.) Portions of these samples are spotted on to phosphate-treated chromatograms (No. 3 Whatman paper is dipped into 0·03 *M* sodium phosphate buffer at *p*H 6·7 and dried). The chromatograms are developed using propanol–buffer (80 v./20 v.) as solvent. In this system all constituents of such reaction mixtures (γ-glutamyl peptides, the resulting free amino-acids, and pyrrolidone carboxylic acid) are separated cleanly and reliably. Pyrrolidone carboxylic acid is detected on the chromatograms by means of the chlorine–starch–iodine method[5] as suggested by Ellfolk and Synge[1].

The γ-glutamyl lactamase activity is measured from the chromatograms by the initial rate of liberation of glycine from γ-glutamylglycine, using the method described elsewhere[6]. For this assay the reaction mixture contains 0·05 mole γ-glutamylglycine, 0·10 mole lithium borate buffer of *p*H 8·0, and usually 50 μl. enzyme solution, the final volume being 200 μl. The presence of γ-glutamyl transpeptidase together with the lactamase is indicated by the formation of the tripeptide γ-glutamyl-γ-glutamylglycine, the course of formation of which may also be followed quantitatively. (The tripeptide runs more slowly than γ-glutamylglycine, whereas glycine and pyrrolidone carboxylic acid run more quickly.)

There have been clear indications for many years that pyrrolidone carboxylic acid is metabolized actively in the animal body[7], and some authors have postulated that it may take the role of an intermediate between glutamic acid and the amino-acids known to be derived from it in the body. Up to the present, however, the evidence has not supported this hypothesis[8]. The demonstrated occurrence of the γ-glutamyl lactamase focuses attention once more upon the interesting problem of the fate of pyrrolidone carboxylic acid in the body since, so far as is now known, this new enzyme catalyses specifically the formation of pyrrolidone carboxylic acid from a common cellular constituent (glutathione) or from other γ-glutamyl peptides which are derived from it in known enzymic reactions.

The programme of which this work forms a part has been supported generously by the J. P. Bickell Foundation. One of us (G. E. C.) held a Fellowship from the National Research Council of Canada, which has supported the work in other ways. We acknowledge our indebtedness to these bodies.

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Paramagnetism of a Reduction Product of Vitamin B_{12}

The fact that vitamin B_{12} is diamagnetic indicates that the cobalt atom in the molecule is trivalent[1]. It can be assumed that it is at a lower valency state in at least some of the products which have been obtained from vitamin B_{12} by reducing agents[2,3]. This has been confirmed by polarographic measurements[4]. However, so far as we know, a direct determination of the valency of the cobalt atom in a reduction product (for example, by magnetic methods) has not been done hitherto.

We began susceptibility measurements on the reduction products of vitamin B_{12} in order to obtain further information on the valency of the cobalt atom in vitamin B_{12} itself, which has been discussed again recently[5]. Furthermore, magnetic investigations, such as have been carried out with hæmoglobin[6] and the catalases[7], seemed desirable since vitamin B_{12} and those substances show structural analogies[8].

The magnetic investigation of vitamin B_{12} presents difficulties, since the starting material is available only in small amounts and the reduction products are unstable. After having developed a micro-method, which was applicable to this special problem and enabled us to work with 100–500 μgm., we were able to show that the reduction product, which has been previously described by Schindler[3], is paramagnetic. An approximate figure for its susceptibility was also determined.

Schindler's[3] procedure, which was adapted to microscale working, was followed. 2–5 mgm. of vitamin B_{12} is dissolved in 500 μl. of 10 per cent aqueous ammonium chloride solution. 60 μl. of this solution is made to react in a sealed tube (100 μl.) with zinc dust (very pure) in a nitrogen atmosphere. The zinc dust is distributed in the solution by rotating the tube. The solution turns brown at first, finally weak greenish-violet or almost colourless. (Schindler mentions a blue colour, but he worked with bigger layers of substance.) The zinc dust is centrifuged off, and the change in susceptibility caused by the reduction is determined immediately. Even in the absence of air the solution is not stable, as can be seen from the colour changes.

The change of susceptibility was determined by our method of 'magnetic balance' (to be described in detail elsewhere). First, the unreacted original solution is 'balanced'. A small sample tube, which holds 40 μl., is filled with this solution and then introduced into a vessel containing cobalt sulphate solution placed between the poles of an electromagnet. When the field is applied, a force is exerted upon the tube, which depends on its mean susceptibility and the susceptibility of the cobalt sulphate solution. Since cobalt sulphate is paramagnetic and water diamagnetic, these forces (for a fixed position of the tube) can be made to balance by varying the concentration of the solution. We then refer to the tube, including contents and solution, as magnetically balanced. After that, the above procedure is repeated with a reduced sample of the same solution. Now the concentration of the 'balancing solution' has to be increased. Consequently the contents of the tube has become more paramagnetic because of the reduction. The change in susceptibility can be calculated from the change in concentration of the balancing solution.

The 'magnetic balance' is determined as follows. The sample is attached to a Cartesian diver, and the whole system is balanced hydrostatically in the cobalt sulphate solution. With this arrangement we have a very sensitive instrument for detecting whether or not the sample tube is magnetically balanced. When the field is applied, movement will occur unless the balancing has been achieved.

One of our solutions contained 3·6 mgm. vitamin B_{12}/ml. (Therefore there were 144 μgm. vitamin B_{12} in the sample tube.) The concentration of the balancing solution (volume 56 ml.) before the reduction was 6·65 mgm. cobalt sulphate per ml. After reduction, another 0·15 ± 0·01 ml. of a solution containing 50 mgm. cobalt sulphate per ml. had to be added in order to rebalance the tube magnetically. The corresponding change of concentration of the balancing solution is 0·13 mgm./ml., and this is equivalent to a change in its volume susceptibility of $8{\cdot}6 \times 10^{-9}$ c.g.s. units. The change in susceptibility of the contents of the tube is proportional to this value. The proportionality factor, which was determined in separate experiments, is 0·7. Consequently the change in volume susceptibility of the contents of the tube is $6{\cdot}0 \times 10^{-6}$ c.g.s. units and the difference in molar susceptibility between reduced and unreduced vitamin B_{12} becomes $(2{,}300 \pm 200) \times 10^{-6}$ c.g.s. units.

In various experiments values for the difference ranged from $2{,}300 \times 10^{-6}$ to $6{,}800 \times 10^{-6}$ c.g.s. units. These values reflect the extent of the reduction, as well as the degree of decomposition of the reduction product. Solutions which could be considered as completely reduced because of the colour change and the time of reduction showed the greatest increase in susceptibility. Solutions which were still brown in colour (the colour of the intermediate stage) showed changes in susceptibility of only $200\text{–}1{,}000 \times 10^{-6}$ c.g.s. units. After standing, the susceptibility always decreases.

By adding the susceptibility of vitamin B_{12} $(-750 \times 10^{-6}$ c.g.s. units) to the values given above, one obtains the molar susceptibility of the reduced form of vitamin B_{12}. The largest value obtained is about $6{,}000 \times 10^{-6}$ c.g.s. units, which corresponds to about 4 Bohr magnetons. (In calculating this value we neglect the contribution of the organic part of the vitamin B_{12} molecule, which may be 10 per cent of the total susceptibility. This is true as long as free radicals are not formed, which is improbable.) The value of 4 magnetons is at the lower limit for compounds containing bivalent cobalt. This, with what we know of the magnetic properties of monovalent and trivalent cobalt, indicates that the cobalt atom in Schindler's reduction product is bivalent.

We wish to thank Prof. W. Kuhn and Prof. T. Reichstein for their interest in our work, and Prof. Reichstein as well for the gift of several milligrams of vitamin B_{12}, Dr. O. Schindler for his advice in the preparation of the products, and the Cibastiftung of Basle for financial aid for this investigation.

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Preparation of Tritium-labelled Dihydrostreptomycin

RADIOACTIVE streptomycin has been prepared by various investigators by biosynthetic incorporation of carbon-14 in the streptomycin molecule. Their aim has been to study actinomycete metabolism. The purpose of the present investigation was to prepare radioactive streptomycin for autoradiographical studies of its distribution in the body.

Streptomycin adds two hydrogen atoms to its molecule by catalytic hydrogenation. The reduction occurs at the aldehyde group and the resultant dihydrostreptomycin is more stable than its precursor[1].

During hydrogenation, it would be advantageous to dissolve streptomycin in a solvent containing no exchangeable hydrogen, otherwise exchange processes would dilute the tritium content of the gas. No such solvent is, so far as I know, reported in the literature, but it was found that streptomycin is soluble in dimethyl sulphoxide. But in this solvent the hydrogenation went on very slowly for five days and stopped when only about 65 per cent streptomycin was hydrogenated. By the addition of a very small volume of water, the reaction was accelerated and stopped after three days when about 85 per cent was hydrogenated.

A microhydrogenation apparatus, with a hydrogenation bottle of only 1 ml. capacity, was constructed. To avoid isotope effects, heavy water was used in the solvent and deuterium gas to complete the reaction.

In the hydrogenation bottle, 100 mgm. streptomycin was dissolved in 0·05 ml. heavy water and 0·30 ml. dimethyl sulphoxide. 4 mgm. platinum oxide catalyst was added. Tritium gas (1 curie) was allowed to react first; then gradually during three days very small volumes of deuterium gas were transferred to the reaction bottle until the hydrogenation stopped.

The product was isolated by filtration and freeze drying. It was then washed with a rather large volume of water to remove exchangeable tritium from the compound. Only tritium atoms bound to carbon are stable.

Analyses for tritium were carried out by combustion of the organic compound and conversion of the tritiated water to tritium. The tritium gas was then counted by introduction into a Geiger–Müller tube[2]. The specific activity was found to be 0·068 mc./mgm. The accuracy in the determination is estimated at ± 20 per cent.

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Inactivation of the Adrenal Ascorbic Acid-depleting Activity of Pituitary Extracts by Ascorbic Acid

IF extracts of anterior pituitary are incubated for several hours in Ringer's solution containing 1–10 mgm./100 ml. ascorbic acid, their activity on the chromatophores of the isolated skin of *Rana esculenta* disappears[1]. Because of the close chemical relationship between adrenocorticotrophic hormone and intermedin, it seemed of interest to investigate whether the adrenal ascorbic acid-depleting activity of anterior pituitary extracts is also affected by ascorbic acid.

In the following experiments an adrenocorticotrophic hormone preparation of Schering (1 mgm. = 3 I.U.) and ascorbic acid B.P. (Roche) were used; for each group of tests, 0·42 mgm. of the former was dissolved in (*a*) 3·1 ml. pure Ringer (solution *A*), (*b*) 3·1 ml. Ringer containing 8·4 mgm. ascorbic acid per 100 ml. (solution *B*). Both solutions were kept for 18–20 hr. at room temperature. Then, after requisite dilution with Ringer, the adrenal ascorbic acid – depleting activity of solutions *A* and *B* was estimated by the method of Sayers, Sayers and Woodbury[2]. Female rats which had been hypophysectomized 21–27 hr. before the assay were used. In order to exclude errors from the injection of ascorbic acid when assaying solution *B*, the equivalent amount of ascorbic acid was given to all rats receiving solution *A* immediately after the administration of *A*. The results of the experiments show that the activity of solution *B* on the adrenal ascorbic acid concentration was only 1·9 (0·1 – 4·4, $P = 0{\cdot}95$) per cent of the activity of solution *A*. In previous experiments the chromatophore-expanding activity of samples of the same batch of Schering adrenocorticotrophic hormone was found also to be reduced to 4 per cent by the same treatment with ascorbic acid. Ascorbic acid dissolved in Ringer's solution, kept for 18–20 hr. and then injected simultaneously with adrenocorticotrophic hormone, did not seem to interfere with the action of the latter on the concentration of ascorbic acid in the rat's adrenal.

That this inactivating effect of ascorbic acid is not due to a general action of this vitamin on all polypeptides was established by the observation that oxytocin, vasopressin and 'substance *P*' (v. Euler and Gaddum) do not lose their activity when incubated with ascorbic acid.

Details of this work will be published elsewhere.

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Propagation of an Air-transmitted Shock Wave in Muscular Tissue

As part of an investigation of the biophysics and physiology of blast injury[1,2], the experiments to be reported here were conducted in order to determine the velocity and damping of a high-explosive shock wave during propagation through a layer of muscular tissue. The velocity of sound in various animal tissues and organs has been extensively studied by Frucht[3]. Concerning the velocity of finite pulses, such as shock waves, no experimental observations are available, and due to the predominance of water in most animal tissues the speed of shock-wave transmission in the body has been supposed to approach that of sound in water[4].

Rectangular pieces of ox thigh muscles (dimensions about 240 mm. × 120 mm. × 60 mm.) were exposed to a high-explosive shock wave in a detonation chamber[1,5]. The time it takes for the wave to cover a known distance was measured by means of two barium titanate crystal pressure-transducers inserted into the meat. The transducer nearest to the explosive charge released the sweep of the recording oscillograph and the distal one recorded the arrival and shape of the wave at the end of the measuring range.

With the low-peak over-pressure used in these experiments (15–30 lb./in.^{2}), the mean velocity of the pressure wave in a covered muscular layer of 170–220 mm. was found to be 650 m./sec., the range being 590–710 m./sec. The relatively great variations are due partly to the inhomogeneous microstructure of the muscular tissue but also to difficulties in determining exactly the arrival of the shock wave at the distal transducer owing to the gradual rise of the pressure curve (see Fig. 1 *B*). The mean velocity during the first 25–50 mm. of propagation was the same as over the whole measuring range, so there was no appreciable slowing down of the wave during the passage of a muscle layer of up to 220 mm.

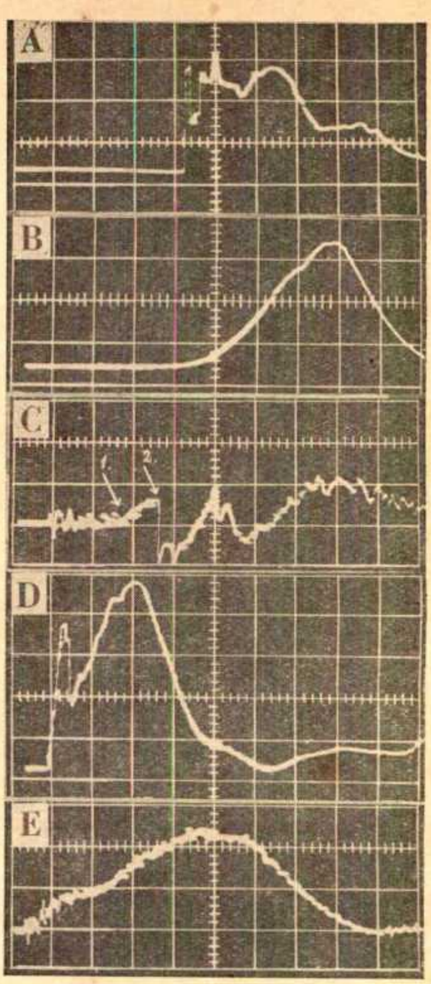

Fig. 1. Recordings of travelling time and pressure curve. Time: 100 μsec. between vertical lines. Pressure: 5 lb./in.^{2} between horizontal lines. The horizontal part of the curves before the increase in pressure corresponds (except in curve *D*) to the passage of the wave through the measuring layer. (*A*) Incident shock wave in air; measuring range, 220 mm.; time of passage, 425 μsec. (*B*) Curve obtained in muscle; measuring range, 200 mm.; time of passage, 330 μsec. (*C*) Differential curve obtained by means of two oppositely coupled transducers, one in the piece of muscle (upward deflexion) and the other in air (downward deflexion), measuring layer with both transducers, 170 mm.; arrows 1 and 2 indicate arrival of wave in muscle and air respectively. (*D*) and (*E*) show steepness of wave-front when the wave has covered a muscle layer of 10 mm. and 25 mm. respectively

The velocity of the incident air shock wave immediately before its impact on the front surface of the meat was 510 ± 10 m./sec. (Fig. 1 *A*).

Due to the inhomogeneity and damping properties of muscular tissue, the steep front of the incident shock wave is already after a very short travel within the meat converted to a wave with a more slowly increasing pressure. In the incident air shock wave, e time interval between the initial increase of ressure is too short to be determined in the recordgs (see Fig. 1 *A*), but it is probably less than 1 µsec. fter having passed a muscle layer of only 10 mm. s in Fig. 1 *D*, the interval is about 40 µsec. and already e passage through 25 mm. of muscle may increase e time to several hundreds of microseconds (in ig. 1 *E* about 420 µsec.). During the further propagaon through thicker muscle layers (see Fig. 1 *B*) the me often becomes shorter and the front of the wave eeper again (cf. Fig. 1 *E* and *B*). With increasing eak pressure in the wave, the time of rise tends to ecome somewhat shorter.

Further investigations are in progress, and a etailed account will be published elsewhere.

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Purine Compounds in Snake Venoms

Fischer and Dörfel[1] identified adenosine in the enom of *Bitis arietans* and *Dendraspis viridis* in oncentrations of 12 and 2·6 per cent of the dry veight respectively, and concluded it was a natural omponent of the fresh venom. In the venoms xamined no other nucleoside was found ; nucleotides vere absent but traces of a guanine compound were ot excluded. The present communication reports he identification and estimation of adenosine 3′-phoshate in addition to adenosine in some species of ustralian snake venoms.

The Australian snake venoms were dried *in vacuo* ver calcium sulphate as soon as possible after ollection. These were pooled, powdered and have een stored satisfactorily for immunization studies n stoppered containers over calcium sulphate for eriods of up to twenty years at room temperature. Purine compounds were first indicated in a freezeried preparation of the fraction of the venom of *otechis scutatus* soluble in 50 per cent methanol, btained by the addition of methanol to an aqueous olution of the venom. This fraction in which these ubstances were concentrated, the whole venom, and he products obtained by dialysis, were examined by paper chromatography using a variety of solvents and the photographic technique of Markham and Smith[2]. Adenosine, adenosine 3′-phosphate and a compound of guanine were identified in three of the eight Australian snake venoms examined. Table 1 shows the relative concentrations found in several samples of each of these and two African venoms.

For quantitative analyses, these compounds were removed from the whole venom by dialysis of aqueous solutions of 2–3 mgm. of the venom, in Visking tubing, against two changes of distilled water and agitation overnight at 6° C. The diffused products were freezedried, reconstituted in 0·04 *N* hydrochloric acid and examined in the Beckman spectrophotometer (by courtesy of Dr. R. K. Morton). From the maximum absorption found at 257 mµ, corrected for non-specific absorption, the total concentrations of the purine compounds were calculated in terms of the major component as percentage of the dry weight of the venom, as shown in the last column of Table 1. The differences between the concentrations of adenosine found by Fischer and Dörfel[1] in the venoms of *B. arietans* and *D. viridis*, and those found here in the former venom and the species *D. angusticeps*, may be due in one case to variations between venom preparations and in the other to variations among species of the same genus. The correction for nonspecific absorption applied in the above analyses may account for further variation.

Table 1. CONCENTRATION OF PURINE COMPOUNDS

Species	Adenosine	Adenosine 3′-phosphate	Guanine compound	Per cent weight*
Notechis scutatus	+ ±	trace ,,	trace —	1·4
Denisonia superba	trace ± ±	+ ± ±	— — —	2·0
Acanthophis antarctica	++ + ++	trace — trace	trace — —	2·4
Bitis arietans†	+++	—	trace	3·8
Dendraspis angusticeps†	+++	—	—	4·3

* Molecular extinction of adenosine and adenosine 3′-phosphate = $14{\cdot}6 \times 10^3$ and $14{\cdot}2 \times 10^3$ respectively (ref. 3*a*).
† Gift from the South African Institute for Medical Research.

Paper chromatography of freeze-dried preparations of the 50 per cent methanol-soluble fraction of *N. scutatus* and the products of dialysis of three venoms (Fig. 1) confirms the identification of adenosine and adenosine 3′-phosphate. The component with R_F close to those of adenosine 2′- and adenosine 5′-phosphate was not identical with either of these substances. The 5′-nucleotidase of *Vipera russellii* venom[4] failed to attack it in eluates from the paper. Using butanol solvents in combination with water, ammonia, or acetic acid, this component exhibited

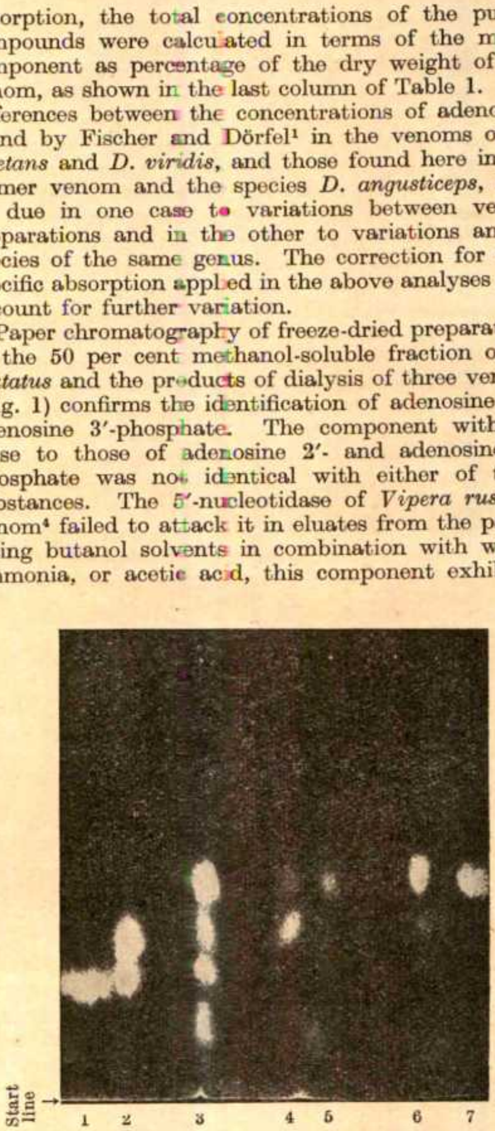

Fig. 1. Photographs of chromatograms. Solvent: sodium dihydrogen phosphate – isoamyl alcohol ; ascending.

(1) Adenosine 5′-phosphate ; (2) adenosine 3′-phosphate and adenosine 2′-phosphate. (3) 500 µgm. 50 per cent methanol-soluble fraction, *N. scutatus*. (4) – (5) 500 µgm. freeze-dried products of dialysis, (4) *D. superba*, (5) *N. scutatus*, (6) *A. antarctica*. (7) Adenosine.

Note, R_F adenosine 2′-phosphate = R_F adenosine 5′-phosphate the fluorescence characteristic of guanine compounds on paper chromatograms[5], and showed an absorption maximum near 249 mμ. The R_F value is consistent with that of guanosine 2′- or 3′-phosphate[3b,6]. The zone nearest the solvent front is attributed to a protein complex absorbing in the ultra-violet region.

The question arises as to whether the adenosine 3′-phosphate and adenosine are natural constituents of fresh venoms or are formed after venom secretion by enzymic action on some precursor. If nucleic acids were their source other bases should have been detected. Of the known coenzymes, only coenzyme *A* could give rise directly to both adenosine 5′- and adenosine 3′-phosphates. However, as the rates of attack by both the 5′-nucleotidase of snake venoms[4] and unspecific phosphatases[7] are considerably faster for the 5′- than the 3′-configuration, one would expect to find adenosine 3′-phosphate in venoms more frequently. In the absence of other evidence it would appear that adenosine, adenosine 3′-phosphate and possibly guanosine 2′-(or 3′-)phosphate are natural constituents of snake venoms (see also Fischer and Dörfel[1]). The direct secretion into milk of enzymes, nucleotides and other metabolic intermediates from the mammary gland is well established[8], while dinucleotides of 2′–5′- and 3′–5′-configuration are now recognized to occur in some tissues[9]. It is therefore suggested that the purine compounds of snake venoms arise directly from the venom glands, which may well yield nucleotides additional to those already identified in the glandular secretions.

I thank the director, Dr. F. G. Morgan, and Dr. J. J. Graydon, of these Laboratories, who made the venoms available, Misses J. Pearson and F. Bates for technical assistance and Mr. K. Rowan for helpful advice. Dr. R. K. Morton made valuable suggestions and collaborated in the preparation of this communication.

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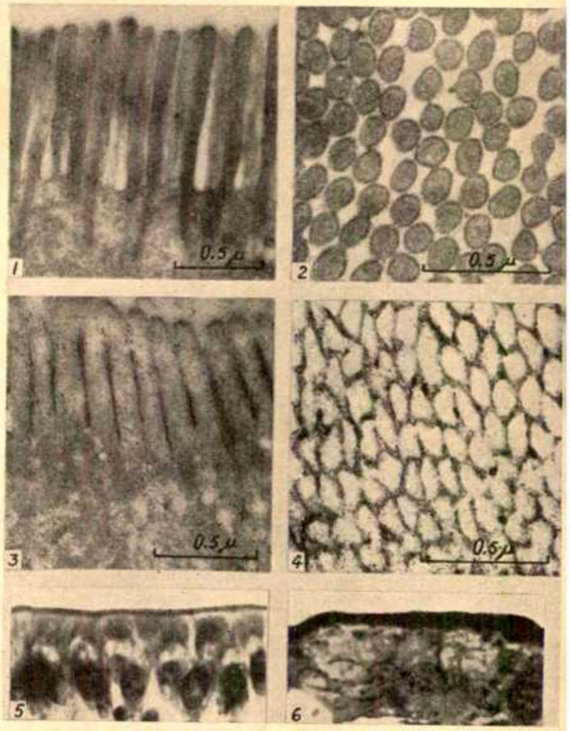
Histochemical Techniques for Electron Microscopy : Alkaline Phosphatase

APPLICATION of histochemical methods to electron microscopy is a logical development of biochemical and biophysical techniques. The comparatively limited resolution of the light microscope fails to reveal the relationship of normal cellular ultrastructure to the sites of histochemical reactions. Therefore, it seemed desirable to utilize recent developments in electron microscopy of biological material[1] in the hope of learning more about the structures demonstrated with these techniques.

An electron microscope study at high resolution (better than 30 A.) of the intestinal epithelium of the mouse has demonstrated that the brush border is composed of minute parallel cylindrical projections of the cytoplasm about 1 micron long and 0·1 micr wide. These projections are bounded by the ce membrane, which appears as two dense lines eac 40 A. thick separated by a non-dense area of 25 The cell membrane is an unbroken unit coveri each projection and continues to adjacent projectio without any discontinuities, either at the apices the base of the projections (unpublished observatio by H. Z.).

High concentrations of the enzyme alkali phosphatase have been demonstrated in the epitheliu of the intestinal mucosa by the method of Gomor and Takamatsu[3], where the reaction is demonstrab principally in the brush border zone[4], and also the Golgi region[5].

The histochemical demonstration of alkaline pho phatase is based on the principle that if enzym containing tissue is incubated with glycerophospha at approximately *p*H 9 in the presence of calciu ions, the phosphate ions liberated will be precipitate at the site of formation as insoluble calcium pho phate. These sites may then be demonstrated by t method of von Kóssa ; in this method the precipitate calcium phosphate is transformed into silver pho



(1) Electron micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. Longitudinal section of brush border. × 24.000.

(2) Electron micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. Cross-section of brush border. × 35.000.

(3) Electron micrograph of mouse intestinal epithelium fixed 8 min. in 1 per cent isotonic osmium tetroxide solution, incubated 120 min. in Gomori's alkaline phosphatase substrate. Longitudinal section of brush border; positive reaction indicated by dense granular precipitate. × 28.000.

(4) Electron micrograph of mouse intestinal epithelium fixed 8 min. in 1 per cent isotonic osmium tetroxide solution, incubated 30 min. in Gomori's alkaline phosphatase substrate. Cross-section of brush border; positive reaction indicated by dense granular precipitate. × 35.000.

(5) Light micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. × 1.000.

(6) Light micrograph of mouse intestinal epithelium fixed 10 min. in 1 per cent isotonic osmium tetroxide solution, incubated in Gomori's alkaline phosphatase substrate for 30 min. Positive reaction in brush border. × 1,000

ate, which is readily visible in electron micrographs a dense granular precipitate.

For these experiments, in order to avoid the hibition of the enzyme by the osmium tetroxide ative routinely used for electron microscopical eparations, tissues were fixed briefly (8 min. or s) in 1 per cent buffered isotonic osmium tetroxide, ashed in Tyrode's solution and incubated in Gomori's kaline phosphatase mixture for 30 and 120 min. at ° C. The precipitate of calcium phosphate was monstrated by immersion in 0·5 per cent silver trate for ten minutes, after which the tissue was ashed several times in distilled water. This was llowed by graded alcohol dehydration and em- dding in methacrylate. Controls were run by in- bating tissues in substrate containing 0·02 *M* anide.

Electron micrographs of thin sections from the stochemical preparations showed a dense granular ecipitate of silver phosphate distributed uniformly intercylindrical spaces of the projections of the ush border. In sections through the cylindrical ojections parallel or tangential to the cell surface e granular precipitate was arranged like a honey- mb, the cylindrical projections appearing non- nse and the interspaces dense. Preliminary work es not elucidate the relation of the reaction to the ll surface membrane.

Cyanide-inhibited controls showed a normal struc- re without the granular precipitate, eliminating the ssibilities of a false positive reaction. With the ort periods of incubation employed, the possibility diffusion artefacts was minimized[6].

Further investigations with such techniques should ove useful in determining a more precise locus of stochemical reactions than has been possible with ght microscopy and may yield information about e true loci of enzymes.

We thank Dr. F. S. Sjöstrand for the privilege working in his laboratory.

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Complementary Action of Melibiase and Galactozymase on Raffinose Fermentation

On the basis of experimental investigations on the heritance of hydrolytic and fermentative ability in easts, we have been led to the conclusion that an xact knowledge of the genotype of the organism mployed is not only desirable but also necessary if he processes of hydrolysis and fermentation are to e studied in detail. Since the existence of six different enes (M_1, M_2, M_3, M_4, M_5 and M_6) responsible for he hydrolysis and subsequent fermentation of maltose as been demonstrated in yeasts (Winge and Roberts[1], illiland[2], and Winge and Roberts (unpublished ork)), and since these genes are not biochemically identical—for example, M_1 hydrolyses both maltose and sucrose and M_2 hydrolyses maltose alone—it is necessary, through appropriate hybridizations and segregations, to isolate each gene individually in a single cultural type in order to investigate the activity of the enzyme synthesized by that particular gene. Otherwise, the presence of additional hydrolytic genes in the culture under investigation may well lead to a confused interpretation of the experimental results.

At present we have isolated, each in a different cultural type, the following genes responsible for the synthesis of hydrolytic enzymes: six maltose-hydrolysing genes, M_1–M_6 (M_5 was, however, isolated by Gilliland), three raffinose- and sucrose-hydrolysing genes, R_1–R_3, and one melibiose-hydrolysing gene, *Me*. In addition, we have isolated two galactose-fermenting genes, *G* and g_s, which bring about rapid and slow fermentation, respectively.

According to the well-known observation of Kluyver, those yeasts which are capable of fermenting at all will always ferment the monosaccharides glucose, fructose and mannose, but not all fermenting yeasts are able to ferment the monosaccharide galactose.

Barring the occurrence of mutation or of nuclear irregularities during spore formation (Winge and Roberts[3]), a yeast hybrid produced by artificially crossing two cultures differing by one fermenting gene will segregate out two fermenting to two non-fermenting single-spore cultures in each of its four-spored asci.

During an investigation of the R_2-gene, which hydrolyses raffinose in such a way that the fructose portion of the molecule is liberated and afterwards fermented, while the melibiose portion remains intact, we produced a series of R_2r_2-hybrids. All the tetrads of these hybrids were expected to segregate out as $2R_2 : 2r_2$, that is, two single-spore cultures capable of fermenting raffinose and two non-fermenting single-spore cultures. The segregations obtained, however, were most surprising in that we found, of a total of 119 tetrads from five different R_2r_2-hybrids, the following:

$4R:0r$	$3R:1r$	$2R:2r$
4	68	47

This was not a one-gene segregation, nor was it a typical two-gene segregation, in which the frequency of the segregations 4 : 0, 3 : 1, and 2 : 2 should theoretically occur in the ratio 1 : 4 : 1. A two-gene segregation, however, could not be expected to occur since the hybrids contained R_2 alone.

A series of planned genetic experiments finally led to an explanation of these segregations. We were aware that all five hybrids were also heterozygous with respect to both the melibiase and galactozymase genes, so that their genotype could be written as $R_2\ Me\ G/r_2\ me\ g_s$. Our working hypothesis, which proved to be correct, assumed that the complementary action of $Me + G$ results in the fermentation of one-third of the raffinose molecule, the galactose portion being fermented away by galactozymase and the sucrose portion remaining intact. If, however, R_2 is also present, then the raffinose molecule is completely fermented due to the hydrolysis of sucrose into fructose and glycose by β-*h*-fructosidase.

Our segregation results showed that the melibiase gene and the galactozymase gene were weakly linked. Assuming the existence of complementary genes and of approximately 40 per cent crossing over, then the theoretically expected raffinose segregations (1 : 19 : 16) of the 119 asci are as follows:

4 *R* : 0 *r*	3 *R* : 1 *r*	2 *R* : 2 *r*
3·3	62·8	52·9

which, as can be seen, are in satisfactory agreement with the segregations actually obtained.

The final proof of the correctness of this hypothesis of complementary action would naturally consist in the genetic analysis of a hybrid which had been produced by crossing an *Me* g_s genotype with an *me G* genotype, neither of which contained any other hydrolytic or fermentative genes (except, of course, the zymase complex for glucose fermentation). These two parent types would each be unable to ferment raffinose, but the hybrid, *Me* g_s/*me G* should, according to the hypothesis, be able to hydrolyse raffinose and ferment the liberated galactose, resulting in a one-third raffinose fermentation.

Eight hybrids of this genotype (*Me* g_s/*me G*) were produced. Each of them was capable of fermenting raffinose after four to seven days.

Even more interesting were the segregation ratios obtained from the offspring of one of these hybrids. Theoretically, the spore tetrads from an *Me* g_s/*me G* hybrid should yield the following results:

Relative frequency	Type of tetrad	Raffinose fermentation
1	2 *Me G* : 2 *me* g_s	2+ : 2−
1	2 *Me* g_s : 2 *me G*	0+ : 4−
4	1 *Me G* : 1 *Me* g_s : 1 *me G* : 1 *me* g_s	1+ : 3−

Six asci from one *Me* g_s/*me G* hybrid were analysed; of these, five gave a 1 : 3 raffinose segregation and one gave a 2 : 2 raffinose segregation. All the seven raffinose-fermenting single-spore cultures fermented both melibiose and galactose (the latter rapidly), while none of the remaining seventeen single-spore cultures was able to ferment both sugars.

On the basis of these results, we propose the following scheme for the gene action responsible for the hydrolysis and fermentation of the raffinose molecule (Fig. 1).

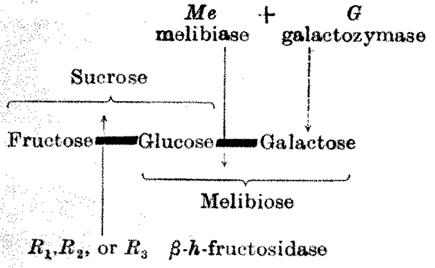

Fig. 1. Gene action involved in the hydrolysis and fermentation of the raffinose molecule

It can be seen that raffinose may be hydrolysed through the activity of R_1, R_2, or R_3 into melibiose and fructose, the latter being fermented by the zymase complex present in all fermenting yeast cells. On the other hand, raffinose may also be hydrolysed through the activity of the *Me*-gene into sucrose and galactose, the latter being fermented by galactozymase. Mr. Manuel Losada, of Madrid, has assisted us by demonstrating that the *Me*-gene in the absence of the *G*-gene is capable of hydrolysing raffinose, in that after growth of an *Me r* yeast type in a raffinose medium the substrate reduces Fehling's solution, thus showing the presence of galactose. As a control, an *me r* yeast type was grown in the same medium; here Fehling's solution was not reduced.

It is for this reason that we speak of complementary gene action with respect to raffinos fermentation rather than raffinose hydrolysis. Th latter process is carried out by the *Me*-gene alone but in order to ferment the raffinose molecule b complementary gene action, *G* must be presen together with *Me*.

Finally, it should be mentioned that the gene g_s which requires long-term adaptation in order t bring about the fermentation of galactose (Wing and Roberts[4]), is also responsible for the slow fermentation of raffinose in co-operation with *Me*. I has also been established that the fermentation c raffinose through the action of the *R*-genes (to th left in Fig. 1) takes place more rapidly than th fermentation of raffinose through complementar action, presumably because fructose may be fermented more rapidly than galactose.

A detailed account of these investigations wi appear in the *Comptes Rendus des Travaux d Laboratoire Carlsberg*.

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Chromosome Number in Rabbit Blastocysts

DURING recent years a series of papers have appeared discussing the constancy or inconstancy in the chromosome number in mammalian tissues. It is now generally agreed that some tissues show a certain degree of inconstancy in the chromosome number either by having aneuploid cells[1] or by developing more constant euploid (or polyploid cells[2]. I have shown[3] that by careful attention to technique, including pre-treatment in hypotonic saline solution and using a gentle squash, about 95 per cent of the cells in rabbit blastocysts (five days old) will appear normal with $2n = 44$, whereas 2–3 per cent have hypo- or hyper-ploid numbers. The reason for low numbers seems in many cases to have been mechanical disturbances introduced by the squash technique.

In a review of the chromosome number in mammalian somatic cells, Beatty[4] raises the question, how early in life the inconstancy originates. Beatty (in collaboration with M. Fischberg) found from haploid to tetraploid cells and few hexaploid cells in mouse blastocysts as early as 3½ days after fertilization. We have examined rabbit blastocysts of five days of age and found the results already mentioned. However, it is of interest to try to find whether the heteroploid cells appear only in certain tissues or if they can arise anywhere in the young embryos. By the way, attention is directed to the fact that in most cases the inconstancy in chromosome numbers has been found in dying tissues and in transitory embryonic membranes (cf. refs. 4, 5). In the following, results are presented of an attempt to count the chromosomes in two different parts of the rabbit blastocyst, described simply as the trophoblast and the embryonic disk.

Due to the small size of the five-day blastocyst, specimens six days old were used in this case. The blastocysts were washed out from the uterine horns and immediately placed in an incubator at 37° C. in a 0·45 per cent saline solution, according to the routine method now used in our laboratory[6]. After pre-treatment, the specimens were fixed in alcohol – acetic acid for 1 hr. and stained according to the Feulgen method for at least 20 min. After staining, a single blastocyst was placed in glycerine in a hollow-ground slide (hanging drop slide), and by use of a micromanipulator the embryonic disk was separated from the trophoblast layer. The two parts were then squashed on separate slides, applying only very gentle pressure. The trophoblasts were more difficult to handle than the embryonic disks.

Twenty-six blastocysts were used, and 104 metaphase plates could be counted from embryonic disks, of which 101 plates had $2n = 44$, one had 41 chromosomes while two plates had clearly 66 chromosomes. From the trophoblast cells, 46 plates were counted. One cell had only 33 chromosomes, four cells had 41 chromosomes each and 41 cells had $2n = 44$ chromosomes. Although a χ^2-analysis shows a small difference ($P < 0·05$) in the distribution of the number of cells with deviation in chromosome numbers between trophoblast and embryonic disk cells, this is not regarded as of significant importance, and it is concluded that aneuploid or polyploid cells appear with the same frequency in the two parts of the blastocyst examined up to the age of six days. It should be mentioned that the total number of abnormal cells—although few—is of the same magnitude, namely, 5 per cent, as found in the earlier work[3].

I am indebted to Mr. Per-Jonas Åström for his valuable help throughout this work.

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Selection for Heterozygotes during Inbreeding

RYE is normally an outbreeding species. When the plants are forced to inbreed by self-pollination, the progeny, being more homozygous, are, as is usual in such species, less vigorous and less fertile than the heterozygotes which comprise a normal population. Since heterozygotes are superior in this way to the homozygotes, it could be expected that, during the course of inbreeding, natural selection would favour to some extent the more heterozygous genotypes. To test this assumption, we have made use of chromosome structural changes where genotypes heterozygous and homozygous for the chromosome segments involved are easily distinguished.

In 1950 an F_1 plant from a cross between two inbred lines was found to be heterozygous for two separate and distinguishable interchanges, *A* and *B*. This F_1 plant was self-pollinated. From the F_2 generation three of the plants which were heterozygous for both the interchanges were selfed and the inbreeding was continued in subsequent generations by selfing a double heterozygote in each of the three families. As a result of inbreeding depression, the proportion of the seeds sown which reached maturity was generally low from F_2 onward and in no family was it higher than 77 per cent. Samples of the mature plants were scored at meiosis. In the absence of selection, the progeny from selfing a plant heterozygous for two separate interchanges would be expected to consist of four equal classes in respect of structural homozygosity and heterozygosity, namely, Hom. *A* Hom. *B*, Hom. *A* Het. *B*, Het. *A* Hom. *B*, Het. *A* Het. *B*. Selection for or against one or both heterozygotes will upset this ratio. The distributions observed in the four inbred generations are given in Table 1.

Table 1. DISTRIBUTIONS OF HOMOZYGOTES AND HETEROZYGOTES IN RESPECT OF TWO INTERCHANGES, *A* AND *B*. EACH FAMILY IS DERIVED FROM SELFING A DOUBLE HETEROZYGOTE

	Family	Hom. *A* Hom. *B*	Hom. *A* Het. *B*	Het. *A* Hom. *B*	Het. *A* Het. *B*
F_2		5	9	11	7
F_3	1	1	1	2	4
	2	5	5	8	4
	3	5	3	6	5
F_4	1	3	4	9	13
	2	8	6	10	10
	3	0	1	7	7
F_5	1	2	5	4	2
	2	2	1	3	5
	3	2	0	1	5
	Total	33	35	61	62

Contingency χ^2 analyses of these results show (1) no significant heterogeneity between generations or families, and (2) the interchanges to be distributed independently of one another. The results from all generations may therefore be pooled and the interchanges analysed separately. The distributions in respect of *A* and *B* in the total progeny are:

	Hom.	Het.	Total
Interchange *A*	68	123	191
Interchange *B*	94	97	191

The distributions of *A* and *B* are significantly different ($\chi^2_{[1]} = 7·246$, $P = 0·01–0·001$). The proportion of homozygous to heterozygous *B*'s is not significantly different from the 1 : 1 ratio expected when neither class is at a selective advantage. In the case of *A*, however, there is a significant excess of heterozygotes. We conclude from this that the genotypes heterozygous for interchange *A* enjoy a selective advantage over the homozygotes. It is to be noted that the selection operates in favour not of heterozygotes in general but of a particular heterozygous combination, which indicates that heterozygosity in itself is not necessarily advantageous. These conclusions agree with Darlington and La Cour's findings[1] in *Campanula*, a species in which interchanges are commonly found in wild populations. A selective advantage of structural (inversion) heterozygotes is, of course, well known from the work of Dobzhansky[2] and his collaborators, and others[3], in *Drosophila*. White[4] also has concluded that certain chromosome structural heterozygotes are at an advantage in populations of grasshoppers.

An excess of heterozygotes could possibly be interpreted in terms of a major gene showing some degree of lethality in a homozygous state. A phenotype with yellowish leaves in the seedling stage which appeared during the course of this experiment was probably determined by a recessive gene of major effect. All those examined were found to be homozygous for interchange *A*, from which we conclude that the gene is located on one of the chromosomes involved in this interchange. It is clear, however, that this major gene difference does not account for the excess of heterozygous *A*'s, because the homozygous *A* plants which are 'yellow' survive as well as those which are green. The ratio of the two types was in fact 16 'yellow' to 11 green. Although we cannot entirely rule out the possibility of some major gene affecting the results, an alternative, and more likely, explanation is that the advantage of the *A* interchange heterozygotes is due to a superior balance of polygenes in heterozygous combinations. We can therefore make use of these interchanges for genetic investigations of rye populations in much the same way as inversions have been used by Dobzhansky in *Drosophila*.

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Chromosomal Polymorphism in a Bark Weevil

The North American bark weevil, *Pissodes approximatus* Hopk., has three different chromosome numbers, namely, 30, 31 and 32, due to what White[1] has called 'centric fusion' of non-homologous autosomes. The 'fusion' homozygote consequently has two large V-shaped chromosomes instead of four smaller rod-shaped chromosomes, and the 'fusion' heterozygote has one V and two rods that form a trivalent in primary spermatocytes (Fig. 1).

Although chromosomal polymorphism of this type is well known in the Orthoptera[2], mainly no doubt because the order has received considerable attention from insect cytologists, this constitutes the first recorded example of the phenomenon among the five hundred or so beetles that have been examined to date. It is nevertheless quite certain that almost 10 per cent of the species have evolved neo-*XY* sex chromosomes through 'centric fusion' of the *X*-chromosome with an autosome, their mode of origin being revealed in the heterogametic male by the morphology and differential staining of the sex-determining complex. However, that the process, as confined to autosomes, must have contributed in large measure to the multiplicity of chromosome numbers found in the Coleoptera[3] is attested by the number of cognate species and neighbouring genera in which the one with the lower chromosome number has a relatively large pair of autosomes. Nevertheless, until this direct demonstration, their true mode of origin has been a matter of inference.

So far, a total of sixty-seven adults, mostly males, have been examined from widely scattered areas in Ontario. At least two of the three types occur in each area, but none has been studied intensively enough to test for deviation from the Hardy–Weinberg equilibrium. However, since the species apparently breeds at random in well-defined populations, an investigation of their genetical dynamics may be expected to reveal much of the mode of operation of natural selection under different environmental conditions and elucidate the problem of the genetical evolution of populations and geographical races of insects.

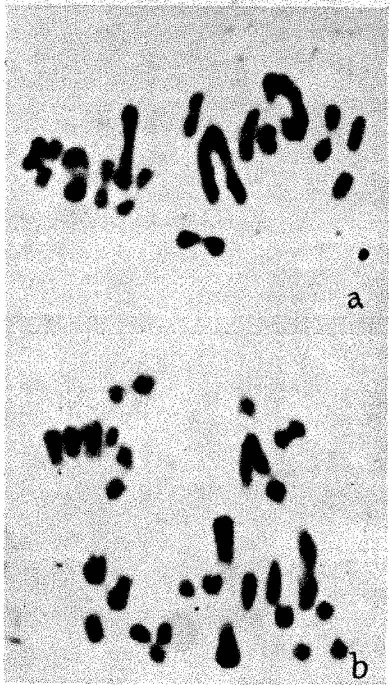

Fig. 1. Primary spermatocytes in *Pissodes approximatus*. (*a*) first metaphase: $13_{\text{II}} + 1_{\text{III}} + XY$; (*b*) first anaphase. (× about 2,300)

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Nucleus and Spindle of *Bacillus megatherium* in Fission and Sporulation

The cells of *Bacillus megatherium* have been stained by DeLamater[1], Fitz-James[2], Robinow[3] and others with various dyes to show the chromatin-threads after pretreatment with perchloric acid, chloric acid or other reagents. Chromosomes have been observed occasionally in mitosis as well as a structure which I identify with the spindle described by Lindegren *et al.*[4] in the yeast cell. The large ellipsoidal nucleus containing the chromosomes in the centre of the bacterial cell can be observed in the living cell. This structure is identical with that which DeLamater[1] observed in stained material of *Bacillus megatherium* and which Whitefield and Murray[5] observed in stained cells of *Shigella dysentriae*. The chromosomes appear when dried (unheated) bacterial smears are stained with 1 per cent aqueous gentian violet. They are not clear when stained directly with Giemsa solution but stain clearly with Giemsa after pretreatment with 10 per cent perchloric acid for 20 min. (Fig. 1,*a*).

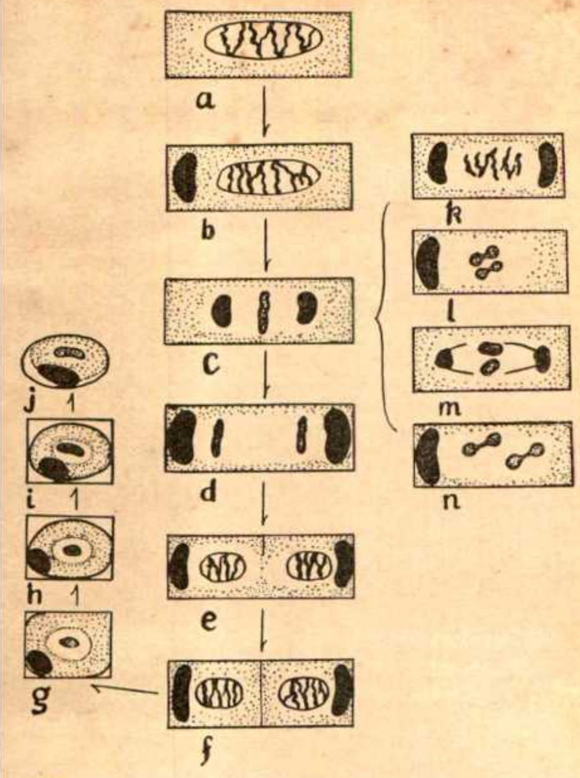

Fig. 1. Schematic representation of *Bacillus megatherium*. (*a*) Resting nucleus, (*b*) prophase, (*c*) metaphase, (*d*) anaphase, (*e*, *f*) telophase, (*g*–*j*) spore formation, (*k*–*n*) various figures of metaphase

The chromosomes are Feulgen-positive (1) after fixation with 75 per cent alcohol, or (2) Carnoy's fluid, or (3) after pretreatment with 10 per cent perchloric acid for 20 min., or (4) without fixation.

A large body on one side of the nucleus stains directly (1) with iron aceto-carmine solution, (2) with 1 per cent aqueous gentian violet, (3) with Giemsa, or (4) with 0·1 per cent aqueous vital red—but it is Feulgen-negative. It seems to appear when the cell enters prophase. After pretreatment with 10 per cent perchloric acid it is stained by either gentian violet or Giemsa. It corresponds to the spindle of the yeast cell[4], although its staining reaction is somewhat different. It is inferred to be the spindle from consideration of its behaviour in mitosis. It corresponds to what Robinow and Murray[6] named "the deeply stained cytoplasm" in *Bacillus cereus*. I identify this structure as the spindle-body.

Small granules often appear in the cell after staining with 1 per cent aqueous Janus green which are thought to be chondriosomes.

When the mitosis begins a single spindle-body appears at one end of the cell (Fig. 1,*b*), and as mitosis proceeds (Fig. 1,*c*–*e*,*k*,*m*) two spindle-bodies appear, one on each side of the nucleus. Between the two spindle-bodies the chromosomes change into one or two blocks of unresolvable chromatin (Fig. 1,*c*,*l*,*m*,*n*). At telophase a separation-wall is formed; each daughter cell contains one nucleus and one spindle-body (Fig. 1,*e*,*f*).

Preceding spore formation the cell divides transversely into a chain of smaller cells. The protoplasm of each small cell becomes ellipsoidal with the nucleus in the centre (Fig. 1,*g*,*h*). The large body in the cytoplasm beside the nucleus (Fig. 1,*g*,*h*) was called the 'peripheral body' by Fitz-James[2] and the 'side-body' (in the *Bacillus cereus*) by Fitz-James, Robinow and Bergold[7]. Each ripe spore contains a large 'side-body' and a nucleus in the centre of the cytoplast (Fig. 1,*i*,*j*). The 'side-body' corresponds to the 'eccentric nucleus' observed by Robinow[3].

The nuclear vacuole with its enclosed chromatin was called the 'basophilic ring' by Fitz-James[2] and the 'basophilic central core' by Fitz-James, Robinow and Bergold[7].

Only the spore coat of the spore stains with 1 per cent aqueous gentian violet or Giemsa, but after pretreatment with 10 per cent perchloric acid, both the nucleus and the 'side-body' are stained. Usually after pretreatment with 10 per cent perchloric acid only the chromosomes are Feulgen-positive, but occasionally the 'side-body' is Feulgen-positive because deoxyribonucleic acid of the nucleus has been retracted on to the 'side-body' (spindle).

In spores fixed with 45 per cent acetic acid or Carnoy's fluid and then stained with 1 per cent aqueous gentian violet (after pretreatment with 10 per cent perchloric acid for 20 min.) the 'side-body' and the chromosomes stain deeply, indicating that the 'side-body' and the nucleus are independent structures and that the 'side-body' is identical with the spindle-body.

I wish to express my cordial thanks for providing facilities for the present study and for criticism of the manuscript to Prof. Carl C. Lindegren, chairman of the Department of Microbiology, Southern Illinois University.

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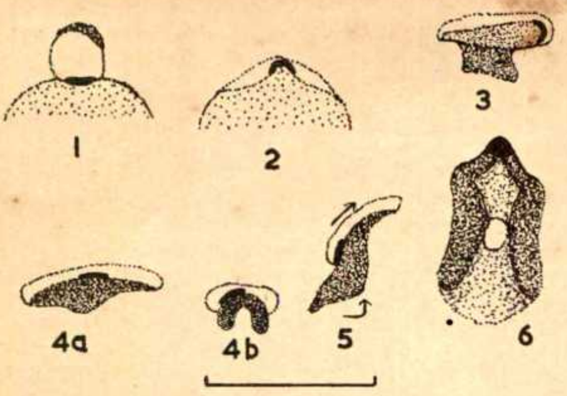
Acrosome Formation in Bandicoot Spermiogenesis

THERE has been some disagreement about the presence of an acrosome in marsupial spermatozoa. Students of spermiogenesis[1] are generally agreed that none is present, whereas Retzius[2] found a diminutive body at the proximal end of the mature sperm head in some species, although not in *Didelphys*[3]. As Bowen[4] remarked, such apparent exceptions to the universal presence of an acrosome in animal sperm are important. A study of spermiogenesis in the bandicoot (*Perameles nasuta*), previously reported to lack an acrosome by Benda[1], has shown that an acrosome is indeed present, although its method of formation presents some unique features. For study of the process, specific staining[5] by the periodic acid – Schiff procedure[6] was essential. The staining was preceded by digestion with saliva and followed by staining with toluidine blue. With classical methods it was impossible to be certain of the presence of an acrosome at any stage.



Figs. 1–6. Camera lucida drawings of the acrosome of the bandicoot at various stages of development. The granular component is solid black, the archoplasmic vacuole is unshaded, while the nucleus, except for the nuclear aperture in Fig. 6, is stippled. Figs. 4*a* and 4*b* are lateral and polar views, respectively, of cells at the same stage of development. The upper margin in all figures, except 1, is directed towards the Sertoli cell. The scale beneath the figures represents 10μ (Figs. 1–5) or 6·8μ (Fig. 6)

As in other animals[4,7], a vacuole is formed in the archoplasm relatively early in spermatic development and within this vacuole a small granule is laid down. Almost immediately, this granule becomes applied to, and flattened against, the nuclear membrane (Fig. 1). No further growth of the flattened granule, later to become the granular component of the acrosome, occurs. An outgrowth from the nucleus diminishes, and finally appears to close, the vacuole (Fig. 2).

Owing to the peculiar process of nuclear condensation, the granular component is carried to a point at one side of the now flattening nucleus (Fig. 3). This point marks the future proximal end of the sperm head. During the nuclear condensation the vacuole again becomes evident; with further condensation and flattening of the nucleus, it becomes considerably lengthened and increased in volume. At the same time the granular component becomes dislocated from its previous position and is now found at a variable position on the dorsal surface of the much flattened and now partially folded nucleus (Fig. 4 *a*,*b*).

After rotation of the nucleus through 90°, a process which brings its long axis radial with respect to the seminiferous tubule and in line with the axial filament, the vacuole becomes reduced in volume and moves towards the proximal end of the nucleus. During this shrinkage of the vacuole the granular component is carried along the dorsal surface and towards the proximal end of the nucleus, by now almost transformed into the mature sperm head (Fig. 5). The granular component finally comes to rest at the tip of the rostrum of the mature sperm head (Fig. 6). Here it forms a conical cap of diameter 1·4μ, height 0·6μ and thickness 0·3μ. The shrinking vacuole becomes attached to the base of the conical rostrum of the sperm head, finally forming what corresponds to a dorsal head cap, although not normally visible as such. Thus both the granular and vesicular derivatives of the archoplasm contribute to the formation of the acrosome in the mature sperm.

Acrosome formation in the bandicoot is unusual in a number of respects: (1) the absence of growth of the granular component, which is normally merely a proacrosome; (2) the earlier hypertrophy, very late condensation, and changing insertion of the archoplasmic vacuole; (3) the dislocation of the granular component of the acrosome from its original position. The latter is quite different from the complex migrations undergone by the proacrosome in some Hemiptera[8].

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Components of the Total Magnesium Content within the Leaves of White Clover and Perennial Ryegrass

LITTLE information exists concerning the quantitative relationships between the forms in which magnesium exists within leaves. Chlorophyll concentrations in leaves have frequently been measured[1], but rarely has this been done simultaneously with estimations of the total magnesium content.

Fully green leaves of perennial ryegrass (*Lolium perenne*) and *S*100 white clover (*Trifolium repens*) were gathered from plants growing in the field on Sept. 20, the petioles of the clover leaves were removed, and approximately 2 gm. of fresh material was extracted in 80 per cent acetone. The residual colourless material was designated 'fibre'; the ryegrass residue looked like cotton wool, that from the clover was more powdery and less fibrous.

The chlorophyll concentration in the solution was determined on a Unicam *S.P.*500 spectrophotometer by the method of MacKinney[2], whose values for the molecular extinction coefficient of chlorophyll *a* and chlorophyll *b*, in acetone at 6630 A. and 6450 A., were confirmed by Holt and Jacobs[3]. In this determination the assumption was made that no compounds in the solution other than chlorophyll *a* and chlorophyll *b* were absorbing light at 6630 A. and 6450 A. The total magnesium concentrations in the fibrous fraction and in the original material were determined, after ashing at 550° C., by the method of Mason[4].

The 'chlorophyll magnesium' was calculated from a knowledge of the formulæ of chlorophyll *a* and chlorophyll *b*, and the values obtained for the ratio chlorophyll *a*/chlorophyll *b*. The magnesium which could neither be attributed to the chlorophyll molecule nor existed within the fibre fraction was designated 'residual magnesium' and was probably mostly soluble in water.

In Table 1 results are given comparing the composition of the leaves of ryegrass and clover. In Table 2 are values of the proportions of the various forms of magnesium (as percentages of the total magnesium content) within these same two types of leaf. All values are the mean of three replicates.

Table 1. Composition of Leaves of Clover and Ryegrass

	% Dry matter (fresh wt. basis)	%Chlorophyll (fresh wt. basis)	%Chlorophyll (dry wt. (basis)	% Fibre (dry wt. basis)	% Mg in leaf (dry wt basis)	% Mg in fibre (dry wt. basis)	Chlor. *b* / Chlor *a*
White clover	19 4±0 06	0 219±0 001	1·13±0 02	65·52±1 08	0 2365±0 000[illegible]	0·1478±0 0019	1 : 2·88±0 052
Perennial ryegrass	16 9±0 22	0 199±0 002	1·18±0 02	70·63±0·26	0 1803±0·0035	0·0960±0·0056	1 : 3 07±0 039

Table 2. Distribution of Leaf Magnesium as Percentage of Total Magnesium Present

	In fibre	In chlorophyll	Residual magnesium (by subtraction)
White clover	62 47±0 64	12·86±0 03	24 67±1 00
Perennial ryegrass	53 29±2 71	17 75±0 61	28·96±2·94

These results indicate that both the maximum concentration of chlorophyll (0·20 per cent fresh weight basis) and the ratio of chlorophyll *a* to chlorophyll *b* (2·5 : 1) given by Hill and Whittingham for green leaves[1] may be exceeded in ryegrass and clover.

Also the fact that more than 50 per cent of the magnesium in these two types of leaf is located within the 'fibre' fraction may affect the availability of this element to animals feeding on these two pasture plants. This in turn may be of significance in the study of the incidence of hypomagnesæmia[5] in the grazing animal.

Grateful acknowledgments are made to Drs. R. Hill and A. E. Flood for advice, and to the Central Research Fund of the University of London.

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Nasal Trichobilharziasis : a New Avian Schistosomiasis

In the course of research on the schistosomes of birds in the Belgian Congo and in the Ruanda-Urundi, I have discovered schistosomes in the nasal cavities of birds[1]. Nasal schistosomiasis is known to affect cattle in India, but it does not seem to have been mentioned in birds.

All parasites that were discovered—there being five new species—belong to the genus *Trichobilharzia* Skr. and Zakh. (1920). Nasal schistosomiasis is very common in the Anatidae. At Astrida (Ruanda-Urundi) we have observed it in the yellow-bill duck (*Anas undulata undulata*), in the spurwing goose (*Plectropterus gambensis*), in the Egyptian goose (*Alopochen aegyptiacus*), in the white-faced duck (*Dendrocygna viduata*) and in the knob-billed duck (*Sarkidiornis melanota*). Further, we have also met it in the Hadeda ibis (*Hagedashia hagedash* Ciconiiformes) and in the grebes (*Podiceps* and *Poliocephalus*).

The adult schistosomes are found in the small veins of the nasal cavities, and the eggs, often in great numbers, are met with in the nasal mucus. It is remarkable that the *Trichobilharzia* of the nasal cavities are exclusively found in these organs, and never in the liver or in the intestinal veins.

The histopathological lesions consist in a thickening of the nasal lining together with an accumulation—often considerable—of lymphocytes and the presence of numerous and voluminous giant cells. Sometimes additional infection is noted together with necrosis.

The discovery of this schistosomiasis opens a new field of research to the parasitologist, and promises to be fruitful. It is also of considerable interest from the medical point of view. Indeed, we know that the cercaria of *Trichobilharzia* are capable of causing a dermatitis known as 'swimmer's itch'. Recently, B. de Meillon and N. Stoffberg[2] have reported the first case in Africa of 'swimmer's itch', and I described, at Astrida (Ruanda-Urundi), a new furcocercaria of the Ocellata group which produces experimentally the same skin affection[3].

Up to now, no attention has been paid to the role that cercaria could take in the pathogeny of pruriginous skin diseases in Central Africa. I am reporting my observations in order to direct attention to this highly important matter.

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Sulphate Deficiency of Lake Victoria

An article by Beauchamp[1] suggests that a sulphur shortage in Lake Victoria is a factor limiting the growth-rate of fish. Owing to the fact that sulphates are removed from the water by biological precipitation in the form of plant and animal remains, Beauchamp suggests that the sulphate ultimately becomes anaerobically reduced to insoluble and unavailable sulphides which accumulate in the mud of the lake bed. Thus, although the water is deficient in sulphur, the element may well be present in large quantities at the bottom of the lake. In order to obtain facts as to the distribution of sulphur in the water, mud and vegetation of Lake Victoria, a preliminary investigation has been undertaken in the small northern area around Jinja.

So far as the area examined is concerned, the results have confirmed Beauchamp's statement that the water of the lake is deficient in sulphur. The sulphate concentration was less than one part per million at all depths, and the total sulphur content was mainly one to two parts per million. The analyses of the muds have revealed several interesting facts. Sulphur was present in abundance (3,000–20,000 p.p.m. dry mud), not as expected in the reduced form of sulphide but practically wholly in the organic form. Only about 1–4 per cent of the total sulphur was present as sulphide and 2–8 per cent as sulphate. Iron was present in both the reduced and oxidized forms in approximately equal proportions, and the oxidation-reduction potentials indicated a condition more on the oxidizing side than the reducing. These results seem to indicate that anaerobic conditions do not exist to any great degree at the lake bottom. Koyama *et al.*[2] found a similar lack of reduced sulphur in certain lakes in Japan, and they attributed this to low iron contents associated with high manganese contents. The mud of Lake Victoria, although containing appreciable amounts of manganese, is relatively rich in iron and thus the same explanation may not apply.

The next point arising from the analyses is that although the mud-surface contained considerable amounts of sulphate, the water immediately above it was devoid of the ion. For example, one mud-surface contained 700 p.p.m. sulphate-sulphur by Morgan's reagent, yet the water filtered from it had less than 1 p.p.m. A similar condition has been found by Koyama *et al.* in Japan. These workers suggested that a colloidal ferric complex selectively sorbs sulphate ions from the water. Mortimer[3] found colloidal ferric complexes in English lake muds that adsorbed sulphates and other ions. On reduction, these complexes were destroyed and liberated the adsorbed ions; this was controlled by the balance between the reducing power of the mud and the amount of oxygen supplied to its surface. As the results for Lake Victoria have shown the muds to be in an oxidized rather than a reduced state, it can be expected that similar adsorbing processes would occur. This conclusion suggests that the observed shortage of soluble sulphates in the water is due, not to their reduction to sulphides, but to the oxidized state of the mud-surfaces.

Sulphates are removed from the water biologically in the formation of plankton and other vegetable matter, and thus sulphur is also incorporated into the mud in the organic form. Beauchamp has stated that the limiting factor in lake fertility is the rate of decomposition of such precipitated organic matter. However, as the reduction of the mud-surface could increase the supply of soluble nutrients, the oxidation-reduction potential of the mud is also an important factor affecting fertility.

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Crystal Structure of Tobermorite

We have examined the crystal structure of tobermorite, using crystals given to us by Mr. J. D. C. McConnell, who has published a preliminary description of them[1]. The substance is a hydrated calcium silicate, closely related to, or identical with, the calcium silicate hydrate I found by Taylor[2] in set cements. Its composition, as found by McConnell[1], is $Ca_6Si_6O_{22}H_{10}$, and this is compatible with our present results, so far as they go.

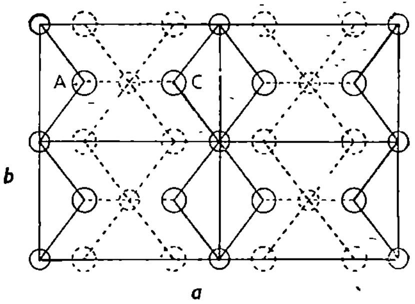

Fig 1(*a*)

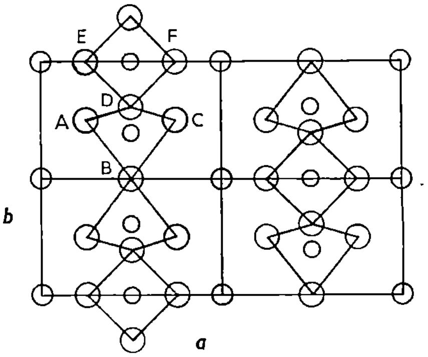

Fig 1(*b*)

Fig. 1. Small circles Si, intermediate circles Ca large circles O. Atoms and bonds shown dotted lie below middle of layer (*a*) Tobermorite: two central sheets of layer projected on (001)—idealized. (*b*) Tobermorite: upper half of layer projected on (001)—idealized

The crystals, a few tenths of a millimetre long, were studied by Weissenberg and oscillation photographs. They turned out to be composite, giving doubled spots, and also giving diffuse scattering of a kind which indicates structural 'mistakes', rather similar to, but not identical with, those found in β-wollastonite[3]. In spite of these effects (which are being studied, but will not be described in detail here) it proved possible to determine the structure in general outline.

The crystal structure is very nearly orthorhombic. It can be described on orthogonal axes with $a = 11 \cdot 3$ A., $b = 7 \cdot 33$ A., $c = 22 \cdot 6$ A.; cell-contents, four formula-units. There are systematic absences of hkl for $h + k$ odd and $\frac{1}{2}(h + k) + l$ odd, indicating that the true unit cell is smaller and implying a symmetry which cannot be greater than monoclinic, with c as the possible symmetry direction. There are systematic weaknesses of hkl for h odd or k odd, indicating a close similarity between the four quarters of the pseudo-orthorhombic cell. (It is convenient to continue to use this cell, and the axes defined by it.)

The cell contains two identical complex layers parallel to (001), displaced relative to one another in projection on (001), and each having a centre of symmetry (at least to the present degree of approximation). Each layer has two central sheets, of composition $4CaO_2$, arranged so that each calcium has four oxygen neighbours in its own sheet and two in the sheet at the next level (see Fig. 1*a*). Each pair of adjacent oxygens, such as *AC*, forms one edge of a tetrahedron containing silicon. These tetrahedra are joined into chains running parallel to *b*, as shown in Fig. 1*b*. Both Figs. 1*a* and 1*b* are slightly idealized; the actual chains are somewhat puckered.

This arrangement, a complex layer with the composition $4(Ca_2Si_3O_9)$, forms the backbone of the tobermorite structure. It is rather like a piece of double-sided corrugated paper, having a strong central sheet reinforced on each surface by longitudinal ridges; but the ridges are themselves toothed, since *E*, *F* (Fig. 1*b*) are at a considerably higher level than *B*. Two sheets pack together with their ridges superimposed vertically. There are grooves between the ridges, and these or the interlayer spaces must hold the remaining calcium and oxygen atoms, but their detailed positions are not yet known. Neither is it known whether the hydrogen atoms are present wholly in OH groups or partly in H_2O; it is, however, certain that (if the composition stated above is correct) some hydrogens are attached to oxygens taking part in the Si—O chains.

Though the atomic positions are only known approximately as yet, they give reasonable interatomic distances and satisfactory agreement between observed and calculated *F*'s. The proposed structure accounts for both the platy and the fibrous character of the crystals. It also explains the observations of Kalousek[4] on the synthesis of the material from lime and silica; he found that the initial products up to about 100° C. were fibrous, and changed only slowly and at slightly higher temperatures into the platy tobermorite. Further, it allows a very natural explanation of the shrinkage of the (002) spacing which has been observed on dehydration[1], since removal of OH or H_2O from the grooves would permit two adjacent layers to pack together with their ridges interleaved instead of superimposed, while still leaving sufficient room to accommodate a calcium atom between them.

Further work is in progress, and it is hoped to obtain more accurate values of the atomic coordinates. We are very grateful to the Cement and Concrete Association for a grant to one of us (C. H. K.) which has made this work possible.

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C. H. Kelsey

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Cavendish Laboratory,
Cambridge.
Nov. 24.

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The Gas-Multiplier: a New Type of Electron Multiplier

I have recently investigated the possibility of using the Townsend electron avalanche process in a gas in a stage-by-stage system to give a highly stable electron-multiplication factor, and have constructed for this purpose a new form of electron-multiplier referred to as a gas-multiplier[1]. This device is designed to permit electron-multiplication by the Townsend α-process, while restricting the accompanying processes which cause positive feedback by releasing further electrons in the input region. As is well known, the latter processes, particularly photoelectric effects and positive ion bombardment of the cathode, have set an upper limit of about 10^4 to the gas-amplification which has been practicable in single-stage devices such as proportional counters and gas-filled photoelectric cells, owing to the imminence of breakdown. The gas-multiplier is designed to be free from this limitation, by operating under conditions that are stable for any number of stages.

The chamber containing the gas is divided into stages by the electrodes, which are plane, parallel and equally spaced. The application of a specified voltage per stage therefore gives a uniform field throughout the working volume of the multiplier. The only communication between one stage and the next is through holes in a central circular area in the intervening electrode. These holes are small, closely spaced, and uniformly distributed, and occupy a fraction *B* of the total working area. The thickness of the electrodes is made small compared with the diameter of the holes, to avoid distortion of the field, and as an approximation each electrode may be taken to intercept all but a fraction *B* of all particles or photons approaching it from either side. This assumes that the gas pressure is sufficiently low and the hole-pattern sufficiently fine for the scattering action of the gas molecules to spread the electrons or ions from a particular hole laterally over several hole-spacings in crossing a stage. It also assumes that the coefficient of light reflexion at the surfaces is low, and that there is no systematic alignment of the holes in successive electrodes, which is ensured by using a suitable random method of arrangement.

There are two essential conditions for a satisfactory margin of stability in the operation of the multiplier. The first is that each stage should have a suitable margin of stability by itself, that is, with no voltage on the others, and this requires $\gamma \exp \alpha S \ll 1$, where α and γ are the usual Townsend coefficients, and *S* is the spacing between electrodes. The second condition is that in operation the flux of positive ions and of photons reaching a stage from a later stage should decrease markedly as the number of stages intervening increases, so that the total feedback does not greatly exceed that in the stage itself. Assuming that there is no appreciable ionization in the gas by positive ions at the field-strength and gas-pressure in use, the ratio of total flux to internal flux can be shown not to exceed $\frac{1}{1 - GB}$, for any number of stages, where *G* is the gain per stage. It is therefore desirable that *GB* should not be greater than $\frac{1}{2}$, say. Provided that both the above conditions are satisfied, the feedback present has only a small effect on the gain, and, neglecting edge effects, *G* is approximately equal to $B \exp \alpha S$.

Table 1 shows a set of operating conditions used and the results observed. These results refer only to a preliminary experiment which was made to demonstrate the action of the multiplier, and was not designed to provide accurate measurements under closely controlled conditions. The rise- and decay-time is considered to be mainly due to the collection of the positive ions in the last stage. No appreciable delay or distortion other than this was observed as the number of stages was increased, provided that the output current did not exceed the value stated, which is of the order at which space-

Table 1

Diameter of perforated areas	3·81 cm.
Electrode spacing (*S*)	1·92 cm.
Hole diameter	0·079 cm.
Hole spacing (square pattern)	0·198 cm.
Electrode thickness (brass)	0·013 cm.
Area ratio (*B*)	0·125
Gas pressure (room air)	0·25 mm. mercury
Breakdown voltage, single stage	500 V.
Breakdown voltage per stage (8 stages, no input)	250 V.
Operating voltage per stage	160 V.
Input pulse length	40 μsec.
Pulse repetition frequency	50 sec.^{-1}
Gain per stage (*G*)	3·2
Rise and decay time	< 10 μsec.
Maximum undistorted peak output	c. 20 μamp.

charge effects are to be expected with an input pulse longer than the collection time. Larger currents show a greater gain than normal, and may initiate breakdown if excessive.

C. H. VINCENT

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[1] Provisional patent filed.

A Film Radiometer for Centimetre Wave-lengths

THERMAL methods for the measurement of power at centimetre wave-lengths normally involve a substitution process in which the high-frequency power is assumed to be identical in magnitude with the d.c. power causing the same rise in temperature or change in resistance. While in some techniques this assumption results in no appreciable error, it is a general limitation of thermal methods that the high-frequency and d.c. powers are not dissipated in precisely the same manner. This feature of existing methods is particularly evident at low power-levels, of the order of 1 milliwatt, at wave-lengths of 3 cm. and less. Although a calibration of centimetre-wave milliwattmeters can be made against standard equipment operating at higher power-levels, this operation requires much auxiliary apparatus and attenuation measurements of high precision. There is a need, therefore, for further convenient power-measuring techniques at the milliwatt-level in which the limitations inherent in existing methods are avoided. It seems probable that a form of film radiometer or bolometer, in which the ideal of accurate substitution of d.c. power for high-frequency power is approached very closely, will fulfil these requirements; the results of some preliminary experiments in the development of such an instrument are summarized in this communication.

Very few direct measurements of power at centimetre wave-lengths using resistive films appear to have been made, and the only published information of which I am aware relates to extended films placed along the axis of a waveguide[1,2]. It has been known for some time, however, that a thin transverse film having a surface resistivity equal to the wave impedance of the waveguide forms a reflexion-less termination when followed at a distance of $\lambda_g/4$ by a perfect reflector (λ_g being the wave-length in the guide), and a modification of this arrangement is described below.

The problem of ensuring equivalent heating effects of high-frequency and d.c. power is obviously still considerable in a resistive film extending across the waveguide; fortunately, it is still possible to terminate a rectangular waveguide in its characteristic impedance by the use of a relatively narrow strip extending across the waveguide from the centre of the broad face. Such a strip is located in a region of very nearly uniform transverse electric and magnetic fields for the dominant or H_{01} mode, and the difficulty of attaching suitable d.c. connexions is at the same time much reduced. In the present experiments, a strip 0·35 cm. wide of surface resistivity 180 ohms per square has been used in a standard 3-cm. band waveguide, so giving a d.c. resistance of approximately 500 ohms between top and bottom edges of the strip. Impedance measurements confirm that the strip behaves, to a close approximation, as a pure shunt resistance. In addition, with the reflecting plunger fixed at a distance of $\lambda_g/4$ at a mid-band wave-length of 3·2 cm., an input-voltage standing-wave ratio of 0·9 or better can be achieved over a 10 per cent band-width by preliminary adjustments of width of film. The strip is insulated from the waveguide at one end and can be connected in a d.c. circuit for calibration purposes.

Theoretically, either changes of resistance or a rise in temperature can be observed; so far, only the latter quantity has been determined by the simple method of attaching a single copper – eureka thermocouple to the centre of the strip with the wires of the couple fixed at right angles to the electric field of the H_{01} mode. A similar thermocouple is placed on the external wall of the waveguide close to the strip, and a steady-state deflexion of about 10 cm. per mW. is obtained on a galvanometer scale after a period of one to two minutes.

Preliminary comparisons, at power-levels of 2–3 mW., with other calibrated equipment have shown that the errors in a d.c. calibration of the instrument are probably not more than a few per cent. Further experiments, using metallic films deposited on mica, are in progress in order to investigate the full possibilities of this form of film radiometer, and a complete account of the work will be published in due course.

I am indebted to Dr. J. A. Saxton for advice in the preparation of this communication. The work described was carried out as part of the programme of the Radio Research Board, and is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

J. A. LANE

Radio Research Station,
Slough. Oct. 26.

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Metal-catalysed Hydrolysis of Thiophosphoric Esters

STUDIES on the hydrolysis of parathion (O-O-diethyl-O-*p*-nitrophenylphosphorothionate) and E.P.N. (thiono-benzene phosphoric acid O-ethyl-O-*p*-nitrophenylester) at *p*H 7 showed unexpectedly that traces of some metal ions, for example, cupric ions, have a marked catalytic effect.

At *p*H 7·8–8·6, at which the measurements were made, the catalysis of the hydrolysis by hydroxyl ions is negligible, so that we have primarily reaction with water. The reaction was followed at 40° C. by measuring as a function of time the optical density of the liberated nitrophenolate in a Beckman spectrophotometer *D.U.*

Assuming a reaction of the first order, we obtain from the general formula for the velocity constant $(k=(1/t)\ln a/(a-x))$, $k=(1/t)\ln(D_\infty - D_0)/(D_\infty - D_t)$, where D_0, D_t and D_∞ are the optical densities at times 0, t and infinity[1].

The buffer solution used was borax–hydrochloric acid (conc. borax ± 0·03 mol./l.). Addition of 20 per cent ethanol in the case of parathion and of 40 per cent for E.P.N. was necessary because of the limited solubility of these compounds in water. Great care was taken to avoid impurities, as it proved that metals even catalysed in concentrations of 10^{-8} mol./l.

The reagents used were analytical grade; we are indebted to the American Cyanamid Co. and the Dupont de Nemours Corporation for providing

Table 1. HYDROLYSIS OF PARATHION, PARAOXON AND E P.N. IN A GLASS VESSEL at 40° C.

Ester	Metal	Concentration metal (mol./l.)	Concentration ester (mol./l.)	pH	First-order constant, k (hr.$^{-1}$)	$\frac{k\text{ (metal)}}{k\text{ (control)}}$
Parathion	Copper	$0{\cdot}32 \times 10^{-6}$	$0{\cdot}11 \times 10^{-3}$	8·50	$1{\cdot}50 \times 10^{-3}$	20·0
	Control	complexon	,,	8·55	$0{\cdot}75 \times 10^{-4}$	1·0
E.P N	Copper	$0{\cdot}32 \times 10^{-6}$	$0{\cdot}105 \times 10^{-3}$	8·25	$1{\cdot}48 \times 10^{-2}$	47·6
	Control	complexon	,,	8·03	$0{\cdot}31 \times 10^{-3}$	1·0
Paraoxon	Copper	$0{\cdot}32 \times 10^{-5}$	$0{\cdot}113 \times 10^{-3}$	7·87	$0{\cdot}40 \times 10^{-3}$	1·7
	Control	complexon	,,	7·80	$0{\cdot}23 \times 10^{-3}$	1·0

HYDROLYSIS OF PARATHION WITH ADDITION OF CALCIUM IONS IN A GLASS VESSEL AT 40° C.

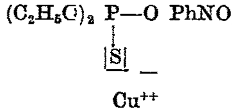
Concentration of calcium (mol./l.)	Concentration of parathion (mol./l.)	pH	First-order constant k (hr.$^{-1}$)	$\frac{k\text{ (metal)}}{k\text{ (control)}}$
1×10^{-4}	$0{\cdot}11 \times 10^{-3}$	8·66	$0{\cdot}507 \times 10^{-3}$	6·8
1×10^{-5}	,,	8·79	$0{\cdot}871 \times 10^{-3}$	11·6
1×10^{-6}	,,	8·68	$0{\cdot}677 \times 10^{-3}$	9·0
1×10^{-7}	,,	8·65	$0{\cdot}709 \times 10^{-3}$	9·5
1×10^{-8}	,,	8·66	$0{\cdot}691 \times 10^{-3}$	9·2
Control solution (complexon)	$0{\cdot}113 \times 10^{-3}$	8·55	$0{\cdot}75 \times 10^{-4}$	1·0

purified samples of parathion and E.P.N. Water, ethanol and hydrochloric acid were redistilled in an all-glass apparatus. All glassware was meticulously cleaned with a complexon solution (disodium-ethylenediamine tetraacetic acid) and with redistilled water.

The volumetric flasks in which the reaction took place were allowed to stand with buffer solution for several days. During the reaction the solutions were kept in the dark.

With these precautions, it was possible to obtain consistent results in each run. However, the use of a newly prepared buffer solution led to slightly different rate-constants (mean deviation ± 10 per cent) without altering the general picture of the catalysis. As reference we used a solution containing 10^{-3} mol./l. of complexon III, to bring down the concentration of most metal ions present as impurities to less than 10^{-15} mol./l. With the concentrations of cupric ions used, no hydroxide formation could be detected, in agreement with the solubility data given by Seidell[2]. The results are shown in Table 1.

When the effect was first found, it was thought that it might be due to the catalytic oxidation of parathion to paraoxon—the oxygen analogue of parathion[3]. This, however, was not the case, as the hydrolysis constant of paraoxon (see Table 1) is lower than the copper-catalysed hydrolysis of parathion. (The effect of cupric ions on the hydrolysis of paraoxon is very small.) Moreover, an experiment in which oxygen was meticulously excluded by keeping the solution under high vacuum ($\sim 10^{-4}$ mm. mercury) showed that the catalysis continued. The effect of other ions (magnesium, calcium, barium, aluminium, cobalt, cadmium and silver) was also investigated. In a glass vessel there was a marked enhancement of the hydrolysis. As we found very little variation of the reaction velocity with the metal ion concentration, the reaction was also measured in a polyethylene flask. Only in the case of copper ions was catalytic action found. The other metals investigated showed about the same velocity as the reference solution (with added complexon) in glass. The cause of this behaviour is being investigated, especially whether there is a real heterogeneous catalysis or if copper ions are liberated from the glass by absorption of other ions. In alkaline hydrolysis of parathion, cupric ions had no catalytic effect. To explain this phenomenon complex formation in much the same way as recently assumed by Wagner-Jauregg[4] for the hydrolysis of di*iso*propylphosphorofluoridate may be considered.



$$(C_2H_5O)_2\,\overset{+}{P}\text{—O PhNO}_2 \quad \begin{matrix} | \\ |\underline{S}|\,\overline{} \\ Cu^{++} \end{matrix}$$

Such a complex will have a more polar P—S bond and as a consequence will show more 'opposing resonance' and a reduced stability.

It is well known that thiophosphoric esters form complexes with salts of heavy metals[5]. An unexplained fact so far is the obvious specificity of cupric ions. It may well be that this type of catalysis, which occurs at very low concentrations, plays an important part in the degradation of spray residues.

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Paper Chromatographic Identification of the 2 : 4-Dinitrophenyl-Derivatives of Aliphatic Amines

DURING recent work on the structure of bacitracin *A*, the identity of small amounts of aliphatic amines was confirmed by allowing them to react with 1 : 2 : 4-fluorodinitrobenzene[1] and chromatographing the resulting dinitrophenyl derivatives on paper[2]. A number of primary aliphatic amines can readily be separated by chromatography on paper[3], or by ionophoresis on paper at pH 7 using collidine acetate buffer[2,4], and the spots revealed with ninhydrin. Schwyzer has separated certain primary, secondary and tertiary amines by paper chromatography, the spots being revealed by spraying with an indicator[5]. However, in view of the fact that the technique described here will give further evidence of the nature of a mixture of primary and secondary amines and ammonia, and that 0·5 µgm. or less of the dinitrophenyl-amines can be detected on the chromatograms under ultra-violet light, it seemed worth while to place it on record.

A small sample of the amine is allowed to react with 1 : 2 : 4-fluorodinitrobenzene and the dinitrophenyl-derivative is identified by reversed-phase chromatography on paper. In a typical experiment, fluorodinitrobenzene (0·15 µl.) in 0·2 ml. of ethanol was added to 10 µgm. of the amine or its hydrochloride in 0·1 ml. water, followed by 0·2 *N* sodium bicarbonate solution (0·1 ml.). After standing for 15 min. at room temperature, the solution was placed at 105° in a sealed tube for 2 hr. Excess fluorodinitrobenzene was removed by addition of a solution of glycine (0·1 ml. containing 300 µgm.) and allowing the mixture to stand for 2 hr. at room temperature[6]. Ethanol was then removed in a vacuum desiccator, 0·15 ml. of 0·2 *N* sodium bicarbonate solution added and the dinitrophenyl-amines extracted into ether. The residue obtained on evaporation of the ether solution was dissolved in 5 µl. ethanol and 1·7 µl. of the solution applied to a paper chromatogram. Whatman No. 1 paper treated with Dow Corning silicone No. 1107[7] was used and the chromatograms were developed with the more polar phase obtained on mixing methanol, chloroform and water (10 : 10 : 6 by volume). The chromatograms were run as recommended by Kritchevsky and Tiselius[7] and allowed to develop for 16 hr., when the solvent front had run off the bottom of the sheet (35 cm. long). 2 : 4-Dinitroaniline (R_F, 0·60) had then travelled 26·25 cm. The values of R_A (defined as the ratio of the distance moved by the substance to the distance moved by 2 : 4-dinitroaniline) and of R_F for the dinitrophenyl-derivatives of the amines used are shown in Table 1.

Table 1. Behaviour of Dinitrophenyl-Amines on Paper Chromatograms

$$R_A = \frac{\text{Distance moved by substance}}{\text{Distance moved by 2 : 4-dinitroaniline}}$$

Dinitrophenyl-derivative of	R_A	R_F
Ammonia	1·00	0·60
Methylamine	0·88	0·53
Dimethylamine	0·80	0·48
Ethylamine	0·67	0·40
*iso*Propylamine	0·47	0·28
Diethylamine	0·44	0·26
*iso*Butylamine	0·33	0·20
*iso*Amylamine	0·20	0·12
*iso*Hexylamine	0·12	0·07

By plotting the values of $R_M \left[= \log_{10} \left(\frac{1}{R_F} - 1 \right) \right]$ for the dinitrophenyl-derivatives of the primary and secondary amines against the number of methylene groups in the amines, two parallel straight lines are obtained for the two homologous series (cf. Bate-Smith and Westall[8]).

With the small spots applied to the chromatograms, all the dinitrophenyl-amines listed are separated from each other except the derivatives of *iso*propylamine and diethylamine. These two substances can be separated by prolonged development of the chromatogram. The spots can easily be eluted from the appropriate areas of the chromatograms with 3 ml. of ethanol. Measurement of the optical density of the resulting solutions at 345 mµ shows that the primary and secondary amines used have reacted almost quantitatively with 1 : 2 : 4-fluorodinitrobenzene. Ammonia gives only about 50 per cent of the expected yield and the high temperature used for the reaction is required to obtain this yield. The low solubility of the dinitrophenyl-derivative of methylamine in ethanol may also result in low recoveries in certain cases. Where an elongated spot due to dinitrophenyl-methylamine will not interfere with other substances, the spots may be applied to the chromatogram in ethanol–acetone (1 : 1) instead of ethanol. The theoretical recovery of dinitrophenylmethylamine is then obtained. The method therefore appears to have potentialities as a semi-quantitative tool.

Since the dinitrophenyl derivatives of the primary aliphatic amines show an absorption maximum at 345 mµ, while the corresponding derivatives of secondary amines show a maximum at 365–370 mµ, the measurement of the optical density of an eluate at two wave-lengths provides corroborative evidence as to whether the substance is derived from a primary or secondary amine.

I. M. Lockhart

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Oct. 26.

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Erosion in Meanders

In connexion with the communication by J. H. Horlock in *Nature* of November 26, p. 1034, I am writing to urge that the term 'meander' should be strictly limited to natural meanders, not to bends due to secondary flows. The term 'meander' is derived from the River Meander, which swings from bank to bank in an almost perfect pattern. The Central Board of Irrigation, India[1], many years ago defined "a meandering river as a river which follows a sinuous path due to natural physical causes, not imposed by external restraint". The experiments quoted were carried out under very unnatural conditions and hence produced highly unnatural results.

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(Director)

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[1] See "The Behaviour and Control of Rivers and Canals (with the aid of Models)"; obtainable from Publications Branch, General Department, India House, Aldwych, W.C.2. 13*s*.

I am grateful to Sir Claude Inglis for pointing out that the term 'meander' should be restricted to bends similar to natural meanders. I agree that the initial shapes of the bends used in the experiments described in my communication were not true meanders; but the point of the experiment was to demonstrate that the nature of the erosion in such bends would depend largely on the initial curvature at entry to the bend. Such artificial bends probably develop into natural meanders. Subsequent experiments on natural meanders of similar amplitude and wave-length show that erosion occurs on the banks on the outside of the bends, and not on one bank, as in the original experiments with artificial bends.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 27

London School of Economics and Political Science (at Houghton Street, Aldwych, London, W.C.2), at 5 p m.—Prof. Morris Ginsberg: "Reason and Experience in Ethics".*

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Prof. Glenn Sonnedecker (U.S.A.): "Structure and Stresses of American Pharmacy".

Royal Institute of Chemistry, London Section (joint meeting with the Woolwich Polytechnic Scientific Society, at the Woolwich Polytechnic, London, S.W.18), at 7.30 p.m —Dr. J. W. Rodgers: "The Extraction and Uses of Titanium and Zirconium".

Tuesday, February 28

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. Judith Grenville-Wells: "Crystals, Temporary and Permanent: (2) Diamond".*

Institution of Electrical Engineers, Measurement and Supply Sections (at Savoy Place, London, W C 2), at 5.30 p.m.—Mr. M. W. Makowski and Mr. K. Mochlinski: "An Evaluation of Two Rapid Methods of Assessing the Thermal Resistivity of Soil".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p m.—Dr. J. M. Zarek: "General Biomechanics".*

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. Anthony J. Barrett: "Use of Elementary Plasticity in Design".

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1); at 7 p.m.—Mr. B. J. Terrell: "Measurement of Angular Speed".

Wednesday, February 29

Society for Analytical Chemistry (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m —Annual General Meeting. 5 p.m —Sir William Slater: "The Evolution of Agricultural Research" (Bernard Dyer Memorial Lecture).

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 30 p.m.—Discussion on "Technique of Microwave Measurements", opened by Mr. E. M. Wareham.

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m — Dr. N. Uri: "Some New Aspects of the Mechanism of Fat Oxidation and Its Inhibition".

Thursday, March 1

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. A. J. Arkell: "Boats and Pyramids in Ancient Egypt".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Geoffrey Taylor, F.R.S.: "Fluid Flow in Regions Bounded by Porous Surfaces"; Mr. C. N. Davies and Mr. C. V. Peetz: "Impingement of Particles on a Transverse Cylinder".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. S. Brian Kendall: "Host-parasite Relationships between Liver-flukes and *Lymnaeidae*"; Dr. L. P. Joyner and Dr. S. Brian Kendall: "Potentiation of the Coccidiostatic Activity of Sulphonamides by Pyrimethamine".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5 30 p.m.—Discussion on "Recruitment in the Engineering Profession".

University College, London (in the Chemistry Theatre, Gower Street, London, W.C.1), at 5.30 p m.—Dr. R. S. Nyholm: "The Renaissance of Inorganic Chemistry" (Inaugural Lecture).*

Cement and Concrete Association (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. T. C. Powers (U.S.A.): "Physical Structure and Engineering Properties of Concrete".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. S. Moult: "Power Plants for Supersonic Flight".

Friday, March 2

Association of Applied Biologists (in the Meeting Room of the Royal Entomological Society of London, 41 Queen's Gate, South Kensington, London, S.W.7), at 10.45 a.m.—Meeting on "Clover Seed Production".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Arthur Bryant. "Samuel Pepys".

Saturday, March 3

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. D. Chilton: "The Weather Glass".*

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Prof. A. D. Baxter. "Combustion Chambers for Rocket Engines".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Electrical Engineering—The Secretary of University Court, The University, Glasgow (February 29).

Senior Lecturer in Chemistry at Birkenhead Technical College—The Director of Education, 63 Hamilton Square, Birkenhead (February 29).

Senior Research Fellow (with an honours B.Sc. degree in chemistry or biochemistry and research experience) to work in the Department of Biological Chemistry on the chemical aspects of a research programme concerned with the fluorescent labelling of proteins, carried out jointly by the Departments of Pathology, Bacteriology and Biological Chemistry—The Secretary, The University, Aberdeen (February 29).

Computer (preferably graduate) for skilled work in mathematical statistics and some applied mathematics—The Registrar, King's College, Newcastle-upon-Tyne (March 3)

Assistant (with special interests in vertebrate palæontology) in the Department of Geology in St. Salvator's College, St. Andrews—Joint Clerk to the University Court, The University, College Gate, St. Andrews (March 9).

Scientific Officer and Experimental or Assistant Experimental Officer in the Brown Trout Research Laboratory, Pitlochry, for duties chiefly concerned with salmon research—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (March 10).

Assistant Experimental Officer (with a pass B.Sc. degree or equivalent) in the Department of Potato Genetics, for general maintenance of stocks and tests for resistance of tuberous Solanums—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (March 12).

Demonstrator in Geography—The Registrar, University College of North Staffordshire, Keele, Staffs (March 12).

Microbiologist (Scientific Officer or Senior Scientific Officer grade), to undertake investigations of the microflora, mainly that of the fungal microflora of the roots of grassland species during their growth and decay—The Secretary, Grassland Research Institute, Hurley, Maidenhead (March 12).

Lecturer (with a special qualification in algebra and/or geometry) in the Department of Mathematics—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (March 13).

Research Fellow in Cosmic Rays for work which will be concerned largely with time variations of intensity and the origin of cosmic rays—The Registrar, University of Tasmania, Box 647C, G.P.O., Hobart, Tasmania (March 15).

Assistant (preferably with a degree in one of the natural sciences) in Charge of the Natural Sciences Library—The Registrar, University College, Singleton Park, Swansea (March 17).

International Wool Secretariat Research Fellow (microbiologist or bacteriologist), for work on the interconversion of steroids and triterpenes—The Registrar, The University, Leeds 2 (March 17).

Lecturer in Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (March 17).

Lecturer in Experimental Pharmacology—Secretary of University Court, The University, Glasgow (March 17).

Lecturer (with a good honours degree in geography) in Geography in St. Salvator's College—Joint Clerk to the University Court, The University, College Gate, St. Andrews (March 17).

Senior Research Fellow (graduate in science or chemical engineering, with experience in coal research) in Coal Research, at the University of Sydney, Australia, to plan and undertake research on occurrence, nature or utilization of coal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (Australia, March 17).

Senior Lecturer (with a degree in metallurgy or equivalent, and industrial and research experience) in Metallurgy—The Registrar, College of Technology, Manchester 1 (March 19).

Metallurgist or Metal Physicist (with a first- or second-class honours degree or equivalent), and an Inorganic Chemist (with a first- or second-class honours degree or equivalent), in the Metallurgy Division, National Physical Laboratory, Teddington, Middlesex, for work on new analytical techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.65/6A (March 28).

Lecturer (with experience either in theoretical or experimental physics) in the Department of Physics—The Registrar, The University, Liverpool (March 29).

Assistant Lecturers (2) (one in pure, the other in applied mathematics) in Mathematics—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 30).

Head (with good academic qualifications and teaching and/or industrial experience) of the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (March 30).

G. F. Grant Chair of Chemistry—The Registrar, The University, Hull (March 31).

Lecturer in Mechanical Engineering—Joint Clerk to the University Court, Queen's College, Dundee (March 31)

Lecturer (with special qualifications in physical chemistry) in Chemistry at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 31).

Technician in the Department of Zoology—The Secretary, The University, Exeter (March 31).

Lecturer or Assistant Lecturer in Statistics—The Registrar, The University, Leeds 2 (April 2)

Turner and Newall Research Fellows in Engineering, Inorganic Chemistry, Physics and Allied Subjects—The Registrar The University, Manchester (April 30)

Bacteriologist (graduate with some general bacteriological experience), for work on phage-typing of staphylococci, with a view to taking responsibility, under the Director, for the routine typing service—The Director, Central Public Health Laboratory, Colindale, London, N.W.9.

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, and postgraduate research experience), to assist in the study of certain physico-chemical properties of mucin—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 56/3.

Brush Research Fellow (honours graduate in science or engineering), for research in the mechanical and electrical aspects of power generation control and utilization—The Registrar, The University, Nottingham.

Demonstrator (with a wide practical knowledge of microbiological techniques and preferably with experience in the food or fermentation industries), for work associated with teaching of practical microbiology—The Secretary. The Royal Technical College. Glasgow, C.1.

Electroencephalograph Recordist (Grade 1)—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Lecturer (Grade I) in the Department of Zoology at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Lecturer in Physics, with special reference to the physics of nuclear reactors—The Registrar, The University, Birmingham 15.

Lecturer (with an honours degree in physics together with suitable teaching experience) in Physics—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

Lecturers (2) (with research interests in applied mathematics, preferably in fluid dynamics) in Mathematics—The Secretary, The Royal Technical College, Glasgow.

Master to teach Mathematics up to advanced level standard—The Director of Studies, Nautical College, Pangbourne, Berkshire.

Master (under 35, with Oxford or Cambridge degree) to teach Biology (mainly botany) with subsidiary chemistry—The Headmaster, The College, Winchester.

Principal Lecturer (with high academic qualifications and preferably some industrial experience) in Food Science—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

Scientific Officer (with an honours degree in biochemistry or physiology, and preferably with previous experience in biological research) in the Nutrition Department, to take part in work that will include the determination of the biological value of proteins, the study of calcium and phosphorus metabolism including the use of radioactive tracers, vitamin A and D assays and general nutritional experiments with rats—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading, quoting 56/5.

Scientific Secretary (with a first- or second-class honours degree in agriculture or other natural science with at least three years appropriate postgraduate experience and some administrative experience) to the Director of the West African Cocoa Research Institute, Gold Coast, to assist the Director in the work of the Institute including technical correspondence, preparation of reports and publications, minutes and other technical matters—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/200/012.

Senior Lecturer in Physiology and Pharmacology, at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Senior Lecturer (with a good honours degree and design experience in nuclear power plant) in Nuclear Power Engineering—The Secretary, The Royal Technical College, Glasgow.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Planning. Vol. 21, No. 390 (12 December 1955): New Writing on Wages—1. Pp. 245–260. 2*s*. 6*d*. Vol. 21, No. 391 (12 December 1955): New Writing on Wages—2. Pp. 261–276. 2*s*. 6*d*. (London. Political and Economic Planning, 1955.) [1312

Institution of Professional Civil Servants. Special Report of the National Executive Committee of the Institution of Professional Civil Servants on the Report of the Royal Commission on the Civil Service, 1953–55. Pp. 34. (London: Institution of Professional Civil Servants, 1955.) [1312

British Gelatine and Glue Research Association. Seventh Annual Report for the year October 1954 to September 1955. Pp. 16. (London: British Gelatine and Glue Research Association, 1955.) [1312

Year Book of the Physical Society, 1955. Pp. iii+92+4 plates. (London: Physical Society, 1955.) Price to non-members, 10*s*. [1312

University College, London: a Survey 1950–1955. Pp. 70+9 plates (London: University College, London, 1955.) [1312

Report on the Work of the British Council, 1934–1955. (Twenty-first Anniversary Report.) Pp. vi+121+6 plates. (London: British Council, 1955.) 2*s*. 6*d*. [1612

Scottish Home Department. Freshwater and Salmon Fisheries Research Series. No. 10: Movements of Salmon and Sea Trout, chiefly Kelts, and of Brown Trout Tagged in the Tweed between January and May, 1937 and 1938. By the late G. Herbert Nall. Pp. 19. (Edinburgh: H.M. Stationery Office, 1955.) 4*s*. net. [1612

Bulletin of the British Museum (Natural History). Entomology. Vol. 4, No. 1: A Study of African Chironomidae, Part 1. By Paul Freeman. Pp. 167+plate 1. 15*s*. Botany. Vol. 2, No. 2: Mosses of Dominica, British West Indies and Mosses of the Ecuadorian Andes Collected by P. R. Bell. By Edwin B. Bartram. Pp. 35–64. 6*s*. (London: British Museum (Natural History), 1955.) [1612

Maudsley, Mott and Mann on the Chemical Physiology and Pathology of the Mind. By Prof. H. McIlwain. (An inaugural lecture delivered at the Institute of Psychiatry, Maudsley Hospital, London, 14th April, 1955.) Pp. 26. (London: H. K. Lewis and Co., Ltd., 1955. Published for the Institute of Psychiatry.) 5*s*. net. [1612

Psychology and the Foundations of Psychiatry. By Prof. H. J. Eysenck. (An inaugural lecture delivered at the Institute of Psychiatry, Maudsley Hospital, London, 3rd February, 1955.) Pp. 32. (London: H. K. Lewis and Co., Ltd., 1955. Published for the Institute of Psychiatry.) 5*s*. net. [1612

Graphic Arts Focal Point. Vol. 1, No. 1. (An Ilford journal for all engaged in the Production of Printed Illustration.) Pp. 24. (London: Ilford Limited, 1955.) [21

Air Ministry: Meteorological Office. Meteorological Reports. No. 16: Winds Between 300 and 100 MB in the Tropics and Subtropics. By A. Gilchrist. Pp. ii+28. (M.O. 535 k.) (London: H.M. Stationery Office, 1955.) 2*s*. net. [21

Other Countries

Proceedings of the United States National Museum. Vol 103, No. 3334: A Supplement to T. M. Tattersall's Review of the Mysidacea of the United States National Museum. By Albert H. Banner. Pp. 575–584. Vol. 103, No. 3336: Supplement and Corrections to J. A. Hyslop's Genotypes of the Elaterid Beetles of the World. By Ross H. Arnett, Jr. Pp. 599–620. Vol. 103, No. 3337: Neotropical Miridae. 64: New Bugs of the Subfamily Cylapinae (Hemiptera). By José C. M. Carvalho. Pp. 621–632. Vol. 104, No. 3338: Revision of the Vittate Species of the Chrysomelid Beetle Genus Disonycha from the Americas South of the United States. By Doris Holmes Blake. Pp. 1–86. Vol. 104, No. 3339: A Revision of the Nearctic Species of the Beetle Genus Meligethes (Nitidulidae). By Alan M. Easton. Pp. 87–104 Vol. 104, No. 3340: Four New Venezuelan Reduviid Bugs. By J. Maldonado Capriles. Pp. 105–114. Vol. 104, No. 3341: Some Polyclad Flatworms from the West Indies and Florida. By Libbie H. Hyman. Pp. 115–150. Vol. 104, No. 3342: Biology and Taxonomy of North American Beetles of the Subfamily Geotrupinae, with revision of the Genera Bolbocerosoma, Eucanthus, Geotrupes, and Peltotrupes (Scarabaeidae). By Heney F. Howden. Pp. 151–320+18 plates. Vol. 104, No. 3343: Fruit Flies of the Genus Tomoplagia Coquillett (Diptera, Tephritidae). By Martin L. Aczél. Pp. 321–412+plates 19–26. Vol. 104, No. 3344: Scarab Beetles of the Genus Psammodius in the Western Hemisphere. By O. L. Cartwright. Pp. 413–462. Vol. 104, No 3348: Neotropical Miridae. 15: New Genera and Species of Bugs of the Tribe Termatophylini (Hemiptera: Deraeocorinae). By José C. M. Carvalho. Pp. 641–650+plate 31. Vol. 105, No. 3349: Notes on Shrimps from the Marshall Islands. By Fenner A. Chace, Jr. Pp. 1–22. Vol. 105, No 3352: Some Polyclad Flatworms from Polynesia and Micronesia. By Libbie H. Hyman. Pp. 65–82. Vol. 105, No. 3353: Biting Lice of the Genus Saemundssonia (Mallophaga: Philopteridae) Occurring on Terns. By Ronald A. Ward. Pp. 83–100. Vol. 105, No. 3355: A Review of the New World Flies of the Genus Conops and Allies (Diptera: Conopidae). By Sidney Camras. Pp 155–188. (Washington, D.C.: Smithsonian Institution, United States National Museum, 1954 and 1955.) [1312

Transvaal Museum, Pretoria, S. Africa. Report for the year ending 31st March, 1955. Pp. 42. (Pretoria: Transvaal Museum, 1955.) [1312

City of Launceston, Tasmania: Annual Report of the Queen Victoria Museum and Art Gallery, 1954–55. Pp. 8. (Launceston. Queen Victoria Museum and Art Gallery, 1955.) [1312

Nuclear Physics. Vol. 1, No. 1. Edited by Prof. L. Rosenfeld. Published Monthly. Subscription price of a volume of 700 pages: 53 florins; 106*s*.; 14 dollars. Postage 8*s*. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1956.) [1312

National Research Council of Egypt. Bulletin of the Scientific and Technical Documentation Centre. Vol. 1, No. 2 (September 1955): Abstracts of Scientific and Technical Papers published in Egypt, and Papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Pp. 10. Vol. 1, No. 3 (October, 1955): Abstracts of Scientific and Technical Papers published in Egypt and Papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Pp. 14. (Cairo: National Research Council of Egypt, 1955.) [1312

Berichte des Deutschen Wetterdienstes. Nr. 19 (Band 3): Beitrag zur Messung der Lufttemperatur mit verschiedenen Formen Strahlungsschutzes. Von Wilhelm Bauer und Richard Buschner. Pp. 12. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [1312

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Bureau Climatologique—Communication No. 10: Bulletin Climatologique Annuel du Congo Belge et du Ruanda-Urundi, Année 1954. Pp. 161. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 120 francs. [1312

World Health Organization. Technical Report Series. No. 100. Amputees and Protheses—Report of a Conference on Prosthetics, Copenhagen, 23–28 August, 1954. Pp. 52. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 3*s*. 6*d*.; 0.60 dollars; 2 Swiss francs. [1612

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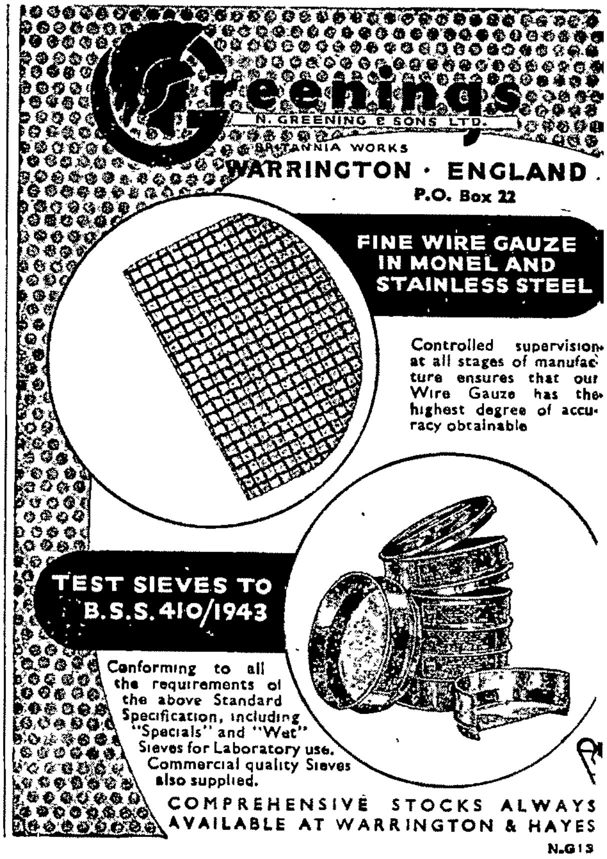

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PEACEFUL USES OF ATOMIC ENERGY

EVEN before the Conference on the Peaceful Uses of Atomic Energy met at Geneva in August last, negotiations were proceeding between several European countries with the view of establishing some system for nuclear energy co-operation. Provision for European co-operation in nuclear research was made in the European Organization for Nuclear Research, established by the Convention of July 1, 1953, and which was adopted by representatives of Belgium, Denmark, France, the German Federal Republic, Greece, Italy, Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslavia. The Organization came into existence in 1954 with the ratification of the convention by Switzerland and six other nations, and the new institution, with an international laboratory and headquarters at Geneva, thereupon took over the work and documentation of the European Council for Nuclear Research, which had prepared the way for the founding of the new permanent organization.

A concise account of the development of the European Organization for Nuclear Research is given in an information pamphlet recently issued by the United Nations Educational, Scientific and Cultural Organization in the series "Unesco and its Programme"*. It is also described by Dr. L. Kowarski, director of the French Atomic Energy Commissariat, who was also director of the Laboratory Study Group which carried out that phase of the scientific work for the European Council for Nuclear Research, in an article, "The Making of CERN—an Experiment in Co-operation", contributed to the *Bulletin of the Atomic Scientists* of December 1955. Private conversations between European physicists took place as early as 1947, and in 1949 L. de Broglie was urging the creation of regional European research institutes in fields of this type. Proposals for co-operation in nuclear research, however, first took definite shape in June 1950, with Prof. I. I. Rabi's suggestion at Florence on behalf of Unesco for an inter-governmental conference on the subject.

The preliminary inquiries which resulted in the formation of the European Council were carried out by Unesco, and this project for co-operation in nuclear research may thus fairly be claimed by Unesco as one of its major achievements. The agreement of February 12, 1952, creating the Council was signed by nine countries: they did not include the United Kingdom, although the United Kingdom had been represented at the Conference of December 1951, when the preliminary arrangements were made, and the United Kingdom is, with France, the largest single contributor to the finances of the permanent organization. For the period 1953–56 it is bearing some 24 per cent of the cost of the Organization's activities, estimated at £10 million over the first seven years, a figure which the Council, of which Sir Ben Lockspeiser is chairman, decided in December to increase by about 40 per cent.

The Unesco pamphlet, which includes excerpts from the convention establishing the permanent organization, outlines the way in which the scientific study groups of the European Council for Nuclear Research clarified the problems in nuclear physics which could most usefully be examined at the international level, and defined the spheres of research within which co-operation between physicists and laboratories in different countries would be specially fruitful. These exchanges of views led to the decision to fix the energy of the proposed synchro-cyclotron for the international laboratory at 600 MeV. and that of the proton-synchrotron at greater than 25 GeV. The cost of building the laboratory and the machines accounts for more than 80 per cent of the Organization's estimated expenditure for the first seven years, and it is considered that its construction near Meyrin, close to Geneva and to the French frontier, will facilitate the creation of the intellectual atmosphere essential to such research as well as safeguard its international character.

The importance of this aspect is brought out particularly well in Dr. Kowarski's article, and he also emphasizes some of the staffing problems which such an organization inevitably encounters. The present staff of 285 is to be increased to 400 by 1956 and to 500 by 1960, and while a free flow of staff from member countries is expected, the general shortage of scientists is being kept in mind. The original director-general, Prof. F. Bloch, was succeeded in September 1955 by Prof. C. J. Bakker, to whose article in *Physics To-day* of September 1955, Dr. Kowarski refers those seeking technical details of the accelerators and buildings. He anticipates, however, that by late 1957 all major services will be installed on the Meyrin site, the cyclotron will be in the final stages of completion and the synchrotron well begun. The initial cosmic-ray programme should assist the starting-up of the instrumentation and, on a modest scale, the Organization will act as a European clearing house for such activities as the standardization of emulsion techniques. Apart from the small permanent staff, scientists are being invited to work at Meyrin for a limited period: for example, Prof. G. C. Wick and Prof. W. K. H. Pankofsky are spending one year there (see *Nature*, January 21, p. 117).

Dr. Kowarski's comment on the United Kingdom's decision to remain in the formal position of an observer should be noted by British readers of his article. That in practice Great Britain became also a keen debater and provided consultants, as well as taking a full share of the financial support, gave general satisfaction, and this has its bearing on the attitude of the British Government to co-operation with other European countries in the peaceful uses of nuclear energy. Questioned on this point in the House of Commons on February 1, Mr. R. A. Butler, the Lord Privy Seal, said that it is too soon to state what form British participation in such collaboration should take. While agreeing as to the importance of Britain becoming more closely associated with the project known as 'Euratom', Mr. Butler suggested that the proposals in the report on European collaboration in atomic energy issued by the working party on nuclear energy of the Organization for European Economic Co-operation* also required very close consideration.

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* European Co-operation in Nuclear Research. (Unesco and Its Programme, No. 11.) Pp. 26. (Paris: Unesco; London: H.M. Stationery Office, 1954.) 1s. net.

This working party was asked to examine and report on the possible scope, form and methods of economic and financial co-operation in the use of nuclear energy; and it should be noted that the working party is no less convinced than those who elaborated the Euratom plan that some form of European co-operation is necessary. It is a matter of deciding the form which co-operation should take, and the report emphasizes that, apart from technical details relating to industrial secrets, all the techniques for the industrial processing of nuclear 'fuels' at all stages were made public at the Geneva Conference in August 1955, with the exception of isotope separation techniques.

In discussing the effort required to develop a European nuclear energy industry, the report stresses not only the capital expenditure still required but also the needs of equipment and the large number of technicians who must be trained. Except in the United Kingdom and in France, with its Saclay centre and the Marcoule pilot plant which began to operate in January, that effort is only in its infancy. The report estimates that within the next five years much of the capital invested in nuclear energy will be used for research, and that while, apart from the small percentage of nuclear physicists required, most of the industrial and nuclear chemists, metallurgists, electricians and nuclear-energy engineers can be recruited in industry and will require only a year's training to adapt themselves to routine work, four or five years are required to provide the nucleus of a research staff. Comparing the situation with that in the United States, it estimates European expenditure on nuclear energy as about 300 million dollars in 1955 compared with 2,000 million in the United States in 1954, and the numbers of technicians employed in nuclear energy as about 15,000 in the United States in 1955, 5,000 in the United Kingdom, 1,800 in France and barely 1,000 in the rest of Europe. Moreover, the number of science students enrolled in the United States in 1952 exceeded 500,000, compared with about 180,000 in Europe.

Taken as a whole, Europe's present nuclear effort falls far short of its industrial potential and the working party suggests that two bodies should be set up by the Organization for European Economic Co-operation. The first of these, a Steering Committee for Nuclear Energy, would be concerned with the co-ordination of plans and of national legislation, the promotion of joint undertakings, training and standardization and the encouragement of international trade. The working party does not, however, contemplate that the Organization would be concerned with scientific and technical information, as distinct from that of an economic or financial character; but it stresses the importance of creating a favourable climate in Europe for the establishment of a nuclear industry. The promotion of joint undertakings is regarded as particularly important and promising in that the demands of some undertakings even on the smallest possible scale, exceed the resources that individual countries could be expected to contribute. Apart from the hazardous nature of some undertakings, and consequent reluctance of a single country to assume the entire financial risk, production costs for some undertakings decrease rapidly as the size increases.

Of the types of joint undertaking which the working party contemplates, plant for separating isotopes is particularly stressed, and it is suggested that such an undertaking might attract the participation of the United Kingdom, on certain conditions. Chemical separation plants for irradiated fuels, the production of heavy water, the fabrication of 'fuel elements' from metal or oxide, plants for the conversion of ore into metal, and electric power stations and semi-industrial laboratories are other possibilities instanced; but the last two or three are only advocated when existing installations are working to full capacity. For the promotion of training, besides the co-ordination of lectures and training courses, the report suggests encouraging the exchange of teachers and students, the creation of scholarships and, possibly, the creation of a European centre for teaching nuclear science, to complete the training given in national centres.

One advantage of the joint undertaking is that it facilitates security control. This would be the main function of the Control Bureau, the second body which it is suggested the Organization for European Economic Co-operation should establish. The sole object of this control is to prevent fissile materials used in the joint undertakings or produced by them from being ultimately diverted to military purposes. It would be necessary, therefore, to establish effective control over each national undertaking using fissile material originating directly or indirectly from the joint undertakings. For this purpose an international control laboratory and a strict accounting system for the production and use of all fissile elements originating directly or indirectly from the joint undertakings would be essential, though the products of nationally owned factories would not be affected.

The report definitely contemplates that the control system which it recommends might prove the first step to a system of world control, and that the proposal is in fact compatible with the system of world control embodied in the project for an international agency which the United States has submitted to the United Nations. It meets, moreover, the stipulation for a guarantee of effective control over all joint activities which the working party believes to be the only condition on which the United States would co-operate fully in the supply of fissile materials, specialized equipment and manufacturing secrets.

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* Possibilities of Action in the Field of Nuclear Energy. (Working Party on Nuclear Energy.) Pp. 70. (Paris: O.E.E.C.; London: H.M. Stationery Office, 1956.) 300 French francs; 6s.

On that ground alone the proposals in this report merit the most careful consideration, and the flexbility on which the working party insists and the fact that the proposal is freely open to European countries and not limited to the six countries of Euratom should commend it particularly to Britain. Euratom, it is true, is also anxious to secure the full participation of Great Britain in the proposed European Atomic Authority, nor is it intended to exclude other countries from the six original participants (France, Belgium, the German Federal Republic, Italy, Holland and Luxembourg). There are, indeed, broad similarities between the two schemes. That which M. Monnet is now pressing so firmly would make Euratom itself supranational by providing that the participating countries should delegate real powers to the European Atomic Energy Commission. It would be concerned solely with the development of atomic energy for peaceful purposes and it provides that all fissile material produced or mported by the importing countries shall become the property of the European Atomic Energy Commission, which alone would authorize the construction and operation of atomic installations. This, of ourse, implies the establishment of a security control ystem, the rules for which would be defined by the Commission in close co-operation with, for example, he United Nations; but the Commission itself would be responsible for seeing that these rules are applied.

A communiqué issued on February 12 by the Foreign Ministers of the six nations in the European Coal and Steel Community "confirmed the need and urgency to create a common European organization n the atomic field". It stated that the necessary directives have been given to the committee to complete its work as soon as possible and the Ministers believe the organization can be set up this year. The British Government, during the present meeting of the Organization for European Economic Co-operation, has stated that it is willing to lend all possible aid to the development of a European tomic energy pool.

There are two points which should here be noted. First, under either plan, the nuclear energy authority will come to grips at a supranational level with the establishment of an international control agency. This problem the Political Committee of the United Nations postponed for discussion at an international conference to be convened in the future. This was one, it is true, at the request of smaller countries ke Sweden; but as a result the establishment of Euratom or such a European Commission as M. Monnet urges may well prepare the way and demonstrate the practicability of control methods, which the United Nations might later be able to extend to he control of nuclear energy for military purposes lso.

The second point is that M. Monnet's scheme overomes the difficulty of including the German Federal Republic, which has renounced the right to make nuclear weapons, and those which have not. As Prof. W. Heisenberg, director of the Max Planck Institute for Physics and adviser on atomic energy to the Federal Government, told the Parliamentary and Scientific Committee on November 8, in his address on post-war scientific developments in Germany, Germany has had to start from scratch in nuclear physics, and post-war development has been slow. The European Organization for Nuclear Research has given valuable assistance, and several German research institutes are already assisting in construction at Meyrin; and when this is complete, the German universities and engineering colleges hope to participate in research there.

The main difficulty in planning such a programme in Germany is the lack of man-power. There are no trained engineers and very few scientists trained to work in this field of nuclear power. The one advantage is the existence of colleges of engineering; but they have still to be suitably staffed. Development is likely to be very slow, although Germany is extremely anxious to co-operate with the Western countries and to send young scientists and technicians to Great Britain and elsewhere for training, as well as to establish scientific stations for reactors. Nevertheless, it has since become apparent that, while desiring free agreement with the United States for the import of uranium and close co-operation with Britain in the industrial exploitation of nuclear power, German industry does not favour a supranational authority but only a co-ordinating committee.

Prof. Heisenberg indicated to the Parliamentary and Scientific Committee that the German Government is prepared to entrust the development of nuclear science mainly to private industry. Since, however, Dr. Adenauer and some of his ministers firmly support M. Monnet's plan for Euratom, difficulties may well arise if German industry maintains such an attitude; and it would seem that the attitude of Great Britain could be an important factor in determining the success or failure of proposals for a European nuclear community, though full British participation in such a community as M. Monnet's Committee proposes seems unlikely.

These are sufficient reasons for welcoming the outlook implied in the reference which Sir Anthony Eden made in his broadcast speech on January 22 to the possibility that nuclear power would transform the whole future of the world as fully as the discovery of the steam engine. Whether this is true or not, the implications of nuclear energy for the economy of Great Britain and its potentialities require very careful and close consideration. On the economic plane, for example, it is understood that experts are thinking in terms of an export trade for British nuclear energy industry of at least £300 million by 1975, with a home trade at a similar figure. Even when due regard is had to the fact that much of this export trade will be within the Commonwealth, where for a long time to come the United Kingdom is likely to supply uranium in return for the uranium oxide and to re-process the burnt elements from reactors, we cannot ignore proposals which may foster a free market in nuclear energy or which bear closely on the development of the backward areas of the world.

Within the British Commonwealth itself, there are already many valuable outlets for the utilization of nuclear energy as a source of power: the copper mines of Northern Rhodesia, the iron ore deposits in Nigeria and the bauxite deposits in Western Australia may be quoted. Major developments within the Commonwealth are in Canada, where in addition to the two earlier research reactors, a new reactor, costing more than £12 million, will provide some of the best research facilities in the world; further, the Australian Government in July 1955 placed a contract of £750,000 with a British company for the design and supply of a research reactor near Sydney as the basis of a £4 million plan to develop nuclear energy for industrial purposes; and Pakistan has established an institute for nuclear energy and India hopes to build an experimental reactor near Bombay within two years. Nevertheless, the United Kingdom's contribution is likely to be large for many years, and particularly in the supply of small reactors of 5–10 megawatts. Since then, it has been announced that an American and a British firm have agreed to collaborate in the manufacture of reactors, and that another British firm is to build an experimental reactor for which the Atomic Energy Authority will provide the fissile fuel.

Such possibilities bear closely on the demands for materials and power which the developing industry makes within Britain itself. Already since the end of the Second World War, £100 million has been spent on the establishments at Capenhurst, Springfields and Windscale. The first of the new nuclear power stations at Calder Hall is expected to come into operation on October 17, and the second within the next six months. Six more reactors, with a total capacity of about 200 MW., should be operating in 1959 or 1960, and although the cost of these power stations is approximately double that of coal-fired generating stations, within ten years it may well be one-third that of the coal-fired station. Moreover, apart from the demand which the nuclear power stations make for the services of technicians and technologists, they are likely to have a considerable effect on the total labour supply required. Only a few hundred men are expected to be employed at the first of the new power stations, instead of the 2,500 men required to provide a conventional power station of the same size with coal alone. Less than 100,000 men will in fact be required to generate the same amount of energy in nuclear power stations of these first experimental designs, instead of the 700,000 men required to supply the coal which conventional power stations would need.

It is clear that we are not only faced with a challenge to shape technical and technological education to meet those needs, but equally with a challenge to face the implications for industry and society in general. These are problems which not merely the Government but industry also has to face—no less on the trade union side than on that of management. The potentialities for increased productivity are not limited to power supply alone. They reach far into other kinds of industry, and if they are to be realized, a new and more imaginative outlook, a greater flexibility and adaptability will be required of all engaged in industry at whatever level. With its plans for seeing that industry is supplied with the technicians, the technologists and the scientists that are needed to-day, the Government should also be planning to ease the process of adjustment and to deal with the changes in the pattern of society as well as of industry that may be required; and to foster the outlook and attitude to change which a wise system of education itself can best encourage.

SPRINGBOARD FOR SUPERSONIC FLIGHT

Thermodynamics and Physics of Matter

Edited by Frederick D. Rossini. (High Speed Aerodynamics and Jet Propulsion—Vol. 1.) Pp. xviii + 812. (Princeton, N.J.: Princeton University Press London: Oxford University Press, 1955.) 100*s.* net

THIS publication, a massive volume of 812 pages is only the first of a series of twelve books planned by a board of editors composed of Theodore von Kármán, Hugh L. Dryden and Hugh S. Taylor assisted at various times by the general editors Joseph V. Charyk and Martin Summerfield. The scientific reputation of the members of this group is a sufficient guarantee of the quality of the contents of the books. Vol. 6, "General Theory of High Speed Aerodynamics", and Vol. 9, "Physical Measurements in Gas Dynamics and Combustion", have already appeared and have been reviewed in these columns (*Nature*, 176, 479 and 1040; 1955). The books are excellently printed by the Maple Press, Inc., of York Pennsylvania, and show what care is devoted to the typography of scientific books by the Princeton University Press. The volume at present unde review is edited by Frederick D. Rossini, of the Department of Chemistry of the Carnegie Institute of Technology, Pittsburgh, and he is to be complimented on the excellence of his accomplished work.

The complete series of twelve volumes is planned to describe recent advances in "High Speed Aerodynamics and Jet Propulsion", a topic which would be termed 'technology' by some and be placed outside the pale of 'pure science'. But it is to the credi of the creative thinking of the editorial board tha the first few volumes of the series are planned to b expositions of those fundamental aspects of physic which lie at the very roots of this relatively new branch of aeronautical engineering. To those wh know little or nothing of the wide ramifications o modern engineering science, the contents of thi introductory volume will come as a salutary shock. The advances made in high-speed flight during th past ten years or so have been very rapid and hav brought into sharp focus the need for producing a comprehensive account, not only of the advances themselves, but also of the fundamental aspects o science which have to be adduced to solve the problems that arise.

The twelve books represent the accumulated work of more than a hundred physicists, chemists, engineers and mathematicians. A programme as vast as this needs powerful sponsors, much financial support and considerable organizing ability. In fact, the series was sponsored and assisted by many departments of the United States Air Force, Navy and Army, and the administration and editorial functions of the undertaking were centred at Princeton University. Apart from this, the University contributed financially to the support of the project. Truly a 'combined operation'.

The opening section of the volume is on the fundamentals of thermodynamics and is a very interesting account covering 110 pages. The second section, covering about 130 pages, deals with quantum mechanics and application to molecular structure, and then there is a section on thermodynamic properties of real gases and mixtures of real gases, and one devoted to the properties of gases and gaseous mixtures. These are followed by sections on critical phenomena; the properties of liquids and liquid solutions; the properties of solids and solid solutions; relaxation phenomena in gases; gases at low densities; and the thermodynamics of irreversible processes. Each section is effectively a brief summary of much of the present knowledge in its own field; the expositions are not unduly discursive and are clearly written. The different parts of the publication are self-contained reviews which could easily serve as texts in fields other than that of high-speed flow and jet propulsion. A detailed scientific review of each of the sections would involve a width of knowledge covering vast fields of modern theoretical and experimental physics; but there is no doubt that the excellence of the books so far published matches that of the original conception.

Sheer size, however, sometimes appals, and the Princeton series may well oppress the spirit of a young engineer or scientist who comes fresh to high-speed flight and who searches for understanding. To any such person it should be emphasized that the books are really Goliath volumes of reference, and are not intended to replace, for example, the two smaller David volumes on "High Speed Flow", edited by Howarth, and the two ancillary volumes of "Tables" and "Graphs" edited by myself. There is no doubt, however, that, in the long run, the Princeton series will have beneficial effects on the development of the aeronautical sciences, and that they will act as a springboard for still further discoveries in high-speed aerodynamics and jet propulsion. In spite of this, Dædalus might well have groaned had he realized that his rudimentary experiments in flying would some day lead to the massive volumes of the Princeton series.

L. Rosenhead

ELECTRIC TRACTION ENGINEERING

Electric Traction Engineering

An Introduction. By E. A. Binney. (Cleaver-Hume Electrical Series—No. 10.) Pp. 224+7 plates. (London: Cleaver-Hume Press, Ltd., 1955.) 15*s.* net.

THE design of electric traction equipment does not attract the attention of authors to the same extent as do the spectacular developments that have taken place recently in other fields. Progress has for a number of years been chiefly in the direction of steady improvements to established practice rather than in any major advance. The development of the diesel-electric system, together with the recent use, on the Continent of Europe, of industrial frequency supply to the contact line, have resulted, however, in a re-orientation of thought. This and recent proposals in Britain have stimulated interest in the subject, and it seems probable that the near future will see considerable expansion of the industry. The present time, therefore, is opportune for the introduction of a book such as the one under review, written especially for the student and the young engineer starting a career in this field.

The history and development of the various systems are first traced briefly, and there is an outline of the work involved in the choice and design of rolling-stock equipment. The major part of the work is devoted to the design of traction motors and their gearing. The modern d.c. traction motor is a highly specialized machine owing to strict limitations of space and exacting conditions of performance, and the author very rightly devotes a considerable part of the book to it. There are also chapters on the single-phase a.c. motor, with its own special problems, and on the diesel-electric generator, another machine of special characteristics. On the mechanical side a section is devoted to gear calculations and a chapter to mechanical drives.

A further chapter is given to d.c. control systems. Power and control diagrams are dealt with, and the principles of interlocks and automatic acceleration explained in detail. The use of rotary amplifiers is briefly dealt with. The final chapter outlines project work, including the preparation of speed–time diagrams.

The book is adequately illustrated with diagrams and half-tone blocks and includes useful appendixes of symbols, mathematical expressions, and calculations on gears.

G. H. Platt

'PROJECT 6' OF THE AMERICAN PETROLEUM INSTITUTE

Hydrocarbons from Petroleum

The Fractionation, Analysis, Isolation, Purification, and Properties of Petroleum Hydrocarbons. (An account of the Work of the American Petroleum Institute Research Project 6, at the Carnegie Institute of Technology, Pittsburgh, Penn.) By Prof. Frederick D. Rossini, Beveridge J. Mair, and Anton J. Streiff. (American Chemical Society: Monograph Series—No. 121.) Pp. xvi+556. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 143*s.* net.

THE sponsorship of fundamental research has been an activity of the American Petroleum Institute since 1926. One of its earliest projects was that established at the National Bureau of Standards under Edward W. Washburn's direction, which has since become widely known as "Project 6". The aim set before the first small group of chemists in 1927 was, quite simply, "the separation, identification and determination of the chemical constituents of commercial petroleum fractions", and yet, at the time, the methods available for the separation or characterization of mixtures of closely similar substances were utterly inadequate for such an undertaking. Unless entirely new techniques could be devised, it was clearly hopeless to expect that much progress could be made towards even a partial solution of a problem so complex. This is the challenge that was accepted.

Project 6 is still in active operation. The achievements of its first twenty-five years have been assembled from scattered publications and set out in this monograph. The account which Frederick D. Rossini (director of the Project since 1934) and his associates have now presented is indeed monumental, for in fact the original objectives have been largely attained. The ten chapters with which the book begins deal very exhaustively with the fractionating processes that were employed and particularly with fractional distillation, of which the unexploited potentialities were quickly grasped. With a wealth of drawings and diagrams, the techniques and the apparatus used for the separation of more than a hundred and thirty different hydrocarbons from one representative crude petroleum are set forth; and most of these individual hydrocarbons were obtained far purer than they had ever been made before. Succeeding chapters deal equally exhaustively with the methods used by the workers on the Project for the characterization of these petroleum constituents, for the measurement of their absolute purities and for the determination of their physical properties. The precision they sought and reached in these measurements (for example, of freezing and boiling points) was without precedent, yet it has come to be accepted as standard for any work of a similar sort intended to be of lasting quality.

More than half the length of the monograph is devoted to descriptions of techniques devised by Rossini and his associates, which are classics of their kind. For many readers who are not specialists in petroleum technology, this will constitute the chief value of the book. For the petroleum chemist there are, in addition, chapters which deal with the hydrocarbon composition of the gasoline, kerosine, gas-oil and lubricant fractions; with the analysis of several representative crudes; and with the composition of distillates, alkylates and co-dimers.

A brief discussion of the work done in other laboratories on the composition of petroleum takes in minor constituents which contain other elements besides carbon and hydrogen, but is out of character with the book as a whole and scarcely adds to its usefulness. It is as the authoritative account of the accomplishments of a famous project that this book takes its place in the literature of petroleum.

THE AUTORADIOGRAPHER'S VADE-MECUM

Autoradiography in Biology and Medicine
By Prof. George A. Boyd. Pp. xiii+400. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 8.80 dollars.

AUTORADIOGRAPHY is an important tool in the workshop of the histologist and histochemist; the provision of an ever-increasing range of biologically significant compounds labelled with radioactive isotopes makes it an attractive method of study, and its relative cheapness and simplicity provide further appeal, if such were needed.

Any worker with average competence in normal histological and photographical methods can produce an autoradiograph. But, unlike the methods of histology and photography, the production of significant autoradiographs demands a much clearer knowledge of the possibilities and limitations of these apparently simple techniques. Some of the limitations—those of the mobility and diffusion of the complexes to be studied—are familiar to the histochemist; others—those of the type of photographic emulsion and its response to radiations of different nature and energy from elements which vary widely in their half-lives—are less familiar even to the expert photographer. Even though the desired result may be mainly a qualitative record of the distribution, the worker needs to know a good deal more of his material—histological, photographic and isotopic—than is apparent at first sight.

Prof. G. A. Boyd has set out to provide a vade-mecum for the histologist who wishes to work in this field. In the theoretical section of the book an elementary treatment of the theory of the photographic process leads up to a consideration of the characteristics of commercial and scientific emulsions and of their response to α-, β- and γ-radiation. A chapter on the autoradiographic image is followed by a study of the important question of resolution. Dosage and exposure time are then dealt with, and finally a valuable chapter discusses the sources of error in various stages of the process.

The second part of the book, entitled "Technique", is a 'cookery-book' presentation of the various special methods in sufficient detail to permit a worker who is quite unfamiliar with a method to reproduce it satisfactorily. More than half this part deals with various types of sections applied to liquid emulsions and to films on permeable and non-permeable bases; the remainder deals with less-familiar problems on specimens which are not flat and on the preparation of difficult material such as undecalcified bone and teeth. Much of it is evidently written from first-hand experience, and each recipe is followed by a brief discussion of its possibilities and limitations. One of the problems for the British worker is the constant reference to proprietary materials which may or may not be available in his country.

The last part includes a comprehensive bibliography to the end of 1952 and a series of cross-referencing indexes which provides a useful guide to the eight hundred references in this list. A supplementary bibliography of 129 titles brings the material up to date to the end of 1953.

The book is well produced and well illustrated, and its price is no more extravagant than that of most American publications these days. A somewhat staccato style in the theoretical sections does not make for smooth reading; but there are negligibly few errors in the text. The technique of a preliminary infiltration of thick emulsions with developer at low temperatures is not referred to; this is a useful method for producing uniform development in track autoradiography. My main regret is the deliberate omission of any reference to quantitative methods; if Prof. Boyd can take the opportunity of a second edition to bring his bibliography up to date and to include a section on quantitative autoradiography, he will still further increase the debt which we owe to him for the present volume.

John E. Harris

Colloque sur l'Acoustique des Orthoptères, Jouy-en-Josas (5–8 Avril, 1954)

Annales de l'Institut National de la Recherche Agronomique. Série *C*: Annales des Épiphyties. Par René-Guy Busnel. Pp. 448. (5e Année (trimestriel); Numéro hors Série.) (Paris: Institut National de la Recherche Agronomique, 1955.)

ALL the papers presented at the symposium on the acoustics of Orthoptera, held in France in April 1954, together with the subsequent discussions, have now been published as a supplementary volume in series *C* of the "Annales des Épiphyties". The meeting has already been reported in these columns by Prof. R. J. Pumphrey (*Nature*, 173, 1219; 1954), and thus it is only necessary to direct attention to certain features of the printed work.

The volume is divided into three sections: definitions, methods and techniques; acoustic emission of Orthoptera; and acoustic reception and behaviour. Of the seven papers comprising the first section, the one of most importance is that by S. Klein describing the ionic loudspeaker, a new tool of great interest in biological acoustics. The second section comprises ten papers on sound emission ranging from morphological description of the stridulatory apparatus to physical analysis of the sound, and indicates the magnitude of the problem from the physical point of view. The third section is the most important, containing in its six papers reviews by Prof. W. Jacobs and Prof. R. J. Pumphrey on behaviour and by Prof. H. Autrum on sense physiology. This latter paper emphasizes the paucity of knowledge of the acoustic receptors of the Orthoptera. Prof. Jacobs's paper treats the subject of the classification and analysis of the acoustic behaviour of Orthoptera by the analytical methods of Lorenz and Tinbergen, while Prof. Pumphrey stresses the need for examination of the functional importance of the phenomena.

The book will be valuable to workers as a reference to the main outlines of the problem, representing as it does preliminary work in this interesting field.

P. T. HASKELL

Minerals for Atomic Energy

A Guide to Exploration for Uranium, Thorium, and Beryllium. By Robert D. Nininger. Pp. xii+367. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 55*s*. net.

THIS is an authoritative handbook written primarily for professional and amateur prospectors. The text is in three parts, with sixteen appendixes. Part 1 is a description of the more important uranium, thorium and beryllium minerals; Part 2 a survey of the known producing-areas of the world and of potentially favourable localities; and Part 3 a review of prospecting techniques with advice on the evaluation of prospects. The appendixes include mineralogical identification tables, a summary of the laws and regulations applying to prospecting in the United States and the British Commonwealth, and information on prices currently being paid for uranium ores and concentrates.

The search for uranium to-day is so intense that, even though it is little more than a year since the text of Nininger's book went to the publishers, the emphasis he gives to the potentialities of vein-type deposits as the future producers of uranium is already out-dated. It is now apparent that, as has been the case with copper and other minerals, large bodies of low-grade ore capable of being worked on a vast scale will provide the bulk of the uranium of future years.

Typographical errors are infrequent and rarely cause confusion, but irregularities such as the use of 'thucholite' as a mineral species, 'columbium' in preference to niobium and the loose usage of 'secondary' (p. 42) might have been avoided. These minor errors fortunately detract little from the usefulness of the book. It is undoubtedly the most comprehensive publication of its kind and is deservedly in world-wide demand.

S. H. U. BOWIE

The Biochemistry of Vitamin B_{12}

A Symposium held at The London School of Hygiene and Tropical Medicine on 19 February 1955. Organized and Edited by R. T. Williams. (Biochemical Society Symposia, No. 13.) Pp. v+123. (Cambridge: At the University Press, 1955.) Paper, 13*s*. 6*d*. net; cloth, 20*s*. net.

AT the meeting in Oxford in 1911 of the newly formed Biochemical Club, now the Biochemical Society, it was proposed to hold meetings for the discussion of special subjects. At the first meeting in December 1914, under the chairmanship of Prof. A. Harden, micro-methods of analysis were demonstrated—truly a prophetic and apt beginning by biochemical pioneers. Further meetings followed at irregular intervals until 1928; after a gap of thirteen years they were resumed, as symposia, in 1941.

In 1948 the Biochemical Society began publishing full reports of these symposia, and now, ably organized and edited by Prof. R. T. Williams, the meetings and their reports are a well-established feature of biochemical progress. A welcome is to be extended to the appearance of the latest volume, the thirteenth of the series, devoted to vitamin B_{12}. Its subject-matter was reviewed earlier in *Nature* (175, 185; 1955) and need not be repeated here.

The symposium was held in February, 1955; barely five months later, an international team of workers, headed by Dr. Dorothy Crowfoot Hodgkin in Oxford and Sir Alexander Todd in Cambridge, announced the complete structural formula of vitamin B_{12} (see *Nature*, 176, 325; 1955). It was a happy thought to print that formula in the volume, the last to be produced by Prof. Williams, who after long service is retiring from the editorship of the symposia. He takes with him the thanks and good wishes of all biochemists.

Compounds with Condensed Thiophene Rings

By Howard B. Hartough and S. L. Meisel. (The Chemistry of Heterocyclic Compounds: a Series of Monographs, Vol. 7.) Pp. xv+515. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1954.) 16.50 dollars.

THIS volume is one of a pair as well as one of a series, for it is the complement of an earlier volume by H. B. Hartough on uncondensed thiophenes. The ramifications of thiophene chemistry and its recent rapid development explain the need for two volumes to accommodate a survey which is at once comprehensive, critical and readable.

The present volume begins with a discussion of orientation in the substitution reactions of furan, thiophene and their benzo-derivatives: this touches on problems which are still incompletely resolved and extend beyond the chemistry of thiophenes. Subsequent chapters contain a systematic account of thianaphthenes, thioindigo, dibenzothiophenes and polycyclic thiophenes, including those in which another fused heterocycle is present; the final chapter describes condensed systems of selenophene and tellurophene. The text, which is clear and well illustrated by structural formulæ, maintains a good balance between descriptions of synthetic methods and chemical properties. Much useful information is assembled in tables inserted in appropriate chapters and serving, with the aid of a general index, to locate a compound in particular quest. An extensive bibliography and a separate list of patents are intended to be complete up to May 15, 1952.

The book will be invaluable for reference purposes, a necessity for all libraries, and a boon to workers in its particular field both now and for many years to come.

The Structural Chemistry of Proteins

By Prof. H. D. Springall. Pp. x+376. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1954.) 45s. net.

FEW satisfactory text-books of protein chemistry have appeared. On one hand, the subject is very extensive, and much of it lies in biochemistry and technology; on the other hand, little structural information is available in all but one or two cases. The present volume concentrates on structural aspects and within its chosen limits is excellent. It provides an adequate account of the organic chemistry, including methods of synthesis of peptides and analytical methods of determining amino-acids and end-groups.

A strong feature of the book, however, is its discussion of physical methods. Students will not find this easy going. The summary of the physical methods of the determination of shape and size is given in such a condensed form that it is probably fair to say that it will only be understood by physicists and physical chemists who have specialized to some extent in the various methods. But readers who are not interested in these technical matters will be able to omit these pages or be content with a general impression.

Used in this way, students will find it a very good introduction to modern studies of proteins, and research workers an excellent monograph to keep on their book-shelves. It is well printed and bound, and quite reasonably priced for the present day.

J. A. V. Butler

The Birds of the British Isles

By Dr. David Armitage Bannerman. Vol. 3: Sylviidae, Turdidae, Prunellidae, Troglodytidae, Cinclidae, Hirundinidae. Pp. viii+399+51 plates. Vol. 4: Apodidae, Caprimulgidae, Meropidae, Upupidae, Coraciidae, Alcedinidae, Picidae, Cuculidae, Strigidae. Pp. xii+260+29 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954–55.) 45s. net each vol.

WITH these two volumes, Dr. D. A. Bannerman's stately work—with the fine plates by the late George Lodge—has covered at least a third of its ground. Vol. 3 completes the account of the passerine birds with, notably, the warblers, thrushes and swallows. Vol. 4 deals with six of the less numerously represented orders—swifts, nightjars, woodpeckers, cuckoos, owls, and that which includes the bee-eater, hoopoe, roller and kingfisher.

It is an advantage that the author is not tied to any standard length in discussing a species; and so he gives long and scholarly articles on those which present problems of special interest, such as the swift and the cuckoo. Nevertheless, even the accidental vagrants, such as three species of nightjar other than the native one, are by no means cursorily dismissed. The blue-cheeked bee-eater, added to the British list only in June 1951, finds its due place; and it provides occasion for quoting at length General Hutson's description of the migration of this and the European species in Egypt and Asia. Indeed, the unusual amount of evidence based on observations, including the author's own, in other parts of the world is again noteworthy as a particularly valuable feature of the work.

Landsborough Thomson

Australia

A Camera Study. By Frank Hurley. Pp. 208. (Sydney and London: Angus and Robertson, Ltd., 1955.) 45s.

THIS is a book of photographs, some coloured and some in black-and-white, by the distinguished Australian photographer, Frank Hurley. Its purpose is to record some of the scenery in town and country in Australia. It fulfils this modest purpose admirably, and it gives anyone proposing to emigrate to Australia a vivid idea of the continent: its clear skies; its parched red inland country; its monster cities; and its forests, mines and pastures. It is not an easy landscape to photograph, for much of it is monotonous and uneventful; but Mr. Hurley's great skill brings the scenery to life in a remarkable way. One has only to turn its pages to realize what opportunities await the biologist, the geologist and the geographer there, and to renew one's admiration at the way such a tough continent has been tamed in less than two centuries.

The book is well produced (a compliment which is unlikely to have been paid to Australian books fifteen years ago), and the colouring of some of the plates is admirable; only occasionally, in the plate of a Queensland sugar-field, for example, are the values false. In this sort of a book one does not expect a text as elegant as the pictures: Mr. Hurley's photographs are accompanied by accurate but undistinguished comments, in the style of a film travelogue; but it is a book to look at, not to read.

Eric Ashby

Suicide in London

An Ecological Study. By Peter Sainsbury. (Maudsley Monographs, No. 1.) Pp. 116. (London: Chapman and Hall, Ltd., 1955. Published for the Institute of Psychiatry.) 15s. net.

THIS study consists of a report on two separate but related investigations on suicides taking place in the London area in the period before the Second World War. In the first, an attempt is made to correlate the suicide-rates in the twenty-eight metropolitan boroughs during 1929–33, with selected social characteristics found in the "New Survey of London Life and Labour". The second consists of an analysis of 409 suicides reported to the North London Coroner during 1936–38. The data are painstakingly analysed, and correlations are obtained between suicide-rates and certain indexes of social disorganization.

The second part of the study is the more interesting, as an essay in method, and shows that the information available in coroners' records is capable of providing valuable supplementary information on suicides. It would, however, have been interesting to try to compare the London material with that in provincial towns, and possibly country areas, to test whether some of the regularities that are observed in London also hold outside the metropolis.

INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS

IN 1944 the Secretary of State for the Colonies invited British universities to set up an Inter-University Organization to assist the development of higher education in the Colonies. This invitation was accepted by all the universities, and their representatives met in London in the rooms of the Royal Society, on March 8, 1946, to establish themselves as the Inter-University Council for Higher Education in the Colonies. The original title later became inappropriate and was changed to Inter-University Council for Higher Education Overseas; but the objects of the Council remained unchanged, namely, those of assisting the development of universities within British territories which are, or have recently been, Colonies, and within the Sudan. A review of the work of the Council for the period 1946–54 was presented to Parliament last year by the Secretary of State for the Colonies, and this has now been published*.

When the Council was established in 1946, it was concerned with two universities which have since moved outside its sphere—the University of Ceylon and the Hebrew University of Jerusalem. In 1948 Ceylon became a Dominion, while the termination of the Palestine Mandate, also in 1948, removed the Hebrew University of Jerusalem from the interests of the Council. From the start the Council was especially invited to extend its assistance to the Sudan, and more recently it accepted the invitation of the Secretary of State for Commonwealth Relations to assist the development of university education in the Federation of Rhodesia and Nyasaland.

At the close of the Second World War there were only two universities in the British Colonial territories and the Sudan apart from those in Ceylon and Palestine. These were the Royal University of Malta and the University of Hong Kong, both of which had suffered much damage as the result of the War. At the present time there are three universities—Malta, Hong Kong and Malaya—and six university colleges—the University College of the West Indies, the University College of the Gold Coast, University College, Ibadan, Nigeria, Makerere College (the University College of East Africa), the University College of Khartoum, and the recently established University College of Rhodesia and Nyasaland. Some of the foundations which existed in 1946 now fall within the province of a post-war development parallel to that of the university institutions, namely, the provision of higher technical education in the Colonies under the guidance of the Advisory Committee on Colonial Colleges of Arts, Science and Technology, a body analogous to the Inter-University Council for Higher Education Overseas. Institutions which come under the Advisory Committee on Colonial Colleges of Arts, Science and Technology include Fourah Bay College, Sierra Leone, Kumasi College of Arts, Science and Technology, Gold Coast, College of Technology, Nigeria, and the inter-Territorial Royal Technical College, Nairobi.

The specific task of the Inter-University Council for Higher Education Overseas has been to assist the three universities and the six university colleges, and this report shows how well the purpose has been achieved. Although figures alone can be dry and unrevealing, the total number of students attending the university institutions coming within the province of the Council illustrates one aspect of the effectiveness of its work. In 1946 the total number of students attending such institutions, of which there were only four active at that time, was 726. In 1949, by which time eight of the institutions were effectively working, the total was 2,456, while in 1954 it had risen to 4,592. As was to be expected, in 1955 the figure approached 5,000. In addition, during the same period, the number of overseas students in universities of the United Kingdom and Ireland grew from 2,014 in 1946–47 to 9,901 in 1954–55.

All the universities and colleges are inter-racial. None has a quota system for races, although preference is given to local candidates. They are wholly or mainly residential, both for students and staff.

Two important principles which the Council has followed during its nine years of existence have been, first, that there should be no compromise on the matter of standards of teaching and of academic attainment, and second, that the university institutions with which it is concerned should be completely autonomous. A price that had to be paid for the achievement of attaining the academic standards of a first-class university has been that initially the number of students was small, with a high ratio of staff to students. This in turn has meant that the institutions required very large funds, both capital and recurrent. It follows that only a few of these university institutions could be established at any one time. There is no doubt that this policy has justified itself, since the Colonial university institutions are fully accepted within the university world. This has been greatly assisted by the fact that all the university colleges have entered into special relationship with the University of London. This has meant that the degrees the students take are those of the University of London. Furthermore, the University of London interests itself in appointments to the academic staff, particularly in the Faculty of Medicine. The Colonial university institutions are already beginning to attract research workers from outside, and they and their graduates are undoubtedly building up a reputation in the world at large for the territories they represent.

The maintenance of the autonomy of the university institutions has been important both with respect to finance and constitution and has been adequately safeguarded in every instance. The independence of the university institutions has meant that the relationship of the Inter-University Council to them has been advisory only.

The three universities, Malta, Hong Kong and Malaya, award their own degrees. The six university colleges will ultimately award their own degrees; but meanwhile their students pursue courses leading to the degree examinations of the University of London. The University of London alone among British universities awards degrees to external students. Special relationship with the University of London is a temporary arrangement intended to safeguard the academical standards of the university colleges while they are establishing their reputations and building up their experience. The first of the colleges to assume university status will be the University College of Khartoum, which has announced its decision to seek degree-granting authority in the present academical year. There is no uniform scheme for special relationship with the University of London and it is developed separately for each college, the college working out in consultation with the University of London the arrangements which best suit its particular local conditions. For example, if the development of secondary schools in a particular territory makes desirable that a minimum entrance requirement to the university college should be adopted which is lower than that obtaining in the United Kingdom, the college and the University of London can agree to accept a modified standard of admission. If a lower standard of entrance examination is instituted, the length of the degree course is normally extended by one academical year. Special relationship involves the arrangement that members of the staffs of the university college take part in the setting and marking of the examinations for their own students, with examiners from the University of London. Furthermore, full-time members of the teaching and research staffs of the colleges in special relationship with the University of London may, if appropriately qualified, register as internal students for the London Ph.D. degree, and continue to carry out their research work in the university college.

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* Inter-University Council for Higher Education Overseas, 1946–1954 (Cmd 9515.) Pp. iv+41+4 plates. (London: H.M. Stationery Office, 1955.) 2s. 6d. net.

The Inter-University Council itself meets four times in each academical year, and annually appoints an executive committee which usually meets monthly during each session. Each of the universities in the United Kingdom, together with the three Colonial universities, appoints a representative member. Recently university colleges in England have also appointed representatives, while the Council has co-opted additional members in their individual capacities. The educational advisor to the Secretary of State for the Colonies, Sir Christopher Cox, has served *ex officio*. The late Sir James Irvine was the first chairman of the Council and served until February 1951, when he was followed as chairman by Sir Alexander Carr-Saunders, who had until then been vice-chairman. Sir Raymond Priestley then succeeded Sir Alexander as vice-chairman. The secretary has until recently been Dr. Walter Adams, who left in May 1955 to succeed Dr. W. Rollo as principal of the University College of Rhodesia and Nyasaland. He was succeeded in the office of secretary by S. J. Worsley. By overlapping membership and by other means, the Council has maintained close co-operation with the Advisory Committee on the Colonial Colleges of Arts, Science and Technology, with the Advisory Committee on Education in the Colonies, with the Colonial Research Council and with the various advisory research councils and committees of the Colonial Office. It has worked in very close association with the University of London Senate Committee on Colleges Overseas in Special Relationship. The Council is represented by two members of the Colonial University Grants Advisory Committee. The cost of the Council's secretariat, office accommodation, visits and advertising of vacancies has been met by an annual grant from the Colonial Office.

The Council has attached great importance to the visits which its members and other representatives have been enabled to make to the overseas universities and colleges, and indeed its work would not have been possible without them. Air transport, which has developed so much since the War, has made possible the close personal contacts between the overseas and the home universities, the visits of experts and examiners, the frequent leave of academic staff, and the rapid exchange of correspondence and examination papers. The post-war period has also fortunately coincided with economic prosperity in almost all the overseas territories, and with the growth of responsible nationalism and the acceptance by both Great Britain and the dependent territories of a policy of transference of power to which the development of universities is well attuned. The University Grants Committee in the United Kingdom has said that "the dependence of the Universities on the State is balanced by a dependence of the State on the Universities". This mutual dependence and partnership is as clear in the Colonies as it is at home. The prestige of university institutions as a whole has never been higher, and they are exceptionally responsible to their national and international obligations.

In the future, as in the past, the overseas universities and colleges will look for co-operation to the universities of the United Kingdom. Although the University of London has been enabled, by its special position, to give more help than other universities in Britain, one may hope that the other universities will not fail to take as much interest in the overseas institutions as circumstances will make possible. One way in which they can help is by assisting the promising graduates of the Colonial university institutions to come to Great Britain for postgraduate and further specialist studies. The need for finances for the provision of postgraduate fellowships is clear. It is to be hoped that all will help who wish to see the development of universities in the British Commonwealth go forward in a manner which is worthy of the name which the Commonwealth has itself won in world affairs.

F. G. YOUNG

ZOONOSES IN EAST AFRICA

THE annual scientific conference organized by the East African Medical Research Scientific Advisory Committee was held in the Makerere College Medical School, Kampala, Uganda, during January 11–13. Some eighty delegates came from East African territories, and visitors from Britain, Egypt, Israel and South Africa joined in the discussions. In opening the conference, the Governor of Uganda spoke of the dependence of East Africa upon Great Britain and the United States of America for basic long-term research and on support for such research, and this was well illustrated in many of the discussions, particularly in relation to taxonomic research.

Dr. H. Hoogstraal, of the U.S. Naval Medical Research Unit, Cairo, described the great faunal explorations which the Unit has carried out in north-eastern Africa as a basic preliminary to ecological studies. This immense collection of mammals, birds, reptiles, amphibians and ectoparasites is now undergoing detailed examination, and much new information is emerging and will be made available in keys and check lists. Much admiration was expressed by conference members of this study; it is not being carried out under the pressure of a disease outbreak, in which circumstances hasty and inaccurate conceptions can arise; and it is regrettable that in East Africa so little collecting is being done. The need for a basic faunal study unit is great, there are serious gaps in existing collections and many taxonomic concepts require stabilizing. It is difficult to get bird, mammal or insect identifications done in East Africa, and the resources of the British Museum are frequently called upon. But there are limits to these resources and frequent delays in identifications, despite the willing help of the Museum staff, who have many other calls upon their services.

The difficulties and expensiveness of faunal research studies in East Africa were clearly recognized, and Dr. Hoogstraal stoutly maintained that the situation is not so gloomy as some have pictured. The British are notable collectors and senders-home of material, the British Museum's resources are immense and can be supplemented and more and better keys can be provided.

Nevertheless, the lack of basic East African data makes research upon the local zoonoses difficult, as was shown in symposia on rabies, *Q* fever, brucellosis, helminthiasis, virus zoonoses and trypanosomiasis. The status of trypanosomiasis as a zoonosis is not at present established, and the conference heard of new efforts being made in the crucial experiment of isolating *Trypanosoma rhodesiense* from wild animals. Dr. K. C. Willett spoke of several lines of investigation which suggest the possibility that *Tr. rhodesiense* may have developed from *Tr. brucei*, the game trypanosome which is non-infective for humans, by repeated passages through *Glossina pallipedes*, and this possibility is being investigated. The conference warmly welcomed the presence of Dr. B. Weitz, of the Lister Institute, whose studies of the blood meals of tsetse fly and other arthropods are so important to East Africa. If the hosts of tsetse fly could be clearly identified, specific measures of eradication could be devised and the distasteful method of wholesale game slaughter discontinued. Thus Dr. Weitz mentioned that he has never found the blood of certain common game animals in tsetse fly. The policy of wholesale game slaughter found no support in the conference, and this for two reasons. First, because of the promises held out by further work on the lines Dr. Weitz had indicated, which would, it was hoped, advance rapidly; and secondly, because of the general realization that until population pressure rises to the point where there is a real need for the land now occupied by tsetse, there is not likely to be any major decrease in the size of such areas. There is, therefore, no point in adopting such an unpleasant and unnecessary policy in East Africa.

Dr. R. B. Heisch pleaded for a holistic synecological approach to the problem of East African zoonoses, on a basis of detailed taxonomic studies and investigations of the host–parasite relationships. This approach has been utilized in existing studies of plague, relapsing fever and kala azar in East Africa. Dr. Heisch believes that the more resistant animal hosts may be important in maintaining the disease organisms, though this is scarcely the case in the virus zoonoses, where a continuous supply of non-immunes, who circulate the virus in the blood in large amounts, is an essential to maintaining a zoonosis. Moreover, when a zoonosis gets under way, man-to-man contact may be sufficient to keep the infection spreading, and in Kenya the kala azar epidemic may be spreading in this way. But Dr. Heisch's conception is worthy of serious study; man's fellow sufferers are too often regarded as his enemies. The snail, that humble but useful member of the aquatic community, as Mr. R. Beauchamp called it, is the chief sufferer from schistosomiasis. The resistant animal hosts of a zoonosis must not be too readily dismissed.

Much more information is needed, too, about the small mammals of East Africa, which may be involved in a number of zoonoses, and co-operation is most desirable between those who trap mammals for a variety of purposes. As much serum as possible should be collected, and a plea was made for the setting up of a 'museum' of deep-frozen sera from mammals, as this would greatly expedite the serological investigations of zoonoses. Detailed synecological studies might explain some of the discontinuities in disease incidence in East Africa which cannot at present be explained. Thus rift-valley fever antibodies are present in sera of cattle in both the Eastern and Western Rift valleys, though they are not found in sera from the higher intervening areas in Uganda. Knowledge is too scanty at present to explain these discontinuities, but in this connexion much attention is being paid to birds as possible disease vectors. Dr. R. M. Taylor described the major part they are believed to play in the endemiology and epidemiology of West Nile virus infections in Egypt and in Israel. The breeding seasons can provide a fresh stock of non-immunes, and in their breeding areas some virus infections may be endemic. In the areas to which or through which, such birds migrate, epizootics and outbreaks of zoonotic diseases may occur. Unusual climatic conditions may delay, alter or extend these areas, leading to mysterious outbreaks of disease in areas previously unaffected or only affected at long intervals. These possibilities in relation to a number of virus zoonoses are now being investigated, and they may be of importance in such an epizootic disease as African horse sickness. There are periodic outbreaks of this disease in widely separate geographical areas after intervals of freedom, which may extend to ten or twelve years.

But in searching for explanations of these and other zoonotic outbreaks, there are limitations in the taxonomic approach which should be borne in mind. Thus Dr. A. Haddow pointed out that the fact that the same species exists in two different areas is no guarantee that it behaves identically in both places. In one place *Aedes simpsoni* will bite man freely, whereas as little as ten miles away it will only bite animals. Some anopheline species feed exclusively by day in some areas, exclusively by night in other areas. There is, in a sense, no end to these studies. Moreover, a parasite introduced into a new area may adapt itself to previously resistant local vectors. Dr. M. Davies quoted examples of this from Israel in relation to schistosomiasis, introduced by immigrants from Iraq, and filariasis introduced from Cochin. Therefore, on a basis of sound taxonomy, each zoonosis requires specific ecological study in each affected area. Lack of appreciation of this has led to much wasted effort in trying to apply control measures, devised upon a basis of experience elsewhere, to a specifically local problem. Thus in Kenya, night screening of cattle from mosquitoes protects them from Rift Valley fever, whereas in South Africa the vectors are day-biting mosquitoes.

If each local problem requires specific study, then it is important to start in the most promising areas. In East Africa, the forest fringes are such areas. There the species of the forest and the open country come in contact, and there are other species which can only maintain themselves on the forest fringes. But this is only one such 'fringe area'; in Kenya, kala azar is somehow connected with the termite hills which represent another such contact area. Several speakers stressed our ignorance of forest animal ecology and hoped that more work would be done in this field. Others directed attention to the effect of turning pasture land into arable land, and to the effects of new irrigation schemes in East Africa.

One curious feature of the conference was the repeated criticism of the laws of the East African territories. It was pointed out that existing legislation in many fields is extremely advanced and ridiculously at variance with existing practice. The laws cannot, in fact, be enforced, and this has had unfortunate results. In other fields they are curiously restrictive, as was brought out by reference to campaigns against rabies. There is no legislation against laying poison bait, but the officers who lay it are personally financially responsible for any ensuing claim for damages. So much publicity is therefore necessary before laying bait "that even the jackals heard about it", and such campaigns have been extremely ineffective.

The conference revealed the enormous fields for research that the zoonoses hold in East Africa, and in his closing remarks the president, Mr. H. R. Binns, of the East African Veterinary Research Organization, stressed this. He called for the closest cooperation of medical and veterinary research workers and other scientists which has been so fruitful in the past, and emphasized the willingness of all institutions and organizations in East Africa to welcome visiting workers from other countries who wish to help in the solution of East Africa's many problems.

J. N. P. Davies

OBITUARIES

Prof. A. O. Rankine, O.B.E., F.R.S.

The death, on January 20, of Alexander Oliver Rankine at the age of seventy-four removes a much respected figure from scientific circles in London, especially those connected with applied physics. He played a leading part in the development of important branches of that subject, including optics and geophysics, not only in their technical aspects but also in connexion with the relevant organizations, both academic and professional. In later years he gave much devoted service to the Royal Institution. He was a frequent lecturer there, and was honorary secretary during 1945–52.

Born in 1881, he was the son of the Rev. John Rankine, of Guildford, a Baptist minister, and started his education at the Board school at the age of four years. Later on, he attended Guildford Grammar School, whence he won a county major scholarship to University College, London, and graduated with first-class honours in physics in 1904. He was awarded the D.Sc. degree in 1910 for his published work, mostly on the viscosity of gases and associated studies of the dimensions of gaseous molecules.

He held a research appointment in University College during 1904–19, except for a period in the Admiralty Experimental Station, Harwich, during 1917–18, in which he worked on a method of telephonic communication by the modulation of a beam of light. He was made O.B.E. in 1919. After the First World War he accepted the post of assistant-professor of physics in the Imperial College of Science and Technology, South Kensington, being later promoted to a full professorship. His outstanding personal gifts, generosity and organizing capacity brought him into prominence, and when Prof. F. J. Cheshire (director of the Technical Optics Department) retired in 1925, Rankine was appointed to that post, which he held until 1931, when the Optics Department became a postgraduate branch of the Physics Department under Prof. (now Sir George) Thomson. About this time he became the last president of the Optical Society.

The great interest in optical research stimulated by the First World War had diminished, and the Optical Society lacked the resources to maintain it as an independent body. Under Rankine's guidance it was united with the Physical Society. (Perhaps the wisdom of this step was not fully apparent until some years later, when the Optical Group of the Physical Society was formed with his help and has continued increasingly to flourish.) Rankine was president of the Physical Society for the first two years after the union. He had always taken a keen interest in that Society as its honorary secretary (1923–29) and member of Council.

He was one of the founder fellows of the Institute of Physics and served on the Board in various offices, including that of honorary secretary and vice-president during 1923–37; also during 1943–47. His tolerance and level-headed counsel made him a highly valued member of committees, and a large amount of such work fell to his share, including various tasks in connexion with Section A of the British Association, of which he was president in 1932.

In the early nineteen-thirties, Rankine became interested in the rapidly developing subject of geophysics, and gave much help to the early development of related studies in the Imperial College. Various papers under his name on geophysical instruments were beginning to appear at the time of his election to fellowship of the Royal Society in 1934. He left the Imperial College in 1937 to become the chief physicist to the Anglo-Iranian Oil Company, in which capacity he paid several visits to Persia, encountering various adventures which he would describe in his own amusing way. Between 1942 and 1945 he was seconded to the Petroleum Warfare Department, in which connexion he had much to do with the development of 'Fido'—the use for fog-dispersal of petroleum vapour burners flanking landing strips on air-fields. A visitor to Earl's Court on a wintry day might find Rankine and his assistants wrapped in duffle-coats and working cheerfully in icy cavernous gloom with giant fans, rows of burners on the floor, and arrays of electrical thermometers to record the three-dimensional temperature distribution. It was a task for which his earlier researches on the viscosity of air had prepared him very well.

After service as visitor and manager, he was appointed in 1945 honorary secretary of the Royal Institution, a post which was to involve him, a few years later, in acutely controversial personal issues. Few will be disposed to deny the courage and tenacity with which he successfully maintained his position and views in the face of increasing difficulties and deteriorating health. The key to his general position on social issues lay in his early upbringing, and an instinct to support humbler ones against power and privilege. He had, as he said, a natural sympathy with the rebel, though he took his place easily and naturally in any *milieu*. His rare gift of friendship will make his loss widely mourned.

He married, in 1907, Ruby Irene, daughter of the late Mr. Samuel Short, of Reading, and had two sons and two daughters. L. C. Martin

Dr. A. L. Hall, F.R.S.

Arthur Lewis Hall, one of the foremost contributors to South African geology, died on August 13, 1955, at his home in Pretoria.

Hall was born on January 10, 1872, at Birmingham. A scholar of Gonville and Caius College and Harkness Scholar in geology at Cambridge, where later he also took his doctorate, he was appointed field geologist to the Geological Survey of the Transvaal in 1903. In 1915 he became assistant director of the Geological Survey of the Union of South Africa and in January 1932, on reaching the age limit, he retired from official duties after thirty years of devoted service to the State and to South African geology. He then busied himself as a consulting geologist, until his eyes began to trouble him and he was forced to withdraw from further active work in the profession in which he took such a lively interest and achieved so much.

Apart from general features, little was known of the geology of the Transvaal in 1903. Consequently, almost wherever his work led him, Hall found himself breaking fresh ground, and he can justly be counted among the able pioneers of South African geology. Most of his work was done in the eastern and north-eastern Transvaal in a much diversified country of rugged mountains and low-lying bush-veld. In the early days, field-work there was accompanied by many obstacles as well as a vast amount of fatiguing work that called for ingenuity, courage and the ability to overcome difficulties in order to achieve success. Hall, a great enthusiast and an energetic worker, possessed these qualities to a marked degree. His strong constitution and tenacity of purpose enabled him to produce the fine geological maps for which he is noted.

By his strenuous field-work, his detailed microscopical studies of large amounts of petrological material and other research work, Hall was able to make many important contributions to geology in the fields of pure as well as applied science, and thus exerted a lasting influence on geological development over a wide part of the Transvaal. He will be especially remembered for the leading part he played in the delineation of the Transvaal System and its relationships to other formations, his studies of the Archæan formations, his investigations of the country's mineral resources and, above all, his elucidation of that great igneous assemblage known as the Bushveld Igneous Complex, with its wide, contact metamorphic aureole. He conducted the Shaler Memorial Expedition and also the Bushveld excursion of the International Geological Congress through the northern and eastern parts of the Complex, when he was able to present "much important field-evidence to a phalanx of geologists that included the élite of international petrographical thought".

International geology was advanced by Hall's share in the deliberations during the sessions of the International Geological Congress held in Spain, the United States and Russia. The success of the Congress in South Africa in 1929, of which he was the secretary-general, was largely due to his organizing abilities.

The Geological Museum of the Geological Survey owes a very large part of its utility and attractiveness to his energy and care.

Hall was a past-president of the Geological Society of South Africa, a Fellow of the Royal Society of South Africa and of the Geological Society of London, a council member and president of the South African Geographical Society, a corresponding member of the Geological Society of America, and a regional vice-president of the Society of Economic Geologists, United States of America. His distinguished services to geology were recognized by his election as a Fellow of the Royal Society and as an honorary member of the Geological Society of South Africa, and in the award to him by the Geological Society of London of the Murchison Medal, and by the Geological Society of South Africa of the Draper Medal.

Socially, Hall was a man of distinct personality whose sterling worth and ability aroused the deepest respect and admiration among those who worked with him. He will be remembered as much for his intense humanity as for his geological prowess.

Louis T. Nel

Dr. E. C. S. Megaw, M.B.E.

By the sudden death of Dr. E. C. S. Megaw on January 25 at the early age of forty-eight, the nation has lost one of its most prominent scientists in the field of applied radio-physics.

Eric Christopher Stanley Megaw, the eldest son of a Belfast solicitor, was educated at Campbell College and The Queen's University, Belfast; and, after obtaining his B.Sc. degree in electrical engineering, he was elected to a research fellowship at the Imperial College of Science and Technology, University of London. While still a schoolboy, he became prominent among radio amateurs, and was reputed to be the first amateur in Ireland to receive signals from New Zealand on his home-made apparatus.

It was at the Imperial College that his scientific interest in the generation and use of very short radio waves was aroused; and, under the direction of Prof. C. L. Fortescue, he studied electronic oscillations in valves. He joined the staff of the Research Laboratories of the General Electric Co., Ltd., in 1930, and rapidly acquired a reputation as a result of his research on the magnetron short-wave oscillator. A paper on this subject read before the Radio Section of the Institution of Electrical Engineers in 1933 was awarded the Duddell Premium of the Institution. He also received the diploma of the Imperial College and later the D.Sc. degree of Belfast.

In the early days of the Second World War, Megaw, as a member of the staff of the General Electric Company, was, with his colleagues, working on behalf of the Admiralty and was closely associated with the design and development for production of the cavity magnetron, experimental models of which had been produced by Prof. J. T. Randall and Dr. H. A. H. Boot, working at the University of Birmingham. As is well known, the cavity magnetron was widely used on both sides of the Atlantic and it has been described as the biggest single inventive contribution towards the technical superiority which the Allies achieved over their enemies. Later in the War he began to investigate the propagation characteristics of radio waves on wave-lengths from a few metres to 3 cm. over both land and sea; and his active interest in this field of research continued up to the time of his death.

Dr. Megaw was appointed M.B.E. in 1943, and three years later he accepted the post of superintending scientist of the Radar Branch of the Admiralty Signal Establishment. Later he was appointed director of physical research in the Royal Naval Scientific Service; and although this involved him in an increasing amount of administrative work, his active interest in the scientific side of radio research remained.

He was the pioneer investigator in Britain who in 1950 directed attention to the propagation characteristics of very short radio waves by scattering in the troposphere, and the advantages, which are only now being realized, of the use of scattering technique in certain fields of communication. His theoretical and experimental work on this problem were assisted by reviewing the analogous case of the fluctuations of light waves transmitted through a turbulent atmosphere; and he used the subject of "Waves and Fluctuations" in his chairman's address to the Radio Section of the Institution of Electrical Engineers in October 1952.

For several years past, Megaw was an Admiralty representative on the Radio Research Board of the Department of Scientific and Industrial Research, and a member of its Tropospheric Wave Propagation Committee. His expert advice and assistance on these bodies will be greatly missed. But his reputation was by no means limited to Great Britain. He attended several General Assemblies of the International Scientific Radio Union in various European countries; and at these he made important contributions to the sessions concerned with tropospheric wave propagation. On such visits, as on all other occasions, he was a delightful companion with an enviable command of the local language, and a flair for knowing the best, inexpensive places for good food and wine. His interest in art, architecture and stained glass were also evident by the opportunities he seized when visiting foreign capitals. He is survived by his wife and two sons. R. L. Smith-Rose

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Dr. Megaw's outstanding ability was recognized in the Royal Naval Scientific Service by his promotion in one step from senior principal scientific officer to chief scientific officer, and his appointment as director of physical research in 1950. Although his previous researches had been mostly in radio, he soon showed that his skill was in no way limited to that field. He brought a freshness of outlook and keen understanding to a wide variety of problems, and his extraordinary energy enabled him not only to direct a formidable programme of research and development but also to initiate and play a direct part in one of its most successful projects. Although security considerations prevent any detailed account of this work being given at the present time, his place in the records of naval science is already assured.

Megaw was not only gifted as a scientist. He possessed personal qualities which contributed no less to the successful outcome of his endeavours. His integrity, sincerity, loyalty and friendliness, combined with a high sense of duty, made him an ideal leader. No one who had the fortune to work with him could have failed to gain inspiration and encouragement from his example.

Megaw will be sadly missed. The loss to naval science will be particularly felt at a time when men of his kind are so scarce. My own association with him was of the happiest, and I could not have wished for a truer friend or more loyal colleague.

H. F. Willis

Mr. D. J. Matthews

With the death at nearly eighty-three years of age of Donald John Matthews, the science of oceanography has suffered the loss of a man of very distinguished standing. He was born at Surbiton in July 1873, was educated at Marlborough and University College, London, and died recently at Camberley. His long life was filled with an astonishing variety of professional activities, and was marked by great skill with wireless, photography and microscopy as hobbies. It was in 1902 that he first took up oceanography when he entered the service of the Marine Biological Association of the United Kingdom, after having been for some years an analytical chemist and research chemist with the British Aluminium Company.

In his University College days, Matthews worked under Sir William Ramsay at the exciting time when the inert gases were being isolated. Letters exist in which Ramsay gives great credit to Matthews for working up the minerals which proved eventually to contain helium, refers to him as a most capable manipulator, and remarks upon his love of studying minute marine animals under the microscope. While at Plymouth, Matthews published some notable papers on the oceanography of the waters off the south-west of the British Isles. In 1913 he was engaged aboard S.S. *Scotia* on studies of the waters around Newfoundland to provide information upon which could be based action designed to lessen shipping risks in those waters. The cause was the *Titanic* disaster and the outcome the International Ice Patrol. After a short time spent working at Rothamsted Experimental Station around 1920, Matthews entered the Scientific Service of the Admiralty in the rank of principal scientific assistant, and was, until 1936, seconded to the Hydrographer of the Navy. It was as occupant of that post that most people will remember him, and it was during that service that he published his well-known "Tables of the Velocity of Sound in Pure and Sea Water for use in Echo Sounding and Sound Ranging". These tables have been an invaluable tool in many hands, and will doubtless be the chief monument of the kindly, quiet personality who was held in great esteem in oceanographical circles far beyond the bounds of his own country. Matthews, who was a widower, is survived by a son and three sisters.

J. N. Carruthers

NEWS and VIEWS

Physics at Newcastle upon Tyne:

Prof. S. K. Runcorn

DR. S. K. RUNCORN has been appointed professor of physics in King's College, Newcastle (University of Durham). He was educated at King George V School, Southport, and entered Gonville and Caius College, Cambridge, in 1941. He took the Mechanical Sciences Tripos in 1943 and later was awarded the John Winbolt Prize in engineering. During 1943–46 he worked in the Radar Research and Development Establishment of the Ministry of Supply at Malvern, particularly in the field of servomechanisms. He was then appointed assistant lecturer in physics in the University of Manchester and became lecturer in 1948. There, with several younger colleagues, he was mainly concerned with the first systematic study of the variation of the geomagnetic field below the Earth's surface. This work was carried out in coal mines down to a depth of 4,000 ft. His results show that the field increased downwards in a way which was in agreement with the hypothesis that the origin of the Earth's field lies in the deep interior of the Earth: thus excluding the 'bulk' theory initiated by Schuster and H. A. Wilson and recently further discussed by Blackett. In 1948 he was elected a Fellow of Gonville and Caius College and in 1949 became assistant director of research in the Department of Geodesy and Geophysics, University of Cambridge. Together with a group of colleagues he has been very active in the field of rock magnetism, studying both igneous and sedimentary rocks. This work has resulted in new evidence for reversals of the geomagnetic field and for polar wandering. To test the latter hypothesis, he has collected rocks in the United States of America. He has also made both observational and theoretical contributions to the understanding of the secular variation of the Earth's magnetic field and the origin of the Earth's general field. Under his stimulation a group of physicists has made important contributions to various aspects of the physical problems involved in this study: thus Dr. Hide has made some very interesting experimental investigations of the effect of rotation on convective systems. The results are of great interest, particularly in relation to meteorology. Other such work has been concerned with the electric conductivity and temperature of the Earth's mantle. Dr. Runcorn spent the summers of 1952 and 1953 as a research geophysicist in the University of California at Los Angeles.

Metallurgy at University College, Swansea:

Prof. A. R. E. Singer

As announced some time ago, the Steel Company of Wales and Messrs. Richard Thomas and Baldwins, Ltd., have together made a gift totalling £100,000 for developments in metallurgy at University College, Swansea. It is intended that these developments shall provide special facilities for the scientific study of casting, deformation, welding and other fabrication processes. This extension involves a type of physical metallurgy which can be called 'fabrication metallurgy', and it will be a special line of research and teaching within the existing Department of Metallurgy; the work will be directed by an additional professor.

Dr. A. R. E. Singer, senior lecturer and acting head of the Department of Industrial Metallurgy of the University of Birmingham, has been appointed to the newly created chair. Dr. Singer graduated with first-class honours at the University of Birmingham in 1938, and took his Ph.D. degree in 1946. During 1938–43 he worked in the Metals Division of Imperial Chemical Industries, Ltd., and was at first concerned with research and development in copper and brass, and then in the manufacture of aluminium alloy castings and wrought products. Until 1944 he was development engineer with Birmetals, Ltd., and engaged in establishing methods for the large-scale manufacture of wrought magnesium products, after which he returned to the University of Birmingham as head of a research team examining the welding of aluminium alloys. In 1946 he was appointed to the teaching staff and became responsible for designing, equipping and eventually managing the new Aitchison Laboratories. He is particularly interested in the principles of technical control in metallurgical manufacture and published a paper on this subject in the *Journal of the Institute of Metals* in 1953. His research publications have included work on the cracking of aluminium-base alloys, and special features concerning the plastic deformation of metals.

Birmingham College of Technology:

Mr. James Wilson

MR. JAMES WILSON is leaving the Birmingham College of Technology, where he has been principal for the past ten years, for the post of director of education and training of the British Motor Corporation. He went to Birmingham by way of the University of Glasgow and Coventry Technical College, and during his time at Birmingham he has seen the development of all the departments of the College cope with the greatly increased demands of this great industrial area. In addition to the problems of increasing numbers in higher level courses, provision has been made in a variety of subjects for special and postgraduate courses, an example of work of great and immediate value to people already in industry. Provision has also been made for 'sandwich courses', and there is a substantial and growing amount of research in most of the departments of the College. There has also been notable growth of studies in industrial administration. In the past few years the Birmingham Education Authority has been developing a very large extensions scheme which involves the Colleges of Technology, Art and Commerce, and it is certain that Mr. Wilson and his colleagues will have found their greater material facilities both an inspiration and the occasion for a great deal of planning. Last November H.M. the Queen and the Duke of Edinburgh inaugurated the new buildings and inspected those parts of the new buildings already finished. The College of Technology obtains considerable increased accommodation in these parts, and when the whole provision is available, Birmingham will possess one of the largest technological institutions in Britain. Mr. Wilson's new post is a sign of the times; but though technological education in his College will be well aware of its loss, it is nevertheless the case that such work as he is to do within industry will greatly help to make the best use of the education and training acquired in the technical colleges.

Dr. P. F. R. Venables

DR. P. F. R. VENABLES, who succeeds Mr. Wilson at Birmingham, went from Southend to the Royal Technical College, Salford, in 1947, and since then has contributed very greatly to the development of technical education not only in Salford but also in the north-western region and nationally. The Salford College has always been an important institution in the region, but during Dr. Venables's term of office it has grown in its service and influence. All its departments have increased their facilities to students, both full- and part-time, and in particular the 'sandwich system' has been established; it now has some 430 students, and this number is expected to grow to 1,100 in five years time. This system, in which students alternate periods in the College with periods in industry, shows that Dr. Venables has the full confidence of industrialists in the area, and it may be expected that this work will be an important contribution to the improvement of technological services in the region. But Dr. Venables's work has not been limited to his own area. In 1951 he visited the United States under the Fulbright Scheme to study the work of universities and technical colleges linked with industry, and to see schemes for industrially sponsored research. Since 1954 he has been chairman of the Regional Academic Board, which includes university, technical college and industrial members, and he is also a member of the National Advisory Council for Education in Industry and Commerce. He has also held high office in the Association of Technical Institutions and in the Association of Principals of Technical Institutions. He has recently published an authoritative book, "Technical Education" (see *Nature*, Feb. 18, p. 296), and holds a Leverhulme Research Fellowship to study "Education and Training Schemes in certain industries with special reference to the work of technical colleges and the needs of smaller firms". He was vice-chairman of the national committee which produced the report on "Liberal Studies in a Technical Age". He is leaving Salford after having devised and started an extension scheme expected to cost £1,500,000. He will be greatly missed in the region on account of his knowledge, energy and good fellowship.

Edward Goodrich Acheson (1856–1931)

Edward Goodrich Acheson was born on March 9, 1856, at Washington, Pa. Of Scottish and English ancestry, he died in 1931, and during his life was granted patents for seventy inventions. Outstanding were an industrial method of producing silicon carbide electrothermally (1891), the manufacture of graphite from a coke base in the electric furnace (1893) and the manufacture of pure graphite of high crystallinity (1896 and 1900). Having prepared pure graphite in the electric furnace, Acheson turned his attention to means of disintegrating it and preparing colloidal dispersions. He succeeded in this (1906–7) and made available stabilized dispersions of graphite for lubrication. Colloidal graphite is used to-day to aid the lubrication of mechanical equipment of all kinds, in filament wire drawing and for the production of electrically conducting coatings. At the 150th anniversary of the signing of the Declaration of Independence in 1926, the United States Post Office exhibited seventeen patents of E. G. Acheson which had benefited industry. The Smithsonian Institution has a permanent Edward Goodrich Acheson Exhibit, showing products springing from his inventions and the medals awarded to him. He was awarded the Rumford Medal of the American Academy of Arts and Sciences (1908), the Perkin Medal of the American Section of the Society of Chemical Industry (1910), and the University of Pittsburgh conferred on him the honorary degree of doctor of science in 1909. The present annual world production of silicon carbide for machining and grinding runs into many thousands of tons, with plants in more than twenty countries. Electric furnace graphite in electrode and powder form, made by Acheson's process, is produced in very large quantities, in Britain, the United States, France and other countries. It was this pure form of graphite that was used as moderator in the first nuclear reactor in the world to be built, at Chicago. At one time Acheson was an assistant to Thomas Edison at Menlo Park and carried out development work on early incandescent lamps, while he installed the first electric lighting system in Europe, at Milan. He lived for some time in London.

Recent Solar Activity

Two streams of large sunspots, in latitudes 20° N. and 20° S., were visible on the Sun's disk during February. The total area of sunspots on February 20 was greater than that of any day since 1947, the previous sunspot maximum year. The most recent sunspot minimum occurred during the first half of 1954. Since that time sunspot activity has, with the usual variations, increased steadily, and about twenty-five sunspot groups have exceeded in area 500 millionths of the Sun's hemisphere within the past fourteen months. The mean daily sunspot number for the months November 1955–February 1956 has been around 90. The steepness of the rise in the sunspot cycle is believed to indicate the 'height' of the coming maximum, so that if sunspot activity continues to increase, mean daily sunspot numbers in excess of 150 may be expected by the end of 1956. The actual epoch of sunspot maximum would probably occur during the first half of 1957.

On February 23 at 0330 hours U.T., a large flare was observed on the Sun from an Indian observatory; it lasted until 0510 h. Complete Dellinger-type 'fade-outs' of radio circuits from Hong Kong and Singapore occurred between 0345 h. and 0500 h., such as are normally associated with the ultra-violet light from a large flare. A large increase of cosmic-ray flux was simultaneously recorded by many types of recorders in different parts of the world. A sea-level meson recorder in Great Britain showed a 100 per cent increase in counting-rate starting during the ten-minute period 0340–0350 h. Previous increases associated with solar flares on similar instruments have only rarely occurred and have never exceeded 40 per cent. The flux gradually diminished and normal counting-rate was resumed two to three hours later. Lower-energy cosmic radiation probably continued to arrive from the Sun.

Research in Industry and Government

In the third E. F. Armstrong Memorial Lecture to the Royal Society of Arts, given on November 23, Dr. B. K. Blount, deputy secretary of the Department of Scientific and Industrial Research, reviewed the growth of research in industry in Great Britain, describing the general form of the organization it had taken, and discussed some of the implications. Fundamental research, he thought, is best done in the universities; but applied, or industrial, research is best done directly by industry in its own laboratories, and the more this work is located physically within the industry the better service it will give. In particular, only thus will the research really correspond with what industry needs, and while research done in a firm's own laboratory is seldom wasted, Dr. Blount is less certain about the adequate exploitation of that carried out in research associations or by other co-operative bodies. There is sometimes, as with the Therapeutic Research Corporation, the danger that member firms will only agree to the pursuit of lines of research in which they are not greatly interested. For a similar reason, Dr. Blount is critical of the location of research departments away from the factory; they are liable to miss the stimulus which an industrial enterprise, of which they are obviously part, can give, and at the same time are lacking in the inspiration that location in a university atmosphere can supply. Nevertheless, Dr. Blount thinks that there will always be much industrial research which requires organization co-operatively and that the research associations will have a place of continuing importance. With regard to government research, he thinks that every effort should be made on the civil side to transfer to industry or the research associations any investigations which they can properly handle; but just as industrial research requires to be located within industry for its efficient operation, so he would expect it to be necessary for a growing volume of government research to be located within the government organization. In regard to research management, Dr. Blount stressed the importance of the research manager, himself a scientist, not only having the greatest practicable freedom but also the fullest opportunity of understanding the outlook and interests of his fellow executives.

Nuclear Physics

A NEW monthly journal, *Nuclear Physics*, edited by Prof. L. Rosenfeld, of the University of Manchester, has been launched by the North Holland Publishing Co., Amsterdam, and Interscience Publishers, Inc., New York (1, No. 1; 1956. Subscription per vol. of about 700 pages: 53 fl., 14 dollars, 106*s*.; postage 8*s*.), and an important feature of it is its international character; this is ensured by the composition of its editorial board, which includes representatives from twenty-three countries where nuclear studies are pursued, including the U.S.S.R. and Hungary. The new periodical is devoted to the experimental and theoretical study of atomic nuclei, nuclear fields and the fundamental aspects of cosmic radiation and should prove an important and valuable addition to the rapidly growing number of scientific periodicals specializing in the field of nuclear energy. The first number contains five original articles and a progress report by P. H. Fowler (University of Bristol) describing the new results on elementary particles which were discussed at the Pisa conference held last June. R. K. Gupta and S. Jha (Tata Institute of Fundamental Research, Bombay), in their article on studies with the scintillation spectrometer, give a brief account of a single-crystal spectrometer (thallium-activated sodium iodide crystal), its calibration and its use for the examination of the gamma-ray spectrum of iodine-128. In another article E. P. George and G. S. Shrikanta (University of Sydney) present results of their observations of the energy spectrum of the cosmic radiation below ground. The underground exposures of Ilford nuclear research emulsions were made in a disused tunnel of the underground railway station at Holborn, London, at a depth equivalent to 57 m. of water. It is concluded that any explanation of the observed frequency of large-angle scatters of cosmic-ray particles underground in terms of a significant departure of the momentum distribution from that usually assumed can now be ruled out.

The editor adds a note on nomenclature to be used in the new periodical. The word 'electron' is to be used for particles with an elementary charge of either sign, and 'positon' and 'negaton' when it is desirable to emphasize the sign of the charge. The expressions 'isobaric spin' and 'isobaric quantum number' are to replace 'isotopic spin' and 'isotopic quantum number', respectively, and the latest nomenclature adopted by international agreement will be used for the elementary particles.

Cancérologie: New French Journal of Cancer Research

A NEW journal, *Cancérologie*, has been launched by the Anti-Cancer Centre at Lille to provide facilities for the publication of original papers by members of its staff and more particularly for the publication of more general papers, not usually acceptable to other cancer journals, given at annual symposia in the Centre. Emphasis is placed on the importance of these symposia for the communication of the results and ideas of a team of workers covering a wide range of clinical and laboratory observations on cancer. In the first number (pp. 98; from the Cité Hospitalière, Lille) many of the papers give convenient and adequate summaries and discussions of varied topics without aiming at the detailed analysis and documentation provided by other periodical reviews of cancer research. These will be of much more than local interest, especially to the general reader; the expert will often need to refer to other sources for fuller information and more complete references. Within the limits set by its editors, the journal therefore seems likely to fulfil a useful purpose.

A Large Sea Bass

A SPECIMEN of what may be the world's largest species of sea bass has just been added to the collections of the Smithsonian Institution. It is a 337½ lb. fish, 78½ in. long, the third of its kind caught near the Eniwetok Atoll in the South Pacific. The great sea bass is challenged for size only by some sharks and some members of the tuna family. The largest of the Eniwetok specimens weighed 414 lb. and was more than 81 in. long. This particular fish (*Promicrops lanceolatus*) has been well known for many years to northern Australians and is highly prized for food; but this is the first record for the Marshall Islands. It ranges from the South Pacific islands to Hawaii and the Red Sea and is closely related to the giant sea bass of the Atlantic and eastern Pacific known as the jewfish. The fish is related to the freshwater large-mouthed bass of the eastern United States but belongs to a different family. It is a deep-water fish and apparently an omnivorous eater.

Studies on Benjamin Franklin

THE American Philosophical Society has devoted an issue of its *Proceedings* (99, No. 6; December 1955) to "Studies on Benjamin Franklin" in celebration of the two hundred and fiftieth anniversary of his birth. Prof. W. E. Lingelbach discusses the relations of the Society with Franklin's writings and also "The Papers of Benjamin Franklin", a new edition of his writings now being prepared for publication under the auspices of the Society and Yale University. W. J. Bell, jun., writes on Franklin's relations with the German charity schools, E. Wolf on Franklin's Stamp Act cartoon, and Prof. C. W. Miller on "Franklin's Type: its Study Past and Present". R. L. Kahn contributes three Franklin–Raspe letters, and C. C. Sellers a note on Jane Mecom's little picture of Franklin. Kahn also writes on Franklin's relations with Grimm and J. H. Landolt, E. Dvoichenko-Markov on those of Franklin with Count M. A. Benyowski, and Prof. A. Pace on "The Franklin–Volta Correspondence: Legend or Fact ?". A long article by Prof. G. Chinard deals with "The Apotheosis of Benjamin Franklin, Paris, 1790–91".

Under the title "Panorama of Progress", the Franklin Institute has issued the January number of its *Journal* in honour of Benjamin Franklin. The most important of the international celebrations during the year are outlined by C. L. Jordan, chairman of the Anniversary Committee, and Prof. W. E. Lingelback writes on Franklin and the scientific societies. The remaining papers, which are planned to give a broad picture of the advances made in the physical sciences (pure and applied), in the social sciences and in economics since the birth of Franklin, are as follows: changing concepts in science (Lord Adrian), Franklin and one Plutonic year (Prof. Harlow Shapley), pioneers in electrical communications (E. Perucca and V. Gori), how medicine became a science (Sir Zachary Cope), Franklin and the unconquered fields of medicine (P. Lépine), Franklin's impetus to education (G. P. Harnwell), food and the future (D. P. Cuthbertson), science and agriculture (F. E. Bear), some aspects of Franklin's life in England (E. N. da C. Andrade) and Franklin the business man and apostle of free and competitive economy (M. L. Musante).

Zoological Nomenclature

THE International Commission of Zoological Nomenclature will start voting, as from June 30, on the following cases involving the possible use of its plenary powers: (1) *Bithynia* Leach, 1818 (cl. Gastropoda), validation; (2) *Osmerus* (cl. Pisces) as from Linnæus, 1758, validation; (3) *Phillipsinella* Novák, 1886 (cl. Trilobita), validation; (4) *Gempylus* Cuvier, 1829, and *serpens* Cuvier, 1829 (*Gempylus*) (cl. Pisces), validation; (5) Seguenziceratidae Spath, 1924 (cl. Cephalopoda, Order Ammonoidea), suppression; (6) *Lepisma* Linn., 1758 (cl. Insecta), gender for; (7) *Pagurus* Fab., 1775, and associated family-group name (cl. Crustacea, Order Decapoda), suppression. Full details have been published in the *Bulletin of Zoological Nomenclature* (11, Pts. 9 and 10; December 30, 1955).

In addition, an application is being made (*Bull.*, 9, Pt. 12; January 1956) for the use of the plenary powers in the following case: Curtis, 1837, 2nd ed. of "Guide Arrangement Brit. Ins.", suppression of, for the purpose of selection of type species of genera. Comments should be sent as soon as possible to the secretary to the Commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

British Glaciological Society: Annual General Meeting

THE British Glaciological Society held its annual general meeting on December 8 in Bedford College, London, when a report was given on the Society's activities and its financial position during the past year. On behalf of the Society, Dr. G. C. L. Bertram presented an inscribed silver tray to Mr. Gerald Seligman in recognition of his long and continuing service to glaciology; Mr. Seligman has been president of the Society since its foundation in 1936 as the Association for the Study of Snow and Ice, and editor of the *Journal of Glaciology*.

A general discussion was held on the "Future Lines of Progress in Glaciology", and a full account will be published in the *Journal of Glaciology* (all contributions should be sent to the Editor, Little Dane, Biddenden, Ashford, Kent). The following were elected officers of the Society for 1956: *President*, G. Seligman; *Vice-Presidents*, J. M. Wordie, W. V. Lewis and K. Sandford; *Secretary for Scotland*, P. D. Baird; *Honorary Treasurer*, G. C. L. Bertram; and *Secretary*, Mrs. H. Richardson (c/o Scott Polar Research Institute, Lensfield Road, Cambridge).

Perkin Centenary Celebration

DURING May 7–10 the centenary of the production by W. H. Perkin of the first synthetic dye will be celebrated in London as follows. On May 7 overseas delegates to the Perkin Centenary Celebration will be received in the City of London at the Hall of the Worshipful Company of Tallow Chandlers. Four lectures will be given at the Royal Institution, Albemarle Street, London, W.1, and the first of these, "The Life and Work of Perkin", by Prof. John Read (University of St. Andrews), will be given in the afternoon of May 8, followed in the evening by a reception to delegates and guests at the Guildhall in the City of London. On the morning of the next day, Mr. Clifford Paine (development director, Imperial Chemical Industries, Ltd.) will give the second lecture, his subject being "The Development of the Dyestuffs Industry", and in the afternoon Mr. J. G. Evans (technical director of the Bradford Dyers' Association), speaking on "The Tinctorial Arts To-day", will give the third; the Perkin centenary banquet will be held in the evening, at the Dorchester Hotel, when the president of the Perkin Centenary Celebration, Sir Cyril Hinshelwood (president of the Royal Society), will be in the chair. On May 10 the fourth lecture, "The Development of Organic Chemistry since Perkin's Discovery", will be given by Sir Alexander Todd (University of Cambridge).

Domestic Heating in Great Britain

THE subject of domestic heating in Great Britain, which is of particular interest at the present time in view of the great changes that will be brought about by the forthcoming Clean Air Act and the programme of slum clearance, will be discussed at a conference arranged by the Institute of Fuel, to be held in the Assembly Hall of Church House, Westminster, London, S.W.1, during May 1–2. The first session will deal with fuels, including the possibilities of the production of smokeless fuel from coals hitherto considered unsuitable. The next three sessions will deal, respectively, with the design and application of appliances, the design of dwellings, and the planning and administration of smoke-control areas. The conference will end with a summing-up by a *rapporteur*, followed by open discussion. The sessions will be open to the public without charge. For enrolment as a member of the conference, non-members of the Institute of Fuel will be charged a fee of one guinea (half a guinea for those belonging to various participating bodies). Enrolment forms and further information can be obtained from the Secretary of the Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1.

Announcements

Prof. and Mme. Bernard Pullman, of the Theoretical Chemistry Laboratory, University of Paris, have been awarded the E.S.S.E.C. Prize for cancer studies (of value 1 million francs) for 1956 by the Ligue Française contre le Cancer. The award has been made for their work on the correlation between electronic structure and carcinogenic activity of molecules, and in particular for their book "Cancérisation par les Substances Chimiques et Structure Moléculaire" (Masson, Paris, 1955).

Dr. A. H. Sully, associate director of the British Steel Castings Research Association, has been appointed director of research in succession to Prof. R. J. Sarjant, who will continue to act in an advisory capacity to the Association.

The following have been appointed to lectureships in the University of Sheffield: R. Kilpatrick (pharmacology) and Dr. R. H. Tredgold (physics).

The following appointments have been made in the University of London: Dr. L. Pincherle, to the University readership in physics tenable at Bedford College; Dr. T. J. Williams, to the University readership in mechanical engineering tenable at King's College.

A symposium on "The Presentation of Science to the Public" is to be held in the Senate House, University of London, on March 21, under the chairmanship of Mr. A. L. Bacharach. The symposium is being organized by the Institute of Biology, the Royal Institute of Chemistry and the Institute of Physics. Principal speakers will be Dr. Archie Clow (B.B.C. Science Survey), Mr. A. W. Haslett (*The Times* Science Review) and Mr. J. McCloy (B.B.C. Television). Further information can be obtained from the Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

The annual general meeting of Science for Peace, to be held in the Holborn Assembly Hall, John's Mews, London, W.C.1, on March 10, will be followed (2–6 p.m.) by a public conference on "The Atomic Age—Perspectives and Problems". The speakers will include Prof. J. B. S. Haldane (on genetic effects of radioactive substances), D. G. Arnott (on the new outlook since the Geneva Conference), Prof. J. D. Bernal (on prospects for science in a world at peace) and Dr. E. H. S. Burhop (report of a sub-committee on disarmament). Tickets for the conference (price 2*s*. 6*d*.) can be obtained from Mr. B. Hayes, 72 Doneraile Street, London, S.W.6, or at the door.

The Institution of Chemical Engineers is holding a symposium and exhibition on "Modern Techniques in Chemical Plant Construction" on March 21 in the University of Birmingham. The papers at the symposium will cover three topics: some special constructional materials, with particular reference to their use by fabricators; fabrication and testing; and plant manufacture and erection. Further information can be obtained from M. G. D. Bailey, 1 Wentworth Gate, Harborne, Birmingham 17.

A symposium on the "Applications of Infra-Red Spectroscopy", organized by the Society of Chemical Industry, will be held in the William Beveridge Hall of the University Senate House, London, W.C.1, during April 9–10. A small exhibition on the same theme will be held in the Department of Chemical Engineering, University College, London. The fee for the symposium is £3 for non-members, and 10*s*. for members, of the Society. Application forms and further information can be obtained from the Assistant Secretary (Infrared Symposium), Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

The Ministry of Agriculture, Fisheries and Food and the Department of Agriculture for Scotland are offering a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering, for the academic year 1956–57. The closing date for applications is March 31. Further information can be obtained from the Secretary, Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, London, S.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

Applications are invited for Lady Tata Memorial Fund grants, scholarships or fellowships from scientific workers of any nationality for research on diseases of the blood, with special reference to leukæmia, or any aspect of malignant disease connected with leukæmia, during the academic year October 1956–57. Grants are for research expenses: scholarships for personal remuneration (usually £600); and fellowships for workers with considerable research experience (£1,000). Application forms, to be returned by March 31, and further information can be obtained from the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, Chester Beatty Research Institute, Fulham Road, London, S.W.3.

Two scholarships tenable at research institutions in France during the academic year 1956–57 are being offered to British workers in medical science by the Medical Research Council on behalf of the Centre National de la Recherche Scientifique. They are intended for young graduates in medicine or science who have already had some experience in a branch of medical science, and are worth 50,000–70,000 francs a month, with a supplementary allowance (payable in sterling) for married men. A working knowledge of French is essential. Application forms, to be returned by March 31, and further information can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

To mark the completion of ten years of publication of the journal *Weather*, the Royal Meteorological Society is offering a prize of forty guineas for an essay of about five thousand words in English on "The Place of Meteorology in Liberal Education". Additional prizes may be awarded, and for these particular consideration will be given to entries from persons less than twenty-five years old. Entries must be sent in by December 31 to the Royal Meteorological Society, 49 Cromwell Road, London, S.W.7.

About £30 is available from the Clough Memorial Research Fund of the Edinburgh Geological Society for geological research in Scotland and the north of England (Northumberland, Durham, Cumberland, Westmorland and Yorkshire) during the period April 1, 1956–March 31, 1957. Applications for grants must be sent before March 31 to the Secretary, Clough Memorial Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh 1.

Erratum. In the letter by C. H. Vincent on "The Gas Multiplier: a New Type of Electron Multiplier", published in *Nature* of February 25, p. 391, in the third and fourth lines for ". . . a highly stable electron-multiplication factor" read ". . . a high stable electron-multiplication factor".

COLONIAL RESEARCH IN THE BRITISH COMMONWEALTH*

The tenth annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research records total commitments of £2,042,000 for research in this field from Colonial Development and Welfare Funds from April 1, 1946, to March 31, 1954, although new grants during the year under review amounted to only £133,156. Of the approximately £8 million available for research for the period 1955–60, £2,730,000 has been allocated for agricultural, animal health and forestry research. With the completion of building activities and the assembly of additional specialists, research activities generally have increased, and the fruits of earlier work are now appearing with increasing frequency. Tribute is again paid to the large amount of willing assistance received from research institutions and specialists in the United Kingdom, and the collaboration between British and foreign specialists in tropical countries. The East African Agricultural and Forestry Research Council has been established, with wide powers of control over inter-territorial research in these fields, while the work of the East African Agriculture and Forestry Research Organization on soil-moisture relations and rainfall reliability is yielding valuable results in the control of water on large catchments, forest cover and erosion control and on crop-husbandry methods in areas of precarious rainfall. Much research into fertilizer requirements of tropical soils is proceeding, but a lot remains to be learnt about the nitrogen cycle under tropical conditions. Research in Northern Nigeria and Uganda has revealed a deficiency of sulphur in many areas which is limiting crop yields, particularly of groundnuts. The adoption of new techniques for micronutrient assessment has shown that in the Gambia and Uganda deficiencies of elements such as copper, molybdenum and boron that are required only in trace amounts may be curtailing crop yields.

Satisfactory progress has been made with soil surveys required for development plans, notably in British Honduras, Nigeria, Gold Coast, North Borneo, Aden and Somaliland. Much attention was given to cocoa, and the Cocoa Marketing Boards of Nigeria and the Gold Coast made further large grants to the West African Cacao Research Institute. The cocoa trade has accepted the very high-yielding Upper Amazon selections in West Africa as conforming to its quality requirements, so that these valuable types can now be issued to farmers, while very promising results have been obtained in breeding superior types of cacao. Research on swollen-shoot disease covered the migrations of mealybugs, which transmit the disease, the wild hosts of the virus and chemical methods for detecting latent infections. African farmers are now controlling black-pod disease of cacao in Nigeria; but control in the Gold Coast is less satisfactory. Notable features of the work of the West African Institute for Oil Palm Research are the studies on the nutrition of the palm and on diseases due to potash and magnesium deficiencies; a substation of the Institute was opened in Sierra Leone for the study of local problems. Promising new material was discovered in New Guinea by the Banana Collecting Expedition from the Imperial College of Tropical Agriculture, Trinidad, sent out in September 1954 as part of the long and complex breeding programme directed towards combating banana-diseases, while the cotton-breeding work and crop-husbandry trials of the research stations maintained chiefly by the Empire Cotton Growing Corporation have yielded extremely valuable results. Among plant selections valuable to farmers singled out in the report are improved groundnuts in Nigeria and Tanganyika (where forms resistant to rosette disease have been bred), new cottons for Uganda, Nigeria and Tanganyika, sugar-canes for British Guiana, Barbados and Mauritius, better sorghums for Nigeria, Gold Coast and Tanganyika, coffee selections in East Africa, rubber resistant to South American leaf blight, and maize resistant to South American rust.

Other work emphasized in the report includes that on pepper disease in Sarawak, leaf scald on sugar-cane in British Guiana, broadbean wilt in Cyprus, *Alternaria* leaf-spot disease of tobacco in Northern Rhodesia and Nyasaland, potato blight in the Cameroons and leaf-spot of bananas in the West Indies. The work on insect pests includes the control of coreid bugs attacking coconuts in the Solomon Islands Protectorate and Zanzibar, midges attacking millet in West Africa, rhinoceros beetles on coconuts in the Pacific area, termites in East Africa, longicorn beetles attacking cocoa in Grenada, aphis transmission of dieback of limes in the Gold Coast, and American bollworm on cotton in Tanganyika. Steady progress is being made with the Floras of Tropical East Africa, West Tropical Africa and Malaya, and preliminary work has been started on new Floras for Cyprus and the Central African region ("Flora Zambesiaca").

Veterinary research has been concerned particularly with the production of safe and effective vaccines for protection against rinderpest. The East African Veterinary Research Organization took over the manufacture of biologicals for the East Africa and Sudan regions during the year, and the research laboratories at Vom (Nigeria) continued to supply most of the needs of the West Africa region. Research is still needed to perfect the vaccines, and increased attention was given to tick-borne diseases, particularly East Coast fever, and to methods of tick-control on cattle, while studies on the African liver fluke and its intermediate snail host continued. At the Joint Animal Industry Division of the East African Agriculture and Forestry Research Organization and the East African Veterinary Research Organization, studies continued into the technique for measuring grassland productivity and into the accuracy of feeding trials, while studies of stock-raising on the intermediate savannas of British Guiana at the Ebini stock farm indicated deficiencies of cobalt and molybdenum as well as of phosphorus. Comparative studies in Fiji on heat tolerance in European and Zebu stock showed variations within breeds as great as between them, and in the Gold Coast, Nigeria and Northern Rhodesia investigations of cutaneous streptothricosis continued. Results are slowly emerging from the long-term animal breeding studies, and the commercial production of livestock in tsetse-infested areas with the aid of chemotherapy and controlled management and feeding was studied in Nigeria and Kenya, while studies of animal management in relation to cropping systems in African territories generally are pointing the way to more efficient farming methods. Extended investigations into pastures for tropical and sub-tropical areas were made in Northern Nigeria, Kenya, Trinidad and Fiji, and the work on nodulation of legumes in Kenya is of particular interest in relation to the nitrogen in tropical soils.

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* Continued from p. 368.

Methods of forest regeneration were investigated in many territories, with particular attention to the use of non-toxic hormone preparations for killing tree-weeds in Uganda. Sylvicultural research in Cyprus for the regeneration of mountain forests and on eucalypt forests in the lowlands was extended. Forest-flora was investigated in Malaya and North Borneo, and the systematic botany of the Malayan region is now associated with the larger project for a new "Flora Malasiana" progressing under Dutch auspices. Failure of natural regeneration in juniper forests in Somaliland is now attributed to microclimatic changes following over-grazing, and considerable progress was made by a research unit in West Africa in assessing damage from boring beetles in felled timber in relation to species, seasons and bark removal.

The eighth annual report of the Colonial Insecticides, Fungicides and Herbicides Committee includes the usual account of the work of the Colonial Insecticide Research Unit at Porton, which was brought up to full strength by recruitment of an entomologist and a physicist, although the recruitment of a suitably qualified and experienced staff for employment both at home and abroad still presents some difficulty. Nevertheless, it is expected that the nucleus of younger scientists trained in the special techniques applicable to insecticide research now being built up will, in a few years, provide a pool of experienced men capable of taking charge of new units or projects and directing investigations. At Porton, investigations on the loss of effectiveness of insecticidal deposits from aqueous suspensions applied to mud walls have shown that loss of toxicity is due to rapid adsorption of the insecticide by the mud; and a survey of soils from various parts of the world showed that red lateritic soils are most active in adsorbing insecticides. No practical method was found of abolishing or reducing the adsorptive properties of Uganda soil. Studies of insecticidal surface coatings showed that the rate of loss of volatile insecticides from non-crystallizing films depends on the plasticizer urea–formaldehyde resin ratio and that the effectiveness of other synthetic resins as carriers for insecticides depends largely on the rate and extent of both hardening and permeability of the films. At the Imperial College Field Station, Selwood Park, investigations on the penetration of the insect integument by DDT solutions in lanoline showed that, in tropical application to *Protophormia terraenovae*, a fraction of the absorbed insecticide is taken up directly by the tissues, and experiments with oily deposits of 20-μ DDT crystals on an absorbent surface have now shown that the availability of particles to walking flies decreases logarithmically as the proportion of oil in the deposit increases. Studies on the persistence of insecticide deposits on glass plates and foliage continued at Rothamsted and investigations at Long Ashton on the tenacities of copper fungicides were completed in September 1954. In April 1954 the Committee took over from the Agricultural Research Council the preparation and publication of the Abstracts and News Summaries dealing with insecticides and herbicides, and plans for the publication of Fungicide Abstracts and News Summaries were also in hand.

The research unit at Arusha continued its investigations on the control of tsetse flies and mosquitoes, and the work with experimental huts at Taveta, now concluded, has shown that dieldrin at 30–40 mgm. per sq. ft. needs renewal at six-monthly intervals, irrespective of surface, but at 70–80 mgm. per sq. ft. persists for seventeen months on a mud and sand plaster. Extensive tests by the Insecticide Research Unit at Ilonga have shown that the main cotton pests (American bollworm and cotton aphis) can be controlled with a DDT/BHC mixture or endrin, but such control is unlikely to give profitable increases in yield on the peasant crop until standards of local agriculture have been improved. A programme of research on the distribution and bionomics of dipterous flies in Uganda was started in September 1954, and the Committee has also assumed responsibility for chemical investigations in connexion with the Western Sokoto Malaria Control Project in Northern Nigeria. The study of the ecology and habits of *Anopheles gambiae* in Mauritius continued, as well as the investigation in Fiji of the incidence and behaviour of mosquitoes and the determination of the vectors responsible for the transmission of filariasis. Research on the use of herbicides, arboricides and defoliants in East Africa was extended, and promising results were obtained with defoliants as an aid to tsetse-eradication. The report also directs attention to research in this field proceeding in the Colonies without the assistance of the Committee, such as that in Barbados on the control with soil insecticides of pests attacking the roots of sugar-cane, the promising results obtained in British Guiana with nicotine and chlordane sprays against *Castria daedulus* on coconuts, the extended campaign on the Gold Coast for control of *Sesamia* spp. and *Busseola fusea* in maize, that on the resistance of *Culex fatigans* to BHC in Penang, on the eradication of dhub grass (*Cynodon dactylon*) with sodium trichloroacetate at Samaru, Northern Nigeria, and on the control of the white stem borer (*Anthores leuconotus*) on coffee in Tanganyika with dieldrin.

The eighth annual report of the Colonial Economic Research Committee records studies at the West African Institute of Social and Economic Research of the working of the Niger Agricultural Project and of Gold Coast cocoa farmers' incomes with special reference to the abusa system, while the Economic Research Unit of the University College of the Gold Coast has completed the first stage of the periodical field investigations into movements of foodstuffs in the Accra region and has undertaken an economic survey of housing schemes in four main towns on behalf of the United Nations Mission. The Industries Branch of the Federal Department of Commerce in Nigeria has examined the economics of establishing fibre- and pulp-material industries, the production of gari and the operation of small craft, and the Commission for Technical Co-operation in Africa South of the Sahara and its scientific advisory council are taking an increasing interest in promoting inter-African co-operation in social and economic research.

The Tsetse Fly and Trypanosomiasis Research Committee has decided to set up special panels to deal with chemotherapy and with cartography and to advise on personnel questions. Its report for the year ended March 31, 1955, records that the problem of staffing the East African Tsetse and Trypanosomiasis Research and Reclamation Organization's new laboratory at Tororo is being overcome, that the East African Governments have agreed in principle to transfer the headquarters of the Organization to the Central Trypanosomiasis Research Laboratory there and that the title of the Organization is to be changed to "The East African Trypanosomiasis Research Organization". Much attention is being given at the Shinyanga laboratory to respiration and water exchange in *Glossina*, and it is intended to link research on the trypanosomes as closely as possible with research on the vector. The Mariakani experiment on the use of 'Antrycide' prosalt as a prophylactic has shown that cattle treated while under attack from tsetse with injections of the pro-salt every two months for more than two years acquired a resistance both to a local and an imported strain of *T. congolense*, which persisted for eighteen months after treatment ceased, and the experiment is being repeated on a larger scale at Kiboko in co-operation with the Kenya Veterinary Department. The Lambwe Valley settlement continued satisfactorily; an investigation into the effect of the arboricide 2.4.5-T on freshly cut stumps of thicket suggests that this substance may be of practical value in preventing regeneration, and in Ankole discriminative clearing against *G. morsitans* is going well.

An information bureau has now been completed at the Kaduna laboratories of the West African Institute for Trypanosomiasis Research. The Institute has collected data on the nature and spread of human trypanosomiasis in Ogoja Province, where the disease is characterized by a rapid invasion of the central nervous system, and measurements of a considerable series of blood sedimentation-rates for active cases of sleeping sickness confirm that the mean rate is exceptionally high in this condition and that the immediate effect of treatment with 'Melarsen' is to reduce the rate by about one half. Trials carried out in Benue and Ogaja Provinces in collaboration with the Nigerian Sleeping Sickness Service indicate that 'Melarsen' is well tolerated by patients treated under dispensary conditions. Further work on the establishment of *T. vivax* in rats suggests that clean serum provides a substance which protects the trypanosome from the rat's antibodies, that the active factor is present in lipid-free serum and that it is a component of serum protein. The cyclical transmission of *T. congolense* by *G. palpalis* was being studied, but investigations on the use of the curative and prophylactic salts of 'Antrycide' have passed largely from the laboratory to the field, although some work has been done on resistance to 'Antrycide'. Trials with a dose of 1 mgm./kgm. of 'Ethidium' bromide cured infections in Zebu cattle which had been produced by a blood-inoculated strain of *T. vivax*. At the Ugbobigha Field Station in Southern Nigeria, although the effects of topography and vegetation on the local distribution of the eight species of tsetse found in the vicinity of the Station was being mapped, research has been confined to *G. palpalis* and *G. longipalpis*. A pilot scheme has been initiated to assess the value of obstruction clearing as a practical measure of tsetse control. No major research into game or game conservation was undertaken, but the fact-finding survey of the major game species in Africa and the biological study of Thomson's gazelle in Tanganyika were nearing completion.

The annual report on fisheries research for 1954–55 of the Colonial Fisheries Advisory Committee reports that the allocation for fisheries research for 1955–60 is £930,000 and that the four vacancies for fisheries research officers at existing research stations should be filled during the coming year. The Inter-Territorial Fisheries Research Station at Jinja, Lake Victoria, has identified twenty species of *Tilapia* occurring in East Africa, and, as a result of ecological investigations which led to the discovery of several species of fish that feed mainly on snails, some of these species have been introduced successfully into dams, where they can be grown together with *Tilapia*. Work on the ecology and physiology of snails has shown that they play a valuable part in the biological economy of both large and small bodies of water. The East African Marine Fisheries Research Organization continued and expanded its work on the bottom fishes and the hydrography of the area, obtaining evidence that the stratification of the Indian Ocean in the deep waters extends right to the fringing reefs, while the data accumulated defining the water layers and changing depth of the upper thermocline between the East African coastal current and the waters of the Arabian Sea may be of very great importance in connexion with the plankton movements and the pelagic fishes. At the Joint Northern Rhodesia–Nyasaland Fresh Water Research Station the echo-sounder of the research launch *Gigipat* has given excellent results, and hydrological work continued, special attention being given to the productivity of coastal waters. The West African Fisheries Research Institute continued its fisheries exploration with the research vessel *Cape St. Mary* from Sierra Leone and the Gold Coast, and at the Freshwater Field Station at Birnin Kebbi, Northern Nigeria, a study of marine invertebrate fauna was in progress. The Fish Culture Research Station at Batu Berendam, Malacca, is expected to be completed at the beginning of 1957, and the Fisheries Research Unit at the University of Hong Kong was at full strength.

The report of the Director of the Anti-Locust Research Centre, on locust research and control during 1954–55, again emphasizes the heavy demands on the personnel of the Geographical Section by the further increase in the area invaded by the desert locust; 1,240 reports were received from thirty-six countries, and they became considerably more extensive, owing to the greater intensity of infestation. Statistical work has been mainly concerned with the analysis of photographs of flying locusts obtained during the field-work on swarm behaviour of the desert locust. Liaison is being maintained with the regional organizations and the insecticide industry with a view of testing new techniques likely to be of value in locust control. Detailed studies have suggested that BHC and DNC in their present formulations are comparable in toxicity, though the action of BHC is slower. The International Red Locust Control Service continued its detailed studies of methods of quantitative assessment of locust populations, their seasonal movements and the dynamics of vegetation in the outbreak areas. The situation with regard to the red locust in the Rukwa Valley in Tanganyika caused some anxiety, and it was also very grave with regard to the desert locust; the Arabian Peninsula continued to constitute a main source of danger, and the efforts of several governments, co-ordinated by the Food and Agriculture Organization of the United Nations, were still inadequate.

Research matters not covered by the reports of the specialist advisory bodies are relegated to a final section of the report and include the research of the African Studies Branch of the Colonial Office into problems of African administration and the noticeable expansion in the work of the Colonial Liaison Section of the Building Research Station, which nevertheless still finds it difficult to meet its present commitments. The work of the Section has included climatological studies, such as solar radiation in West Africa, the mechanism of heat transfer in building structures under tropical conditions, and the design of buildings for air-conditioning in the tropics, and a study of the fundamental causes of weathering of building materials in different climates is projected. Reference is also made to the Falkland Islands Dependencies Survey, a major task of which is topographical mapping of the Dependencies, and to the Geodetic and Topographical Surveys, where recruitment of field staff kept level with transfers and resignations. Good progress was made with geodetic surveys, and the triangulation and photo-control work over twenty-thousand square miles between Dar es Salaam and Jinja, in Tanganyika, and down into the Kilombero Valley, was completed as far as weather permitted.

The overseas scientific staff of the Colonial Geological Surveys was further increased from 196 to 202, but the number of vacancies has risen to more than thirty in consequence of the desire of some territories to enlarge their geological surveys. In some territories the fundamental task of mapping has been impeded by the diversion of geologists to other duties—for example, in connexion with the Volta River project and Tema harbour. Progress in establishing eight seismographs in the Windward and Leeward Islands and Trinidad is reported. Meteorological research was again somewhat restricted by the shortage of qualified meteorologists; but establishment of a separate research section of the East African Meteorological Department was being considered and the Department has continued to study the artificial control of rainfall and has used cetyl alcohol successfully to reduce evaporation from reservoirs. No laboratory work was carried out on Colonial road-research problems, but the Committee on Colonial Road Research has now been appointed. A report issued by the Colonial Road Research Liaison Officer on his visit to the Caribbean area in 1954 indicates that the basic problems for research there are much the same as in other Colonial territories, with an outstanding need to develop a method of pavement design suitable for traffic and sub-soil conditions in the various territories.

MECHANISM OF PHASE TRANSFORMATIONS IN METALS

A SYMPOSIUM on the "Mechanism of Phase Transformations in Metals" was organized by the Metal Physics Committee of the Institute of Metals and held in London at the Royal Institution on November 9. Nucleation and growth changes were considered during the morning session, when the discussion was based on an invited review paper by Drs. H. K. Hardy and T. J. Heal and on seven contributed papers. The afternoon meeting was devoted to martensitic changes, and there were nine contributed papers, in addition to a review paper by Drs. B. A. Bilby and J. W. Christian. Each session was introduced by a *rapporteur* (Dr. Hardy and Dr. R. W. Cahn), and there were fourteen speakers in the morning discussion and seventeen in the afternoon. In the circumstances, a comprehensive report is not possible in these columns, and this survey will merely mention some of the views that seemed important to me.

A pleasing feature of the symposium was the large number of speakers from abroad. Opening the morning discussion, Prof. A. Guinier (Conservatoire des Arts et Métiers, Paris) gave a masterly survey of recent work on the early stages of precipitation. He showed a series of remarkable electron micrographs (or radiographs), obtained by R. Castaing, using a new fine electron-beam technique with very thin solid copper–aluminium specimens. The θ' and θ'' (or Guinier–Preston [2]) precipitates were clearly visible, the latter being thin platelets of length about 1μ and thickness less than 100 A. At very high magnifications, a regular variation in the background is believed to show individual Guinier–Preston [1] zones. Prof. Guinier also directed attention to the distinction between Guinier–Preston zones in copper–aluminium alloys, which consist of enriched copper platelets in a uniform matrix, and those in aluminium–silver alloys, where the spherical silver-enriched regions are surrounded by silver-depleted regions of matrix. Similar 'complexes', though of different shape, are believed to occur in copper–nickel–iron and nickel–chromium–aluminium alloys, and to be responsible for 'side-band' phenomena in powder photographs.

Among the subsequent speakers concerned with pre-precipitation effects, Dr. A. Seeger (Max-Planck Institut, Stuttgart) suggested a dislocation model for the energetics of formation of Guinier–Preston [2] zones. Dr. J. Nutting (University of Cambridge) maintained the view already expressed in his paper with Mr. G. Thomas that white spots observed in electron micrographs correspond to the formation of Guinier–Preston [1] zones, and Dr. W. H. Taylor (University of Cambridge) said that M. E. Hargreaves's explanation of side-bands was essentially equivalent to that proposed by Prof. Guinier. Prof. C. S. Smith (Institute for the Study of Metals, Chicago) suggested the application of topological principles to segregates forming during the early stages of precipitation; it might be that growth of segregates occurs because an equilibrium array cannot be attained. Miss J. M. Silcock (Fulmer Research Institute) described some recent structural work, and Dr. A. Berghézan (Centre de Recherches d'Antony, France) emphasized the importance of imperfections produced by quenching or by external stresses.

Prof. G. Borelius (Kungl. Tekniska Hogskolan, Stockholm) showed that there are, after all, probably no large discrepancies between measured lattice diffusion-rates and the rates of early precipitation phenomena. He discussed the first stage of precipitation, which he called primary clustering, and which may be shown by electrical resistance measurements before detectable diffraction effects are produced. The paper given by Prof. Borelius, with Mr. L. E. Larrson, and some of his remarks, were concerned with lead–tin alloys, and Dr. O. Krisement (Max-Planck Institut, Düsseldorf) reported further work on this system. In contrast to D. Turnbull's results, he found that a single kinetic law did not apply at all temperatures, which suggests that the spinodal curve may have some influence. Krisement's description of the precipitation process, however, seemed to be closely similar to Turnbull's model of cellular precipitation.

Further remarks on precipitation from solid solution were made by Mrs. M. K. McQuillan (Metals Division, Imperial Chemical Industries, Ltd.), who described some anomalous effects in titanium–chromium alloys, and by Mr. F. B. Pickering (United Steel Companies) and Dr. G. Pomey (Irsio, France), both of whom discussed sigma phases in relation to the paper by Dr. H. J. Goldschmidt (B.S.A. Group Research Centre). Dr. Pomey showed that in some alloys nucleation is heterogeneous, and cold-working produces many more nuclei. Another topic at the symposium was the allotropic change in pure tin, which formed the subject of a paper by Dr. E. O. Hall (University of Sheffield). Dr. Groen (Technische Hogeschool, Delft) emphasized the different behaviour of pure tin and of tin–mercury alloys, and Prof. Smith suggested two simple experiments which might yield pure grey tin in compact form. The other papers of the morning session were concerned with precipitate morphology (Dr. H. I. Aaronson, Carnegie Institute of Technology), superlattice formation (Dr. H. Steeple and Prof. H. Lipson, Manchester College of Technology), and structural work on titanium–vanadium alloys (Miss Silcock, Mr. M. H. Davies and Dr. Hardy).

The afternoon discussion was opened by Prof. F. C. Frank (University of Bristol). He thought the crystallographic problems are now largely solved, but criticized the dilatation parameter used by J. S. Bowles and J. K. Mackenzie, since, if this represents an elastic strain, it implies an effective Poisson's ratio of -1. Prof. Frank drew an analogy with the cleavage of mica to emphasize that the experimental results should not be expected to agree exactly with predictions based on some simple theoretical postulate (for example, an invariant plane as the habit plane). A point of physical significance, still to be explained, is why in iron–carbon alloys there is an abrupt change in the habit plane as the carbon content is varied.

Prof. Crussard (Institut de Recherches de la Sidérurgie, Saint-Germain-en-Laye) presented views on martensite essentially different from those in the review paper. He described experiments to show that stabilization in retained austenite is due to the diffusion of carbon or nitrogen atoms, and suggested that nucleation is always partly dependent on thermal activation, although it is necessary in solids to consider the energy of elastic waves rather than to apply reaction-rate theory in the usual manner. In support of this, he cited recent experiments in the U.S.S.R. on isothermal transformation at liquid helium temperatures. Prof. Crussard believed that a dynamic approach is necessary in considering the growth process, which he likened to the propagation of a shock wave. Calculations based on this model are being made in collaboration with Dr. Krisement, and he believed that the compatibility equations will ultimately lead to the crystallographic criteria used in the phenomenological theories.

The conventional theories of martensite crystallography were discussed by Dr. D. S. Lieberman (University of Illinois), who described a simple graphical method for finding the habit plane in any transformation from the invariant plane strain condition, and by Dr. Bilby (University of Sheffield), who described the latest results obtained by the prism-matching and surface-dislocation approaches. Both he and Lieberman have found that a lattice invariant shear on a $\{111\}$ austenite plane gives approximately both the Kurdjumov–Sachs orientations and habit plane and the low-carbon $\{111\}$ habit plane without the need for dilatation or other length changes within the habit plane. Mr. R. Bullough, working at Sheffield, has obtained a general parametric solution for the habit plane for any set of lattice principal strains and specified shear elements. Other speakers on crystallography were Dr. T. Ll. Richards (Metals Division, Imperial Chemical Industries, Ltd.) and Dr. K. W. Andrews (United Steel Companies).

Transformations in low-carbon steels were dealt with by Dr. A. R. Entwisle (University of Sheffield), who presented convincing evidence that the habit plane is $\{111\}$, and by Dr. A. P. Miodownik (Battersea Polytechnic, London), who pointed out the rather anomalous position in which, since the formation of ferrite in pure iron sometimes produces relief effects, it is a martensitic transformation on Bilby and Christian's definition. Dr. Seeger discussed the transformation in cobalt with special reference to a contributed paper by Drs. F. Sebilleau and H. Bibring (Office National d'Études et de Recherches Aeronautiques) and reiterated his belief in the correctness of the dislocation–node model for this change. Dr. Christian (University of Oxford) referred to recent evidence obtained at Oxford by Mr. P. Gaunt that a macroscopic shape deformation occurs in both cobalt and the analogous $\gamma \rightarrow \varepsilon$ transformation in iron–manganese alloys.

The remaining papers contributed to the afternoon meeting dealt with the transformations in β-brass (Drs. D. Hull and R. D. Garwood, of University College, Cardiff) and in uranium–chromium (Mr. B. R. Butcher and Mr. A. H. Rowe, of the Atomic Energy Research Establishment, Harwell), the correspondence in the uranium transformation (Dr. W. M. Lomer, of Harwell), nucleation problems (Dr. M. A. Jaswon, of the Imperial College of Science and Technology, London), crystal geometry (Dr. Ll. Richards and Dr. W. T. Roberts), bainite reactions (Dr. Krisement and Prof. F. Wever) and the stabilization of austenite (Dr. S. G. Glover and Mr. T. B. Smith, of the University of Birmingham). Bainite was discussed by Dr. L. Habraken and Dr. Miodownik, the selection of the correspondence by Dr. Cahn (University of Birmingham), Dr. Lieberman, and Dr. Christian, stabilization by Mr. Kumar (University of Sheffield), and the thorny problem of isothermal versus athermal nucleation by several speakers. The meeting closed half an hour late with many people still wishing to contribute.

A minor point which emerged from both discussions was the dissatisfaction felt by several speakers with the present nomenclature. Prof. Smith pointed out that neither nucleation nor growth is the prerogative of nucleation and growth changes alone, and it was also felt that the present extension of the term martensite to cover the wide class of transformations which show a shape change in the transforming region is not wholly suitable. The difficulty about such a situation, of course, is that the existing usage is established; the problem has arisen largely because the kinetic features on which Greninger and Troiano based their classification of transformations have gradually had to be replaced by other criteria.

In conclusion, it is necessary to applaud the care and thoroughness with which the two *rapporteurs* managed to summarize so much material, and the success of the chairmen (Profs. G. V. Raynor and A. G. Quarrell) in keeping speakers to their allocated times. The papers and discussion will be published in the Monograph and Report Series of the Institute of Metals. J. W. CHRISTIAN

BIOLOGISTS AND NATIONAL SERVICE

THE Institute of Biology has made inquiries of the Ministry of Labour and National Service about the opportunities open to graduate biologists in the Services (*J. Inst. Biol.*, 3, No. 1; November 1955). The position appears to be as follows. All science and engineering graduates entering the Forces are considered for National Service commissions, and in the past about 40 per cent of them have been commissioned during their National Service. Both in the Royal Navy and the Royal Air Force, science graduates are accepted for National Service only if they can be recommended by a pre-call-up officers' selection board for a National Service commission. In the Army all graduates are called up in the ranks; but each is given an opportunity of being considered for a National Service commission during the period of his basic training.

There are comparatively few opportunities for a graduate in the biological sciences to be employed in any of the three Services in a capacity which will make direct use of his qualifications. So far as the Navy is concerned, his acceptance is unlikely. The demands of the Navy are mainly for mechanical and electrical engineers, mathematicians and physicists, and it does not usually have any requirement for graduates in the biological sciences. In the Royal Air Force, a comparatively small number of graduates in biology is accepted for National Service commissions in the Education Branch. It is also open to any National Service recruit to opt for service in the General Duties Branch for training as a pilot.

The War Office has recommended that a graduate in the biological sciences should apply for service in either the Royal Corps of Signals, the Royal Artillery, the Royal Engineers or the Royal Armoured Corps, where his scientific background is likely to be particularly valuable. There is, of course, nothing to prevent a science graduate from applying for service in any branch, technical or non-technical, and acceptance for a commission will depend solely on qualities of leadership and character and does not depend on technical or academic qualifications, except in so far as a potential officer must be intelligent and able to express himself clearly. Commissions in the Royal Army Education Corps are not given to National Service men; but a graduate in biology, especially if he holds the postgraduate Certificate of Education, may elect to do his service in that Corps where he could expect to be appointed sergeant instructor. The Royal Army Medical Corps is normally officered by medically qualified men; but an occasional vacancy occurs for a physiologist, biochemist or entomologist in commissioned rank. Otherwise, biology graduates may be appointed as laboratory technicians or in similar posts, and promotion to sergeant rank is possible.

An increasing number of science graduates now apply for short-service commissions as an alternative to National Service. These are voluntary regular engagements and usually involve a minimum of three years full-time service. Short-service commissions are available for science (including biology) graduates in the Education Branch of the Royal Air Force or in the Royal Army Educational Corps, as well as in other branches of the Royal Air Force and the Army.

There is no 'allocation' of scientists to defence work; but there is a number of projects of high priority carried on by government departments and private firms on which science graduates may be employed and given deferment on the applications of the government department concerned. Most of the vacancies are for physicists, mathematicians, chemists and engineers: biologists are required only on rare occasions. Deferment can also be granted for certain appointments in the Colonial Agricultural Service, for which biologists are much more in demand.

INTERNATIONAL SURVEY OF PROGRAMMES OF SOCIAL DEVELOPMENT

IN accordance with a resolution of the United Nations Economic and Social Council, the Bureau of Social Affairs of the United Nations Secretariat, in co-operation with the International Labour Office, the United Nations Educational, Scientific and Cultural Organization, the Food and Agriculture Organization and the World Health Organization, has prepared a survey of national and international measures taken to improve social conditions throughout the world*. Entitled "International Survey of Programmes of Social Development", it is concerned primarily with measures taken since 1945, and with those taken by governments rather than by voluntary or private organizations, and is intended to supplement the "Preliminary Report on the World Social Situation". The survey brings out the remarkable recent expansion of such programmes throughout the world, an expansion which has necessitated the report being limited to the outlining of trends and developments, using concrete cases only for illustrative purposes. The report should be particularly useful to all concerned with Colonial development and welfare and with technical assistance generally, whether under the Colombo Plan or in other ways.

An introductory chapter reviewing the similarities and differences in national approaches to social welfare, production and rural development points out that, in practically all the types of programme surveyed, the three problems constantly being encountered are those of obtaining adequate personnel to execute the programmes, adequate information to guide them, and adequate resources to finance them. Shortages of trained personnel are experienced by countries at all levels of development. Training abroad on fellowships has made an important but limited contribution to the supply of the higher-level technical and professional workers in some countries; attempts have been made in many countries to deal with the maldistribution among the professions, and the less-developed countries are increasingly turning to auxiliary workers, or technical assistants.

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* International Survey of Programmes of Social Development. Pp. iv+200. (New York: United Nations; London: H.M.S.O., 1955.) 2 dollars, 15s., 8 Sw. fr.

The problem of obtaining adequate information for social programmes is in part that of balancing the use of limited resources; but reliance on social research as a basis for formulating, checking and evaluating systematic plans and programmes is increasing, and more attention is being given to experimentation and small trials before launching large projects. In regard to finance, however, there is little agreement as to what constitutes balanced development or a balanced allocation of funds for simultaneous economic and social development, or as to the order and timing of expenditures on different types of programme; nor does a chapter in the survey dealing specifically with research and surveys in connexion with social programmes warrant any confidence that a more detailed framework of thought to guide specific decisions is either possible or desirable.

This chapter is well documented and gives a brief picture of the organization of government research in various countries, as well as of such recent developments in the technique of research into social problems as the sample survey and the interdisciplinary approach, known as operational research. While, however, the increase in government statistical activities, especially in the under-developed areas, is emphasized, little information is given, or appears to be available, as to expenditure on social research. In the United States it amounts to some 2–3 per cent of the Federal expenditure on research, but no figures are given for other countries. In Norway, public research expenditure rose from 14·7 million kroner in 1938 to 83·4 million kroner in 1952, and total expenditure on public and private research and development (both civil and military) is estimated at about 1 per cent or more of gross national expenditure in the German Federal Republic, Great Britain, the Netherlands, the United States and the U.S.S.R. In the economically developed countries, non-military research expenditure appears to be between 0·3 and 1 per cent of national income, but in undeveloped countries it is much less. During the decade ending 1952, population censuses were conducted in 155 out of 239 areas of the world, covering nearly 60 per cent of the world's population. Ninety-five countries and territories have taken on agricultural censuses within the framework of the 1950 World Census of Agriculture, and since 1948 more than thirty countries or territories have published a general statistical bulletin for the first time. In general, however, the role of the social scientist in relation to social policy appears to be uncertain.

The remaining chapters of the survey deal separately with health, nutrition, education, labour and social security programmes; with the programmes to improve housing and community facilities and to aid the consumer; and with special programmes of social protection and rehabilitation, or of social development for rural areas; and with general approaches to social development.

A DIETARY DEFECT IN MAIZE DEVELOPED DURING TREATMENT WITH LIME

By P. L. PELLETT and PROF. B. S. PLATT, C.M.G.

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IN a recent appraisal of the state of knowledge on pellagra[1], it was agreed that the problem of the pellagragenic properties of maize is not yet solved and that the etiology of the disease is by no means simple. The incidence of pellagra is reported to be low in some regions of Mexico where the consumption of maize is high; the explanation of this is not clear—it may be that the disease is not diagnosed or reported, that the diet contains some foods, for example, beans, which protect the consumer, or it may be the result of the method of preparing the maize grain for making tortillas. The last of these possible explanations has led to several investigations on the effects on the nutritive value of maize when treated with lime in the Mexican manner.

Krehl *et al.*[2] found no difference between rats fed on lime-treated or raw maize. However, Laguna and Carpenter[3], Cravioto *et al.*[4] and Squibb *et al.*[5] reported that rats fed on lime-treated maize grew better than rats given untreated maize; these results have been confirmed in our laboratory. Recently, Braude *et al.*[6] reported the curative effect on pellagra in pigs of maize which had been partially hydrolysed with sodium hydroxide; but Goldsmith *et al.*[7] were unable to demonstrate any beneficial effects of lime-treated maize in human pellagrins.

The effect of lime on the nutritive value of maize has been ascribed either to an increase in 'available' nicotinic acid following hydrolysis with alkali of a 'bound' form[3,6], or to the racemization of certain amino-acids, thereby avoiding amino-acid imbalance in the diet[4]. The highly critical nature of the balance of amino-acids for growth has been emphasized in a recent paper by Elvehjem and Harper[8].

The diets of the rats in the three previously reported experiments on the effect of lime-treatment of maize have contained adequate amounts of the known B-vitamins except nicotinic acid, the investigators having been concerned primarily with the effects of lime on the availability of nicotinic acid. However, since lime-treated maize, when substituted for untreated maize in human dietaries, may not be combined in diets with foods supplying adequate amounts of B-vitamins, experiments have been made on the effects on rats of diets consisting mainly of lime-treated or untreated maize and without supplements of the B-vitamin complex.

The results obtained in three separate experiments are summarized in Table 1, from which it can be seen that: (i) the rate of growth of the rats fed on lime-treated maize was significantly lower than that of the rats on untreated maize; (ii) supplementation of the diet with either nicotinic acid or tryptophan had no effect on this depressed growth-rate; (iii) on addition to the diet containing lime-treated maize of aureomycin or of a mixture of B-vitamins, the

Table 1. WEIGHT GAINS OF RATS UPON RAW AND LIME-TREATED DIETS WITH AND WITHOUT VARIOUS SUPPLEMENTS

Experiment	Diet (*a*)			No. of rats	Average weight-gain (4 weeks) gm	Average weight-gain per 100 gm. food eaten (4 weeks) gm.	*P**
	No.	Maize	Supplement				
A	I	Raw	None	6	59·3	23·5	< 0·001
	II	Lime	None	6	40·5	18·9	
	III	Raw	Aureomycin (*b*)	6	65·2	24·9	
	IV	Lime	Aureomycin (*b*)	6	64·7	25·1	
B	I	Raw	None	6	56·5	21·8	< 0·01
	II	Lime	None	6	39·5	18·1	
	III	Raw	Aureomycin (*b*)	6	53·2	20·8	
	IV	Lime	Aureomycin (*b*)	6	50·0	21·6	
	V	Raw	Nicotinic acid (*c*)	6	58·7	22·6	
	VI	Lime	Nicotinic acid (*c*)	6	37·3	16·6	
C	I	Raw	None	6	49·7	21·7	< 0·001
	II	Lime	None	6	27·3	15·0	
	VII	Raw	B vitamins (*d*)	6	64·8	23·9	
	VIII	Lime	B vitamins (*d*)	6	60·2	23·0	
	IX	Raw	Tryptophan (*e*)	6	50·0	20·1	
	X	Lime	Tryptophan (*e*)	6	27·8	15·0	

* Analysis of variance technique used. Effects of diet differences shown to be highly significant when results of weight-gain per 100 gm. food were analysed.

(*a*) Diet: casein (alcohol extracted) 3 per cent, salt mixture (de Loueiro) 4 per cent, sucrose 5 per cent, lard 3 per cent, maize (raw or lime-treated) 85 per cent. The method of lime-treatment of maize was that of Cravioto (ref 9).

(*b*) Aureomycin: 10 mgm. per 100 gm. diet.

(*c*) Nicotinic acid: 3 mgm. per 100 gm. diet.

(*d*) B vitamins (all per 100 gm. of diet): choline 200 mgm., inositol 100 mgm., para amino-benzoic acid 44 mgm., thiamine hydrochloride 1·0 mgm., riboflavin 1·2 mgm., pyridoxine 1·0 mgm., calcium *d*-pantothenate 2·0 mgm., biotin 0·2 mgm., folic acid 0·6 mgm., nicotinic acid 3·0 mgm.

(*e*) Tryptophan. 100 mgm. per 100 gm. diet

growth-rate was the same as that of rats on a diet of untreated maize.

It was suspected from a consideration of these experiments that the lime-treated maize contained less of some of the vitamins of the B-complex than untreated maize, probably of those known to be required for growth and alkali-labile, namely, riboflavin and thiamine. According to Cravioto *et al.*[9] vitamins are not destroyed during lime treatment; but Zozaya and Alvarado[10] have reported that riboflavin was absent from tortillas and Squibb *et al.*[5] have reported losses of 32–42 per cent of total nicotinic acid during lime treatment.

Analysis of raw and lime-treated maize for total nicotinic acid, riboflavin and thiamine revealed (Table 2) considerable losses of all three vitamins during lime treatment and, since it was known from previous experiments that additions of nicotinic acid did not affect the depressed rate of growth, the possibility that it was due to insufficiency of riboflavin or thiamine was investigated.

Table 2. VITAMIN CONTENT OF RAW AND LIME-TREATED MAIZE

Vitamin	Method of analysis	Content in µgm/gm (water content 9–10 per cent)	
		Raw	Lime-treated
Nicotinic acid	Microbiological: *Lactobacillus arabinosus*	18·0 18·6	12·0 10·5
Riboflavin	Microbiological: *Lactobacillus casei ε*	1·4 1·6	0·6 0·8
Thiamine	Chemical: thiochrome	5·3 5·0	1·0 1·1

The results in Table 3 show that addition of either riboflavin or thiamine to lime-treated maize produced an increased growth-rate as compared with that of the control animals.

The effect of riboflavin was much greater than that of thiamine, and the weight gain on the former of about 2·2 gm. per rat daily is close to that of 2·1 gm. per day for rats of similar weights on the diet with the vitamin B-complex supplement. It appears, then, from these results that the main cause of the retarded growth of animals on lime-treated maize is an inadequate amount of riboflavin consequent on destruction during lime treatment of the grain; the thiamine intake is probably marginal and the growth increase obtained with aureomycin may be due to a vitamin-sparing action effected in some way by the microflora of the gut of the rat.

The low incidence of pellagra reported from Mexico and the possibility of this being due to the alleged beneficial effects of lime-treated maize has led to some trials in Southern Rhodesia[11] with a view to the introduction of the process into a region in which the prevention of pellagra is a problem.

The substitution of lime-treated for whole maize meal would have the merit of increasing the amount of calcium in the diet, of raising the proportion of the total nicotinic acid in the grain in 'available' (that is, unbound) form, though from Table 2, about a third of the total may be lost and, since the 'bran' of the grain is removed in lime treatment, digestion and absorption of the treated product might be improved.

The disadvantages would include substantial reduction in the amounts of riboflavin and thiamine.

Table 3. AVERAGE WEIGHT-GAINS OF ANIMALS FED ON LIME-TREATED MAIZE AND SUPPLEMENT OF RIBOFLAVIN OR THIAMINE

Diet	No. of rats	Initial average weight (gm.)	S.E.*	Average weight after 10 days dosing (gm.)	S.E.*	Average weight gain (gm.)
Lime-treated maize	4	62·5	6·1	69·0	7·3	6·5
Lime-treated maize + riboflavin	4	56·0	3·3	78·0	3·8	22·0
Lime-treated maize + thiamine	4	61·7	3·8	75·0	4·8	13·3

* Standard error of the mean.

All animals had previously been on a lime-treated unsupplemented diet for 4 weeks. The supplements were 150 µgm. daily of riboflavin or thiamine for a period of 10 days.

The amount of riboflavin in the traditional diets of the tribes of Central Africa having maize as their staple food may be low. Platt and Webb[12] estimate a content of 1·13 mgm. riboflavin for a 3,060 Cal. diet (not containing grain 'beer'); the allowance of riboflavin recommended by the British Medical Association Committee[13] is 1·8 mgm. for a male adult on a 3,000 Cal. diet. In the dietaries of sophisticated African communities whole maize meal (machine-milled grain) frequently replaces the domestically prepared maize flour, and in such dietaries the amount of vegetables and fruit, which are important sources of riboflavin, is often much less than in the traditional dietary.

It is important in this connexion to note that one of us (B. S. P.) has worked throughout the year in the Central African territory of Nyasaland, where the people obtain sometimes as much as three-quarters of their energy from maize, and yet, in the rural areas, pellagra was never seen. The maize flour used was prepared by the women by a process widely used throughout Africa which includes soaking and fermentation. The use of such flour may have contributed to the absence of pellagra; the extensive consumption of grain 'beer'[14] may also be a factor[12,14].

We are grateful to the Lederle Laboratories Division of Cyanamid Products, Ltd., for their gift of a sample of aureomycin and to Dr. V. Mikulicic, a World Health Organization Fellow, for his assistance in the later stages of the above work. [Nov. 22

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MEANING OF DEUTERIUM ABUNDANCE IN METEORITES

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THE article by G. Edwards on the "Isotopic Composition of Meteoritic Hydrogen"[1] contains some very questionable statements about the meaning of the deuterium content of meteorites and an incorrect interpretation of the results and conclusions reached by me on the same subject[2].

The significance of the determination of the D/H ratio in planetary objects in connexion with the problem of the origin and the formation of the solar system was pointed out a few years ago by Urey[3] and by Kuiper[4] and was discussed in detail more recently by me[2a]. Some further comments can be added here.

The isotopic evidence may be used in the following way. First, it is necessary to determine whether there is a definite difference between the deuterium content of the Earth and that of meteorites, these last being regarded as our only specimens of the material present in the planetary space outside the Earth. A definite difference, namely, a difference of more than one average fractionation stage, would suggest that an enrichment process other than ordinary chemical fractionation had operated on the hydrogen isotopes at some time between the initial accumulation of the planetary bodies and the present time. The lack of such a definite difference in the carbonaceous chondrites, together with the other experimental evidence, suggested to me that the primeval cosmic abundance of deuterium could not be different from the terrestrial abundance within a factor of the order of a chemical fractionation stage. Such a conclusion is supported also by the data of Edwards on the iron meteorites.

The second step to be taken is a more detailed study of deuterium abundance in different types of meteorites and different hydrogen compounds, in order to understand which fractionation processes are responsible for the observed variations. This kind of work requires a large number of analyses, carried out in a systematic manner, since the experimental method is delicate and additional evidence is generally lacking. Thus I feel that the limited amount of knowledge on the origin of the meteorites and the small number of deuterium analyses make meaningless at the present time such questions as whether the D/H ratio in the iron meteorites is more 'reliable' than the D/H ratio in carbonaceous chondrites, as Dr. Edwards tries to prove in his article. The detailed reasons for this will be given at the end of this article.

In attempting to demonstrate that his results are more conclusive than mine, Dr. Edwards makes two main criticisms of my work: (1) that I "attached special significance" to some specific results; (2) that my analytical data may be wrong, since Wiik[6] found systematically higher water contents in his chemical analyses of the carbonaceous chondrites.

So far as the first point is concerned, my interpretation of the significance of the *four* results showing deuterium content outside the range of terrestrial variations was clearly stated. It was only one additional proof that we were dealing with true meteoritic water, but it was never stated that "special significance [was attached] to the three results in which he found deuterium to be more than 25 per cent higher than in Lake Michigan water" (quote from Edwards's paper). I would like to emphasize that I never said that the concentration of deuterium in the planetary space was 25 per cent higher than that on the Earth.

The second point, that is, the difference between Wiik's results and mine on the total water content, needs a little more attention. The reason for the divergence—which Dr. Edwards perhaps did not think of—is clear: Wiik used the Penfield method, which is carried out at atmospheric pressure, whereas in my combustion apparatus the powdered meteorite was previously placed in a vacuum—a procedure that was considered correct, since the meteorites are coming from the perfectly evacuated interplanetary space. Thus, an outgassing of the powder took place, with the result that all the water loosely adsorbed (and undoubtedly atmospheric) was given off very rapidly. Consequently, this water is not given in my paper (Tables 2 and 3)[2b], whereas I took into consideration the water extractable in a vacuum at higher temperatures. On the contrary, the Penfield method, used by Wiik, gives the total water content, which is comprehensive of *all* adsorbed atmospheric water. It is not surprising that this total water can amount to 20 per cent of the meteorite in weight, since carbonaceous chondrites are very porous stones; in one experiment, I found a 10 per cent increase of weight in a sample of Cold Bokkevelt left for a while in an atmosphere saturated with water vapour at room temperature.

Incidentally, it should be noted that the method I used for the determination of water was thoroughly checked for quantitative recovery by repeated runs with small 'Pyrex' tubes containing known amounts of water of known isotopic composition, since a total yield was the necessary condition for obtaining no isotopic fractionation during the processing.

One possible objection to my method could be raised, namely, that I used a temperature too low for a complete extraction, since some hydrated silicates are known which give off their last amounts of water at very high temperatures. I had a maximum temperature of 800°–900° C. and did not check if some water was extractable at higher temperatures; however, Penfield's method does not use higher temperatures either. On the other hand, that the incomplete extraction *cannot* be the reason for my four higher D/H ratios was proved by the fractional extraction of water in a vacuum at different temperatures[2b]. In this respect, my results seem to be in complete disagreement with the finding of Godfrey[5], cited by Edwards, since I constantly found that the stone, and not the extracted water, becomes enriched in deuterium with rising temperature.

The question as to the meaning of the results remains to be discussed. As is generally known, irons and stones (to which group the carbonaceous chondrites belong) are two completely different types of meteorites; their origin and mutual relationships are still somewhat obscure. A detailed discussion of the meteorite problem, based on the best available experimental evidence, was given by Urey and Craig[7], who found that the ordinary chondrites fall into two distinct groups with respect to the total iron content. These two groups very likely represent the two parent bodies of the meteorites, that is, two asteroids which came into collision and broke apart. The same authors attempted to give an explanation of the formation of the meteoritic material prior to the final collision, in the light of present views on the origin of the planetary system and dissipation of volatiles from the protoplanets[8,9]. The process was certainly extremely complicated, involving high temperatures, chemical reactions and repeated breaking and mixing up of material. At the time that paper was published, no good analyses of the carbonaceous chondrites were available, and no clear relationship was apparent between these stones and the ordinary chondrites; therefore, no definite conclusion could be reached by Urey and Craig about these objects. Since then, Wiik[6] has carried out complete analyses of many carbonaceous chondrites, and it turned out that they belong very definitely to Urey and Craig's 'high' group of chondrites, that is, that they have exactly the same chemical composition of these stones, as far as the non-volatile constituents are concerned. On the other hand, there are large variations in the volatile elements, namely, oxygen, sulphur, hydrogen (mainly as water) and carbon. It appears, then, that the carbonaceous and the 'high' group ordinary chondrites are closely correlated and that they derive from each other through the simple dissipation and/or condensation of volatiles.

Unfortunately, no definite evidence has been found as to whether the carbonaceous chondrites represent a sample of the primordial cosmic material, as Urey had postulated some years ago[3,10]. On the contrary, their relationship to the 'high' group of chrondrites is a point against this hypothesis, if one accepts the theory of Urey and Craig that the 'low' group represents more nearly the primordial material.

In any event, while the carbonaceous chondrites were never heated at very high temperatures, since they have partially preserved their volatiles, the iron meteorites were probably formed by a high-temperature reaction of silicates or oxides with hydrogen gas. In these circumstances, no clear way can be seen for a comparison of the hydrogen isotopic composition of irons and carbonaceous chondrites. In the first meteorites the hydrogen is contained as dissolved hydrogen gas in the metal and/or as some hydrogenated compound in the minute discontinuities between the nickel–iron crystals (this point is not clear in Edwards's paper); in the carbonaceous chondrites the hydrogen is mainly in the form of combined water and possibly a few per cent of it is present as organic material. It is seen that the fractionation processes which eventually produced the observed difference in isotopic composition were certainly of a complicated nature, and any assumption at the present time would be pure imagination.

Thus, it is not possible to deduce, from the present data, the exact isotopic composition of the primordial hydrogen. For this reason, the final conclusions reached by Edwards are devoid of meaning. On the other hand, if one assumes, with Edwards, that the primeval abundance of deuterium was indeed that of the iron meteorites, one cannot see how the same abundance can be assumed for the primitive Earth, since mainly water and not hydrogen gas was retained by the gravitational field and it would seem almost certain that these two compounds did not have the same isotopic composition. In fact, kinetic fractionation processes were certainly operative and, if an equilibrium condition was established, then very likely sufficiently low temperatures were present to produce a remarkable fractionation.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Hormones and the Cytoskeleton

THE object of this communication is to present the hypothesis that hormones modify the 'cytoskeleton' of the cell. Though I have held this view for some time, and have discussed it with others, I have not advanced it formally, because until now it did not appear to be useful. There are, it is true, subcellular actions which have been described for hormones; notably one may mention the interesting effects of thyroxine upon the oxidative phosphorylation of mitochondria which formed the basis of a recent lecture to the Third International Congress of Biochemistry by C. Martius. There are also conclusive observations upon the action of insulin in altering permeability to sugars[1,2]; and also, on the contrary, the widespread idea that insulin controls the formation of glucose 6-phosphate. Yet in spite of interest in these facts, there is a general feeling that hormones act upon the cell as a whole, and that their action is somewhat diverse rather than being upon one enzymic or other step (cf. A. Beloff-Chain *et al.*[3], and see particularly the discussion of this by O. Hechter[4]). It is from this aspect that I think the 'cytoskeletal' view may prove to be a useful working hypothesis.

Many years back I became impressed by the idea that to view the cell as a bag of enzymes, however specific these might be in their action, could not account for the integrated behaviour of cells, any more than disorientated carbon atoms could account for the reactions of the benzene ring; and I felt forced to postulate the presence of a fluid anatomy in the geography of the cell, being some tenuous network by the action of which the cell's enzymic activities were co-ordinated. (The term 'cytoskeleton' was given to this by J. Needham; it is a good description provided that it does not convey the idea of the rigidity of a bone.) Other biologists have felt the difficulties in accounting for the whole actions of cells, too, and a critical discussion of pros and cons may be found in the book "Cytology and Cell Physiology"[5]; see also ref. 6.

The 'cytoskeletal' hypothesis has met with some hostility, both from those who consider wrongly that it excludes the essential studies on isolated enzymes, and also from those who feared it might be a return to the long-discarded ideas of the giant molecule. Belief in the presence of intracellular structures has been made easier by recent electron microscopy of mitochondria (by Palade[7] especially and by other work); by the now known existence of nucleic acids in the cytoplasm, and by the recent report of the existence of cytoplasmic membranes seen by Palade. (I am indebted to Dr. E. F. Gale for telling me of these observations, reported to the Ford Enzyme Symposium on November 2, 1955.)

Whether the cytoskeleton consists of continuous thin membranes, or whether it is arranged like the bentonite gel by rapid re-formation of oriented particles, or by more classical chemical links or by hydrogen bonds—whichever way it takes place is immaterial from my present point of view. It has always been to me an obvious consequence of the 'cytoskeletal' idea that it was the cytoskeleton rather than individual enzymes which was the co-ordinating factor, as it were the master structure of the cell this was pointed out by me some twenty-five years ago and is an essential emphasis in my point of view Hence an agent which could change the cytoskeleton might be expected to modify several enzymic reactions simultaneously by giving a new direction to this fluid anatomy.

Hormones are active in small amounts, and it is definitely conceivable that very small amounts of peptide or steroid structures could enter the surface of cells and accomplish such an orientation. This is the reason why it is here advanced that a hormone re-orientates the cytoskeleton. From the point of view of this working hypothesis, the search for some one enzymic reaction which a hormone modifies is doomed to failure, and further efforts should be directed to clarifying the patterns of diverse reactions which may be modified by the actions of hormones upon whole cells.

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An Antigen determining Virulence in *Pasteurella pestis*

DESPITE assiduous search by many workers, the factor conferring the property of high virulence of strains of *P. pestis* has remained undetected. Virulen and protective avirulent strains have been studied comparatively by the methods of immunology immunochemistry and biochemistry without yielding convincing evidence of a difference in their properties sufficient to account for their difference in virulence This communication reports results showing that an important antigenic difference between virulent and protective avirulent strains does in fact exist.

It has been demonstrated that virulent and avirulen strains can be differentiated on the basis of ability of the former and inability of the latter to develop resistance to phagocytosis by mouse polymorphonuclear leucocytes under well-defined conditions *in vitro*[1]. Virulent organisms harvested from growth on nutrient agar incubated at 28° are highly sensitive to phagocytosis; I term these *V/S*. When they ar incubated, with gentle rotation, for 3 hr. at 37° in tubes of tryptic-digest meat broth at *p*H 7·0, they become resistant to phagocytosis; virulent organisms so treated I term *V/R*. Avirulent cells similarly grown at 28° are also highly sensitive to phagocytosis (*AV/S*) and retain this sensitivity on similar incubation in broth at 37° (*AV/'R'*).

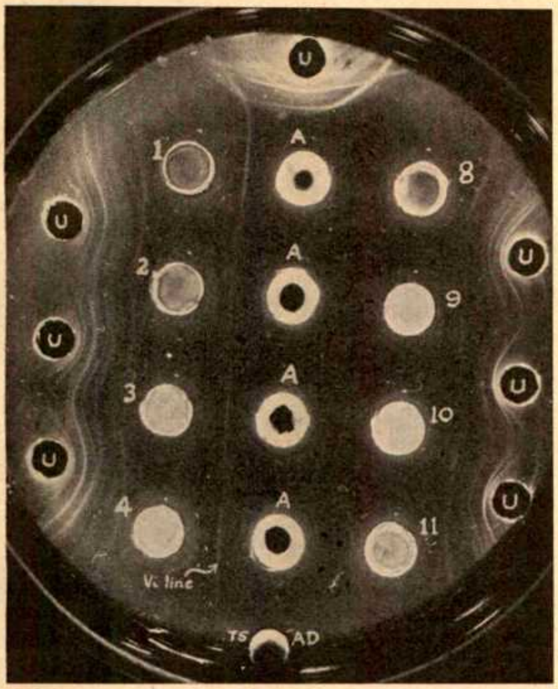

Fig. 1

Reservoirs *A* contain rabbit anti-live *V/R* (strain *MP*6) serum heavily absorbed (100 mgm./ml. serum) with acetone-dried *AV/'R'* (strain *TS*). Reservoirs *U* contain the same serum, unabsorbed.
Reservoirs 1–4 contain virulent organisms in the *V/R* condition (1 strain *MP*6, 2 Yokohama, 3 Shasta, 4 *F*9581).
Reservoirs 8–11 contain avirulent organisms in the *AV/'R'* condition (8 strain *TS*, 9 *A*1122, 10 Soemedang, 11 53*H*1).
Reservoir *TS/AD* contains material as used for absorption

Antisera prepared in rabbits against live *V/R* have the ability to render *V/R* organisms sensitive to phagocytosis when added to a test system *in vitro*. Antisera similarly prepared against *AV/'R'* are poorly able to render *V/R* sensitive under the same conditions. Antisera against both types of organisms contain many antibodies in common, and in similar quantities, and do not differ materially in their content of the important antibody to fraction 1, which, from the studies of Meyer's school[3], plays a major part in protection against virulent infection. Although Englesberg *et al.*[2] consider virulence in strains of *P. pestis* to be intimately connected with the possession of a critical amount of fraction 1 antigen and avirulence to reflect the possession of lesser amounts, I do not think that the resistance of virulent organisms achieved under the above conditions (and hence high virulence) is primarily due to their content of fraction 1.

The evidence for this statement is as follows: The fraction 1 contents of *V/R* and *AV/'R'* as determined by the Ouchterlony[4] technique are similar and very low. *V/R* is not visibly capsulated. *V/R* is poorly agglutinated by high-titre rabbit antisera prepared against highly purified fraction 1 (kindly supplied by Dr. K. F. Meyer). This serum does not render *V/R* sensitive to phagocytosis. Excessive absorption of *V/R* antisera with fraction 1 leaves their ability to render *V/R* sensitive to phagocytosis virtually unaltered. An antigen other than fraction 1, therefore, is responsible for the resistance to phagocytosis shown by *V/R*, and hence, for reasons given earlier, is a determinant of high virulence. As a corollary, all fully virulent strains would be expected to possess this antigen, while avirulent strains may or may not possess it. An avirulent strain possessing this antigen must then owe its avirulent state to the absence of a second determinant of virulence (for example, independence of purine)[5].

Visual evidence for the existence of an antigen differentiating strains capable of resisting phagocytosis, in the absence of visible capsulation, from strains incapable of so doing, is readily obtained by the agar diffusion technique. Fig. 1 gives clear evidence that the fully virulent strains *MP*6, Yokohama, Shasta and *F*9581 contain a diffusible antigen which is not present in detectable amount in the avirulent strains Tjiwidej *S*, *A*1122, Soemedang and 53*H*1. This antigen has been similarly shown to occur in the virulent strain *L*37, the potentially virulent strains *M*1 and *M*7 (Jackson, S., personal communication), and to be undetectable in the avirulent strains Java and 14. It is also to be found in the classical strain *EV* 76, which has frequently been regarded as an avirulent strain possessing a small 'residual' degree of virulence. It is difficult to detect in virulent strains in the *V/S* condition.

Antisera containing antibody specific for this antigen are capable of rendering *V/R* sensitive to phagocytosis. Such antisera retain this capability following heavy absorption with acetone-dried *AV/'R'* but are deprived of it following equal absorption with acetone-dried *V/R*. The antibody response of the mouse towards this antigen appears to be considerably less rapid and intense than that of the rabbit. Experiments to date clearly indicate that specific antigen materially contributes to the passive protective value for mice of antisera produced in rabbits against living *V/R* organisms.

I suggest that, on the evidence presented here, the antigen conferring the important biological property of resistance to phagocytosis and possessed in quantity by all fully virulent strains examined, and undetectable in the majority of avirulent representatives, is a major determinant of virulence in *P. pestis* and represents the long-sought *Vi*-antigen of this organism.

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Effects of Anaphylactic Shock and Compound 48/80 on the Mast Cells of the Guinea Pig Lung

Several experiments show a correlation between the number of mast cells in a tissue and its content of histamine[1], and it is possible to obtain histamine from isolated mast granules[2]. Furthermore, alterations of mast cells have been described under conditions in which liberation of histamine occurs in the dog, rat and mouse[3]. We have found that similar changes can be produced in guinea pig lung mast

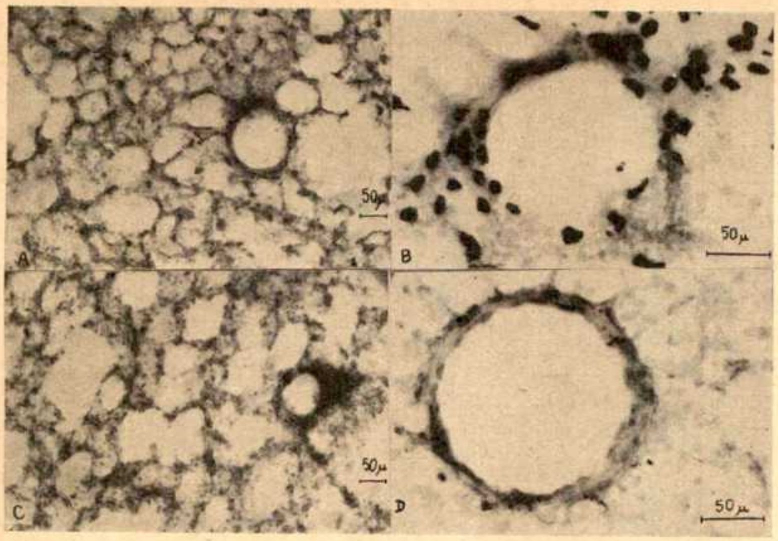

Fig. 1. Frozen sections from guinea pig lung after lead subacetate–ethanol–acetic acid fixation, stained with toluidine blue (pH about 4).

(*A*) and (*B*). Lung from sensitized animal injected with histamine (group II); numerous mast cells in the walls of alveoli and around bronchioles. (*C*) and (*D*). Lung after anaphylactic shock (group I); note reduction in the number of mast cells

cells by means of anaphylactic shock, but not by the action of compound 48/80. Male guinea pigs weighing 300–450 gm. were used throughout. Groups of five animals each were studied. Group I: animals sensitized by injecting 100 mgm. of commercial egg albumin intraperitoneally and 100 mgm. subcutaneously; anaphylactic shock was induced three weeks later by intracardiac injection of 100 mgm. of the antigen in 1 ml. of 0·85 per cent sodium chloride. Group II: sensitized animals killed after shock was induced by intracardiac injection of 200γ of histamine. This group was chosen in order to obtain lungs in similar conditions (emphysematous) to those of group I. Group III: animals injected through the intracardiac route with 0·5 mgm. of compound 48/80. The animals from these three groups were killed by bleeding from the jugular vein when breathing had practically stopped. Group IV: animals killed by a blow on the head and bled from the jugular vein.

The lungs were fixed by injecting a 4 per cent solution of lead subacetate in 50 per cent ethanol plus 0·5 per cent acetic acid through the trachea. Fixation was allowed to proceed overnight, and frozen sections 50μ thick were stained by toluidine blue in acidified solution (pH about 4). The number of mast cells was determined in one hundred randomly chosen 0·1364 mm.[2] areas with the aid of a square-ruled ocular micrometer, the magnification being 250 ×. From the analysis of the counts, the standard error was estimated to be about 7 per cent. Results were studied by variance analysis and the significance of the difference between pairs of means evaluated through the *t* test[4].

In all sensitized animals, the injection of the antigen induced an anaphylactic reaction with death from asphyxia in 3–10 min. Guinea pig lung is rich in mast cells which are present in the walls of the alveoli, around the bronchioles, and concentrated in the pleura. Anaphylactic shock brought out a significant reduction in the number of mast cells (Fig. 1, *A* and *C*, and Table 1), and degranulation and decrease of the metachromasia of the remaining granules in most of the cells (Fig. 1, *B* and *D*). Some mast cells retained their usual morphology. The diminution in the number of recognizable mast cells seemed to be due chiefly to loss of the granules from the cells located in the walls of the alveoli. In one additional group of five sensitized guinea pigs protected with anti-histamine (chlorprophenpyridamine maleate, 5 mgm. for each animal 1 hr. before the injection of the antigen) killed 2 hr. after the injection of the antigen, the mast cells presented the same alterations. Thus, antihistamine is ineffective in protecting mast cells from damage resulting from the specific antigen, seeming rather to act by blocking tissue receptors against free histamine than by preventing the release of histamine.

The injection of compound 48/80 induced a clinical picture similar to that presented by the sensitized animals injected with the antigen. However, no morphological and numerical changes could be found in the mast cells of these animals (Table 1). No significant differences in either number and morphology of the mast cells were found when groups II and IV of control animals were compared. The alterations of guinea pig mast cells in anaphylactic shock were very similar to those observed by Wilander and Jaques and Waters[3] in the dog in peptone and anaphylactic shocks.

The fact that anaphylactic shock produces alterations of the lung mast cells is suggestive of the mast cell origin of the histamine liberated during anaphylactic shock in the guinea pig. Histamine assays have shown that the histamine content of the guinea pig lung is correlated with its mast cell population and that in anaphylactic shock there is a correlated drop in both. It seems that guinea pig mast cells are much more resistant to the action of compound 48/80 than those of the rat. Thus, repeated intraperitoneal injections of compound 48/80, which practically cause the disappearance of mast cells from rat tissues[5], are ineffective in the guinea pig (unpublished results). It is interesting to note that in the guinea pig the release of histamine is not the major toxic action of compound 48/80 [6], and that the histamine-releasing activity of compound 48/80 is very small when its action is studied on the perfused guinea pig lung[7]. A comparative study of the behaviour of the mast cells and the histamine content of guinea pig organs

Table 1. MAST CELL COUNTS IN GUINEA PIG LUNG IN DIFFERENT CONDITIONS

Group	Treatment	Mean counts*	Stand. error	Range
I	Anaphylactic shock	75·3	± 7·7	62–98
II	Sensitized, injected with 200γ histamine	170·1	± 21·0	135–249
III	Injected with 500γ of 48/80	252·1	± 43·8	116–389
IV	Normal animals	255·0	± 32·0	160–334

* Number of mast cells in 13·64 mm.[2] of frozen lung sections.

F found, 8·4 ($P < 0·01$). *t* tests between groups I–II, I–III, I–IV, $P < 0·01$; between groups II–III, II–IV, III–IV, $P > 0·05$. Groups of five animals each.

under the action of several histamine-releasing substances is in progress and will be published later.

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Labelled Pronuclei in Mouse Eggs fertilized by Labelled Sperm

APPROXIMATELY 38 days after injecting adenine-8-^{14}C into mature male mice, ejaculated sperm showed an autoradiograph in smear preparations[1]. Pronuclei in eggs fertilized by labelled sperm have been examined for autoradiographs.

Fallopian tubes from a superovulated female, killed approximately 12 hr. after mating to one of these males, were fixed in Bouin. They were sectioned at 10µ, bleached in lithium carbonate, and coated with Kodak stripping film. The sections were stained with celestine blue and studied under a phase-contrast microscope.

Of twelve eggs examined, eleven had two pronuclei, and one had three pronuclei. In each bipronucleate egg one pronucleus showed an autoradiograph, and was assumed to be male. The unlabelled pronucleus was nearer the second polar body in six out of seven eggs in which the distance could be estimated; this agrees with the morphological evidence of the proximity of the female pronucleus to the second polar body. A possible autoradiograph on the vitellus of some eggs was perhaps related with the path of entry of the sperm. Spermatozoa in the perivitelline space, in the lumen of the tubes, and in the cumulus showed distinct autoradiographs.

In the tripronucleate egg, two pronuclei showed autoradiographs. The egg was presumably dispermic. The labelled pronuclei were larger than the third, and the second polar body had been extruded; this evidence supports the postulate of dispermy[2].

Calculation from data of total incorporation of the tracer in sperm[1] shows that for a pronucleus with diameter 20µ, sectioned at 10µ, and assuming all the tracer from the sperm to be present in the pronucleus and evenly distributed, the maximum density of the autoradiograph could be approximately $0{\cdot}2 \times 10^7$ grains/cm.^{2}. This value is at the limit for recognition[3]. But usually the tracer is concentrated in certain parts of the pronucleus, and this gives a more contrasted autoradiograph which can be clearly recognized.

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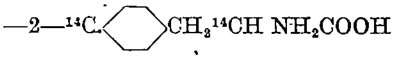
Conversion of Phenylalanine into Tyrosine in the Silkworm Larva (*Bombyx mori*)

IN silkworms, it has been found that tyrosine is used not only for biosynthesis of the silk proteins[1], but also to form melanin pigments, but little is known of its origin. The present work was carried out, using phenylalanine labelled with carbon-14, to examine whether phenylalanine is a precursor of tyrosine.

Radioactive L-phenylalanine,



(0·84 mc. per m.mol.), was obtained from the Radiochemical Centre. 0·5 µc. of radioactive phenylalanine (99 µgm. as amino-acid) per worm was injected into the body cavity of the silkworms, *Si* 122 × *Nichi* 122♂, at the fourth day of the fifth instar. Following the injection, these silkworms continued to feed normally for 72 hr. and then they began spinning their cocoons. Specific activity of the cocoon fibres measured with an *SC*-16 windowless gas-flow counter (Tracerlab Inc.) was 4·154 c./min./100 mgm. (average). 4·86 gm. of the radioactive cocoon fibres was cut into small pieces and degummed by boiling with distilled water and *M*/50 sodium carbonate solution repeatedly, until the weight of fibroin became constant. The fibroin was washed with ethanol and ether, and dried; the yield was 3·47 gm. 3·47 gm. of fibroin was hydrolysed with concentrated hydrochloric acid as usual. Tyrosine was isolated directly from the hydrolysate according to the procedure of Abderhalden[2]. From the filtrate from which tyrosine had been removed, glycine was removed as a salt of 5-nitro-naphthalene-1-sulphonic acid, and then alanine as azobenzene *p*-sulphonate, and these amino-acids were separated from their respective salts[3]. Tyrosine was recrystallized from hot water, and glycine and alanine from water by adding absolute ethanol repeatedly until their specific activities became constant.

Radioactivities of the amino-acids isolated from fibroin are summarized in Table 1. Almost all the activity was located in tyrosine.

Isolated tyrosine was analysed by paper chromatography, using phenol containing 0·1 per cent ammonia as a solvent. The strip was sprayed with ninhydrin in the usual way, the position of tyrosine

Table 1. RADIOACTIVITIES OF THE AMINO-ACIDS ISOLATED FROM FIBROIN

Amino-acids isolated	Specific activity	Yield from 3·47 gm. of fibroin (mgm.)
Tyrosine	41·147 c./min./mM	194
Glycine	26 ,,	101
Alanine	50 ,,	145

marked and the strip scanned for radioactivity by an *SC*-16 windowless gas-flow counter (Fig. 1). As shown in Fig. 1, high radioactivity was recognized at the position of tyrosine. A radioautograph obtained by superposition of an X-ray film on the chromatogram of isolated tyrosine at 1° for two weeks gave also an image at the position of tyrosine. These results seem to suggest that the tyrosine isolated is labelled with isotopic carbon.

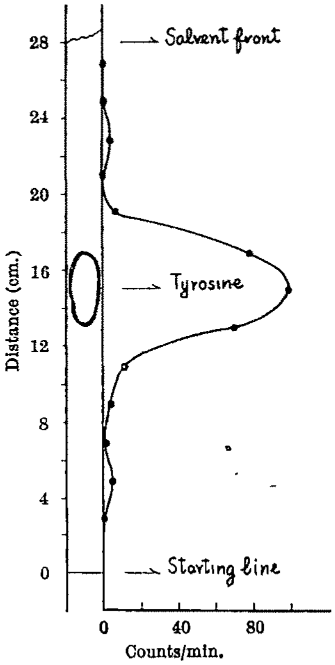


Fig. 1. Radioactivity of chromatogram of isolated tyrosine. Phenol run from starting line

In view of the high tyrosine content of the cocoon fibres, Holtzmann[4] compared quantitatively the tyrosine intake of the silkworms with that of the cocoon fibres produced, and suggested that the mulberry leaves contained so much tyrosine that there was no need to suppose that the silkworm synthesized tyrosine. Recently J. Kirimura (unpublished work) carried out the same experiment, using the microbiological method instead of Folin and Marenzi's method adopted by Holtzmann for the assay of tyrosine, and claimed that tyrosine was synthesized *in vivo*. The present work confirms that tyrosine is synthesized from phenylalanine *in vivo*, and then is utilized for biosynthesis of the silk proteins.

Raper[5], Mason[6] and others have suggested that melanin pigments are derived from tyrosine. Since the present work shows that tyrosine originates from phenylalanine in the silkworm, the mechanism of formation of melanin pigments in insects may be as follows :

Phenylalanine → tyrosine → dopa → dopaquinone → leucodopachrome → dopachrome → 5,6-dihydroxyindole → indole-5,6-quinone → melanin.

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Effect of Cortisone on the Reticulo-Endothelial System

PATIENTS undergoing cortisone treatment are very liable to intercurrent infection[1]. Further, it has been established by animal experimentation that cortisone enhances all the common bacterial infections[2], including those with spirochætes[3] and the tubercle bacillus[4].

Preliminary investigations by Nicol and Snell[5] showed that, in the guinea pig, cortisone depresses the activity of the reticulo-endothelial macrophages especially in the spleen, and suggested that this was the manner in which the defences of the body are lowered against infection and new growth. These researches have now been extended, using different doses of cortisone and continuing the treatment for a longer period, and the results are recorded in the present communication.

Seventy-nine male guinea pigs aged about one year were used for the investigation. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The remaining seventy-two animals were divided into twelve groups each of which received 5, 10 or 25 mgm. of cortisone intramuscularly once daily for a period of 1, 2, 3 or 4 weeks in addition to the dye. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells present and the intensity of the vital staining.

In the animals which received cortisone treatment for one or two weeks, the intensity of the vital staining was markedly reduced in the macrophages of the spleen, liver and lymph nodes compared with the appearances in the controls. At the same time the mortality was high and the lymph nodes became atrophied. This depressant effect showed itself earlier in the animals which received the larger doses of cortisone. Post-mortem examination of the animals which died suggested that death had occurred as the result of the reticulo-endothelial system becoming depressed and unable to detoxicate the trypan blue.

In the animals which received cortisone for three or four weeks, the intensity of the vital staining was practically similar to that of the controls, the mortality was low and the lymph nodes were hypertrophied.

The above results show that the reticulo-endothelial system becomes markedly depressed during the first two weeks of cortisone treatment, then recovers to about the normal level during the third and fourth weeks. This suggests that patients should be specially protected from intercurrent infection during the early stages of cortisone therapy.

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Factors influencing the Transport of Sea Water Cations across the Ectoderm of *Fundulus heteroclitus*

In 1913 George G. Scott reviewed the then existing literature and added experiments of his own on the remarkable ability of adult *Fundulus heteroclitus* to withstand wide variations in the osmotic pressure of their environment[1]. The significance of his conclusions is retold in the easily observed hardiness of these teleosts. The survivors of such changes appear to function adequately to gross observations. Similarly the *Fundulus* embryos, although less than 2 mm. in diameter, and with tissues that are readily torn with sharp glass needles, will develop in extremes of distilled water and sea water with salts or sucrose added up to twice the normal osmotic pressure.

Following closure of the blastopore, the *Fundulus* embryo is essentially two compartments. The first is the yolk, which is entirely surrounded by the second, the embryo proper. This latter is not really homogeneous, for it consists of the syncytial periblast, in direct contact with the yolk, and the developing organs of the embryonic axis, as well as the ectoderm, which is the only tissue in contact with the surrounding medium. When Oppenheimer stages 22–26 are used[2], there are no orifices present, such as gill slits, or cloaca, so it will be seen that a single membrane is presented to the external environment, and that the yolk compartment is totally surrounded. The changes in the cationic content of these two compartments are therefore functions of the permeability of the ectodermal membrane.

Studies of this permeability consisted of artificial media containing each of the cations sodium, magnesium, potassium, and calcium in the same concentrations as in sea water, and combining them in twos and threes, and singly as well as all four together. The chlorides were used throughout. Each medium was studied with sucrose to balance the osmotic pressure to that of sea water as well as without the sucrose. Radiotracer sodium, calcium and potassium were used. Magnesium was studied by photometric microchemical analysis. Total cellular sodium and potassium were estimated by flame photometry, while total calcium was estimated by a photochemical technique using ethylenediaminetetraacetate. The uptake and loss of ions under the influence of 0·05 *M* fluoride and 0·001 *M* iodoacetate were studied.

The uptake curves were essentially linear with a decrease in the slope near equilibration. Fluoride changed only the slope, but not the linearity, except for sodium, which developed a biphasic curve. Loss of ions into media lacking them also followed a linear pattern. Fluoride again changed the slope but not the linearity.

When the effects of presence and absence of ions were considered, several patterns appeared. When magnesium and potassium were combined, the result was always an increased gain in magnesium and inhibition of potassium. Calcium and sodium were mutually antagonistic, as were calcium and the two other ions. The change in osmotic pressure gained by removal of sucrose profoundly altered many ion balances.

The position of the yolk requires that any ions entering or leaving it must pass across the dual membrane that surrounds it. The inner half of this is the syncytial periblast. Parpart, in a discussion of a paper by Sheppard and Stewart[3], raises the pertinent question as to just where in the cell is the potassium (and for that matter, the other ions as well). In an epithelial layer, if the ions existed and moved in the plasma membrane complex of the individual cells, then they could travel across a cellular membrane by passage in some manner along the cell membranes that run vertically in the epithelium. No such 'passage-ways' exist across the periblast. Radiotracer sodium, calcium, and potassium have been recovered from, and observed to pass out of, the yolk of *Fundulus* embryos. The results failed to indicate whether magnesium did the same. Unless some specific mechanism can be demonstrated, such as fragmentation of the plasma membranes or intermittent functional contact between opposite layers, this represents evidence that ions pass in some fashion through the medullary cytoplasm of cells.

Studies with the fluoride ion suggest that a glycolytic mechanism provides energy for the transport of ions both into and out of the cell. Patterns of inhibition and facilitation suggest that to some extent places on a transport mechanism are nonspecific.

The internal colloid pressure of these eggs is about 20–25 per cent of the surrounding sea water, and some mechanism may be active to maintain this. Indirect evidence from these studies suggests that part of the water may be under the influence of glycolysis. Each of the partial media is hypotonic to sea water and should dilute the egg contents. In some examples, however, concentration occurs. Based on this indirect observation, fluoride added to sodium balance in the presence of a constant osmotic pressure (from sucrose) showed a marked increase in the intracellular sodium, which is opposite to both the effect of fluoride by itself and the change that comes from adding sucrose to maintain the external colloid pressure. The time course was two-and-a-quarter hours, or insufficient time to lose significantly other intracellular ions in the presence of fluoride. This is interpreted as fluoride interfering with mechanisms which normally carry water into the egg, the loss being a manifestation of the markedly higher external colloid pressure. That the egg may indeed have some control is further shown by reducing the external osmotic pressure to about 75 per cent of its normal value, at which point the influence of 0·05 *M* fluoride in this time interval is essentially none on the same situation. The effect of higher concentrations of fluoride has not been studied.

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Organic Binding of Iodine in the Endostyle of *Ciona intestinalis*

It has very commonly been supposed that the endostyle of the Protochordata is homologous with that of the ammocœte larva and is thus the forerunner of the thyroid gland, which is well known to develop from the ammocœte's endostyle when this animal metamorphoses into the adult lamprey. This interpretation has, however, come under criticism as a result of recent investigations which have established the existence of thyroidal function in the endostyle of the ammocœte[1,2], but have failed to demonstrate any organic binding of iodine in the endostyle of the Tunicata, although this has been shown to occur in the stolonic septum of *Perophora annectens*[3]. These findings have been held to indicate that the endostyle "may not be the homologue of the thyroid"[3], and that "it is probably unfortunate that the elongated subpharyngeal glandular sac of cyclostome larvae . . . has come to be known as 'endostyle' "[4].

This uncertainty of interpretation has led us, in the course of a study of endostylar function in the ammocœte, to examine the situation also in *Ciona intestinalis*. The existence of iodine in the ascidian test has long been known[5], but we are now able to report that autoradiographs of *Ciona*, prepared by the stripping-film technique, clearly demonstrate the presence of bound iodine both in the epithelial cells at the base of the test and also in the endostyle. In the latter organ it is found in a well-defined zone of non-ciliated epithelium which lies along the medial sides of the lips of the endostylar groove; this zone lies dorsal to, and is quite distinct from, the glandular tracts which provide the secretion utilized in the feeding mechanism. A dense deposit of iodine is also associated with an equally well-defined zone of ciliated epithelium which forms the summit of the lips, and which is said to sweep the endostylar secretion out of the groove and on to the lateral walls of the pharynx, where it aids in entangling the food particles[6]. It thus seems probable that the iodinated product must become mixed with the food and transferred to the intestine, and in agreement with this we do, in fact, find iodinated material on the wall of the pharynx and in the intestinal contents.

The association of thyroidal products with the bound iodine in the endostyle of *Ciona* is still to be established, although it is rendered highly probable by the known existence of thyroxine or its precursors in the epithelial or skeletal tissues of invertebrates as diverse as cœlenterates, annelids and molluscs[4,7]. It has been plausibly argued[4] that such iodinated amino-acids might often have been formed 'accidentally', and that the thyroid gland might have arisen in the Chordata in consequence of these compounds becoming directly involved in metabolism, with the resulting need for localization and specialization of the source of iodoprotein. From our study of the ammocœte's endostyle we had already concluded that the organization of its epithelium could best be understood on the view that it comprised two distinct types of secretory process, one alimentary (in the general sense of being concerned in the feeding mechanism) and the other thyroidal, and even on the present limited evidence the similarity between this situation and that in *Ciona* is striking enough to suggest that the first steps in the evolution of thyroidal function may already have been initiated in the protochordate endostyle. In this connexion it may be significant that secretory inclusions which are positive to the periodic-acid–Schiff test are conspicuous in the non-ciliated iodine-binding cells of the endostyle of *Ciona*, for we have also found characteristic inclusions positive for the periodic-acid–Schiff test in the thyroidal cells of the ammocœte's endostyle and believe that these may well be homologous with thyroid colloid.

These investigations are continuing, but the facts at present available appear to us to offer the strongest support for the interpretation of the protochordate endostyle as the homologue of the thyroid gland, and for the old-established view that the history of the latter "has been one in the course of which a feeding structure has been transformed into a gland of internal secretion"[8]. They carry also the implication that the characteristic features of thyroidal function may eventually prove to have been established much earlier in the chordate line than has previously been suspected.

We are indebted to Miss J. Plumtree for technical assistance.

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Examples of Anti-competitive Inhibition

Anti-competitive (uncompetitive) inhibition, in which the inhibitor combines with the enzyme-substrate complex but not with the enzyme, has been considered theoretically by Burk in Ebersole, Guttentag and Wilson[1].

The kinetic equation for this type of inhibition is

$$\frac{1}{v_i} = \left(1 + \frac{[I]}{K_i}\right)\frac{1}{V^0} + \frac{K_s}{V^0}\,\frac{1}{[S]}$$

where v_i is the velocity of the enzymatic reaction at substrate concentration $[S]$ in the presence of inhibitor concentration $[I]$, V^0 is the maximum velocity in the presence of inhibitor and K_i and K_s are the inhibitor and equilibrium constants respectively. If anti-competitive inhibition occurs, the plots of $1/v_i$ against $[I]$ at different substrate concentrations, or

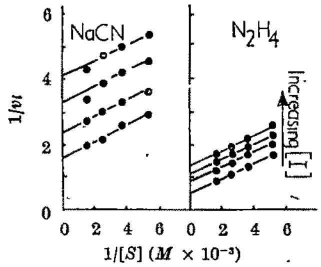

Fig. 1. Relation between $1/v_i$ and $1/[S]$ for the arylsulphatase of *Alcaligenes* using four different concentrations ($6·25 \times 10^{-3}$, $12·5 \times 10^{-3}$, $18·7 \times 10^{-3}$ and 25×10^{-3} *M* sodium cyanide or hydrazine) of inhibitor

$1/v_i$ against $1/[S]$ at different values of $[I]$, yield families of parallel lines[1,2].

Known cases of this type of inhibition are rare. An example is afforded by the combination of azide with the oxidized form of the *Atmungsferment*[3], and it seems to us that the inhibition of pepsin with hydrazine[4] provides a second example. Two further examples have now been obtained during investigations of the inhibition of the arylsulphatase of *Alcaligenes metalcaligenes*. Using *p*-nitrophenyl sulphate as substrate, the plots of $1/v_i$ against $[I]$ or $1/v_i$ against $1/[S]$ for the two inhibitors, sodium cyanide and hydrazine hydrochloride, gave families of parallel lines, an example of which is shown in Fig. 1.

An examination of the variation of K_m with change in *p*H had indicated that the complex arising from the combination of this arylsulphatase and *p*-nitrophenyl sulphate contains a dissociating group (*pK* at *p*H 7·9) which is not present in the enzyme alone[5], and this may be the group which reacts with cyanide and hydrazine. Moreover, the degree of inhibition of the enzyme caused by cyanide and hydrazine varies with *p*H and increases sharply above the region of *p*H 7·9.

The inhibition of other arylsulphatases by carbonyl reagents, such as cyanide and hydrazine, has been previously noted[6-8], and it has been suggested by Rosenfeld and Ruchelman[6], for the arylsulphatase of takadiastase, that the enzyme contains aldehydic groups which are essential for activity. If, on further examination, these cases of inhibition also prove to be anti-competitive, then the views of Rosenfeld and Ruchelman would need to be modified, since the inhibitor-coupling group would not be present *in esse* in the enzyme.

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Avidity of the Tetracyclines for the Cations of Metals

THE high affinity of chlorotetracycline (aureomycin) and oxytetracycline (terramycin) for the cations of heavy metals has been reported[1]. This investigation is now extended to the parent substance, tetracycline, with the results shown in Table 1, which also includes some new values for the substituted tetracyclines.

Ionization Constants. Tetracycline hydrochloride, dried for an hour in air at 110°, was dissolved (0·001 *M*) in boiled-out water and titrated potentiometrically under nitrogen with three equivalents of 0·1 *N* potassium hydroxide added in thirty equal portions. This gave the three ionization constants: 3·35 (basic), 7·82 and 9·57 (all within ± 0·06). The two acidic constants, being close together, were separated by Noyes's method[2]. Consideration of inductive effects indicates that these constants belong to the 2-, 5- and 7-positions respectively because they are all higher (up to 0·4 unit) than those of chlorotetracycline, which are higher than those of oxytetracycline[1].

Stability Constants. One half atom of a di- (and one third of a tri-) valent metal per molecule of chelating substance was added as a salt to a fresh portion of solution which was titrated as above (two equivalents of alkali only). Aluminium was introduced as alum, and ferric iron as the nitrate recrystallized from dilute nitric acid, dissolved, adjusted to *p*H 2 and standardized (this prevented interference by the bisulphate ion previously encountered with ferric ammonium sulphate[1]). For determination of log K' of ferric ion, the solution had to be back-titrated with *N* nitric acid (7 equiv.). Formation curves showed good inflexion between the steps of complex-formation[3], and hence the appropriate calculations were those used for the simpler amino-acids[4]. Foaming was observed as before[1].

It is seen from Table 1 that the stability constants of tetracycline are similar to those of its chloro- and hydroxy-derivatives[1]: the overall ferric value (K_s), however, is exceptional in being 1,260 times greater. The affinity of the three tetracyclines for divalent cations is of the same order as those of the common amino-acids[4] which do not combine appreciably with ferric ion.

It is not yet known if the antibacterial action of the tetracyclines is connected with their metal-

Table 1. STABILITY CONSTANTS FOR THE METAL COMPLEXES OF THE TETRACYCLINES

Cation	Log K' (1 : 1-complex)	log K'' (2 : 1-complex)	log K_s (overall)	Colour of complexes
	Tetracycline			
Fe^{3+}	9·9	8·6	25·3[b]	Red
Al^{3+}	7·4	6·4	19·2[e]	Yellow
Cu^{2+}	7·8	5·0	12·8	Green
Ni^{2+}	6·0	5·0	11·0	Green
Fe^{2+}	5·3	4·0[a]	9·3	Red
Co^{2+}	5·4	4·4	9·8	Yellow
Zn^{2+}	4·9	ppt	(9)[f]	Yellow
Mn^{2+}	4·4	ppt	(8)[f]	Yellow
	Chlorotetracycline			
Fe^{3+}	9·4	7·2	22·2[c]	Red
Al^{3+}	7·2	ppt	(18)[f]	Yellow
Ni^{2+}	5·8	4·7[a]	10·5	Green
	Oxytetracycline			
Fe^{3+}	9·6	7·2	22·5[d]	Red
Al^{3+}	7·0	ppt	(18)[f]	Yellow
Mg^{2+}	3·8	—	—	Green

(*a*) Precipitation prevented direct determination. Hence log K'' was obtained by subtracting log K' from log K_s (which was found at $\bar{n} = 1$).

(*b*), (*c*), (*d*), (*e*). These values include a log K''' of 6·8, 5·6, 5·7, and 5·4 respectively.

(*f*) Deduced values (approx.).

binding powers, as that of 8-hydroxyquinoline is[5]. Dr. A. J. Tomlinson, who has kindly compared these substances on *Staphylococcus aureus*, reports that the tetracyclines kill much more slowly than 8-hydroxyquinoline and, unlike the latter, are highly active in iron-depleted media. In any event, knowledge of the metal-binding properties of these drugs is valuable because in the human body they cannot fail to combine with metallic cations. Model experiments[6] have shown that the practice of giving alumina with the tetracyclines (to prevent gastric irritation) completely inactivates them, as the constants given here would suggest.

We thank Dr. B. L. Hutchings of Lederle Laboratories for the chemically pure tetracycline.

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Stabilized Interference Fringes on the Retina

A method of producing a stabilized retinal image (that is, an image which is stationary on the retina) was first described in *Nature*[1], and other work has been reported elsewhere[2-4]. Here we describe a method of producing a stabilized image with interference fringes. A cylindrical unit 6 mm. in diameter and 3 mm. thick is formed by cementing a calcite crystal between two pieces of 'Polaroid'. This unit is cemented to a steel ball which fits tightly into a ball-socket joint on a stalk fixed to a contact lens as shown in Fig. 1.

If convergent light is incident as shown, the subject wearing the contact lens sees a pattern of rings and brushes when the eye is focused for infinity. The centre of the pattern is in the direction of the optic axis of the calcite and the image on the retina is stabilized provided that this axis is fixed relative to the optic axis of the eye. It has been previously shown[5,6] that a well-fitting contact lens follows small eye movements very accurately.

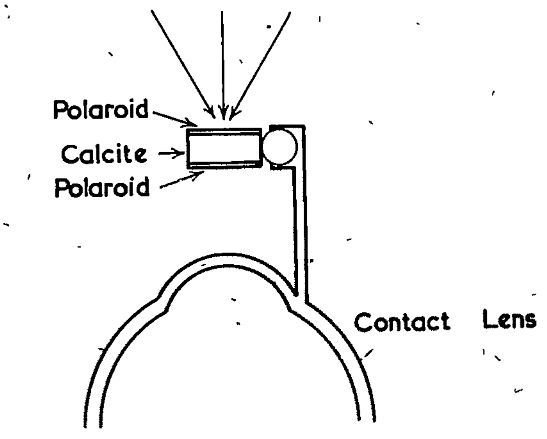

Fig. 1

When the subject first looks at a suitable source, the fringes are clearly seen but they fade in a period of 1–5 sec., leaving a grey field which sometimes goes black. This fade-out persists for about 10 sec., after which the eye makes a sharp and uncontrollable movement and the fringes are again seen very clearly. Sometimes the fringes reappear much less clearly and over only a part of the field without any violent movement of the eye. The fade-out has been observed at the very high brightness obtained by allowing the subject to view a bright cloud through the unit. With light interrupted at a suitable frequency the image does not fade out.

Other ways of producing stabilized fringe systems on the retina are being investigated. A sharp fringe pattern has been obtained by substituting a small Fabry–Perot étalon for the 'Polaroid'–calcite unit and the fade-out has been observed with this arrangement.

The method here reported is not suitable for certain types of experiment which can be carried out with the apparatus previously described[3], but for some experiments it has considerable advantages of simplicity and convenience.

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Bombardment of Glass by Alpha-particles

In the course of work previously carried out elsewhere, the production of a solid amorphous deposit in soda-glass vessels containing solutions of radium salts was observed; visible quantities were produced, for example, in six months by a solution containing 3 mgm. of radium (as chloride) in 25 ml. of solution. Recently, further investigations have been undertaken on this effect, which is attributed to the physico-chemical breakdown of the surface of the glass following α-particle bombardment.

The solid formed by the action of strongly α-active solutions upon glass is of an amorphous flocculent nature and off-white in colour. After thorough washing, spectroscopic analysis of a typical sample showed silicon as the only major constituent. The solid is strongly adsorbent. Irradiation of glass by a 30-curie cobalt-60 source to give absorption of a γ-ray flux comparable to the α-particle energy deposited, followed by prolonged digestion with water on a steam-bath, did not bring about any formation of solid material in the digesting liquid.

In the present experiments, radon was used as a source of α-particles. Irradiations were carried out in the presence and absence of water; subsequent digestion at 80° C. with dilute acid produced solid deposits in both cases. To the naked eye, these products appeared to be of different types, in that that from the dry-way irradiation appeared to be in the form of minute plates, whereas irradiation in the presence of water produced the amorphous solid previously observed. X-ray diffraction photographs, however, showed that both solids were amorphous.

The leaching of soda-glass and 'Pyrex' samples irradiated in the dry state has been followed by measuring the build-up of 'soluble' silica in the aqueous phase. Analysis was carried out by measuring absorptiometrically the colour produced by the reduction of the silico-molybdic acid complex with ascorbic acid (Gibson, unpublished work at Harwell). Fig. 1 shows the results for soda-glass samples. After the initial attack, complete in about seven hours for irradiated soda-glass and in about twelve hours for 'Pyrex', leaching takes place at a steady rate which is characteristic of the original material. The effect of α-particle dose is clearly shown. Soda-glass yields approximately ten times more silica than 'Pyrex', for equal intensity of irradiation. There was no detectable difference in the small quantities of sodium leached from normal and irradiated soda-glass.

Slight changes in density have been observed in both 'Pyrex' and soda-glass after α-particle bombardment.

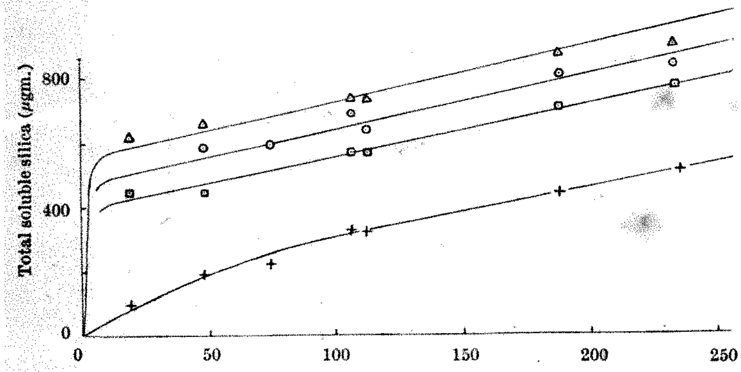

Fig. 1. Leaching of silica from irradiated soda glass: ⊡—⊡—, 10^{14} α-particles/cm.^{2}; ⊙—⊙—, 2×10^{14} α-particles/cm.^{2}; △—△—, 3×10^{14} α-particles/cm.^{2}; +—+—, unirradiated sample

The overall α-particle dose absorbed by the glass is smaller than that predicted by Seitz[1] as necessary to cause significant changes in the physical properties of a solid. A microscopic study of the surface of the irradiated specimens has been carried out by Mr. D. R. Knowles (U.K. Atomic Energy Authority (I.G.), Culcheth, Lancashire; private communication), whose assistance is gratefully acknowledged. This reveals small localized areas of affected surface on the irradiated specimens, suggesting that non-uniform α-bombardment may have occurred. This work, and that on other aspects of the problem, are continuing; it is hoped to publish a fuller account elsewhere.

This communication is published by permission of the Managing Director, United Kingdom Atomic Energy Authority (Industrial Group).

D. G. Tuck

Chemical Services Department,
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Windscale Works,
Sellafield, Cumberland. Nov. 1.

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Heat Convection from the Earth's Surface

Evidence has been presented[1] which suggests quite strongly that a regime of effectively free convection of heat begins to operate in the surface layers of the atmosphere at a negative Richardson number as low as 0·02 or 0·03. It is improbable that this can take the form of regular cellular convection of the type studied by Rayleigh and recently elaborated by Malkus[2], for this would require in a layer of depth h that

$$\frac{-\frac{g}{\theta}\frac{\partial\theta}{\partial z}h^4}{\kappa\nu} > 1{,}100 \text{ at least,}$$

the symbols having their usual significance. If we replace κ and ν by their turbulent counterparts

$$K_H \approx K_M \approx k^2z^2\left(\frac{\partial u}{\partial z}\right)$$

and average through the depth of the layer, then

$$\overline{K_H} \approx \overline{K_M} \approx \alpha k^2h^2\,\overline{\frac{\partial u}{\partial z}}$$

where α is less than but comparable with unity. This transforms the Rayleigh criterion into a Richardson criterion

$$\frac{-\frac{g}{\theta}\frac{\partial\theta}{\partial z}}{\left(\frac{\partial u}{\partial z}\right)^2} = -Ri > 28\,\alpha^2$$

When there is some wind and wind shear, therefore, cellular convection should not set in until $-Ri$ exceeds a value of order 1–10, whereas the free-convection regime in fact effectively sets in at a very much smaller value.

By considering the dynamics of convection in isolated columns in a thermally stratified environment, it may be shown, from the equations formulated by Priestley and Ball[3], that the heat flux brought about by spontaneously generated columnar convection may exceed that due to forced convection provided that $-Ri > 0·035$. If we now consider these columns as drawn out by the wind into vertical planes, from which heat and vertical momentum are lost by diffusion in only one horizontal dimension rather than two, the free convection at a given lapse-rate would be yet stronger; convection in this form can exceed the forced convection when $-Ri > 0·011$. There is therefore reason in theory to expect free convection to begin to operate at quite small Richardson numbers, and to take initially the planar form with orientation downwind, with an increasing proportion of columnar forms as $-Ri$ increases. A number of other lines of evidence (see, for example, ref. 4) support the appropriateness of this picture.

There is a limit to the rate at which Nature requires heat to be carried away from the surface. Since the columnar and planar forms of convection appear capable of disposing of the heat at sufficient rate, the very strong temperature gradients required for the onset of cellular convection of the Rayleigh type will not in general be realized.

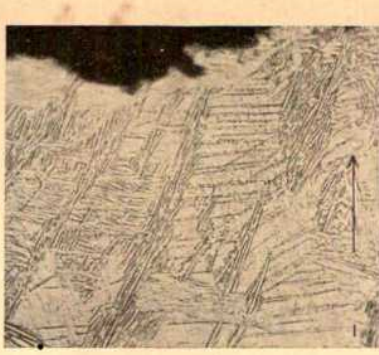

Fig. 1. Mechanical twinning near the fracture in tensile specimen of *RC*-130*B* titanium alloy. × 250

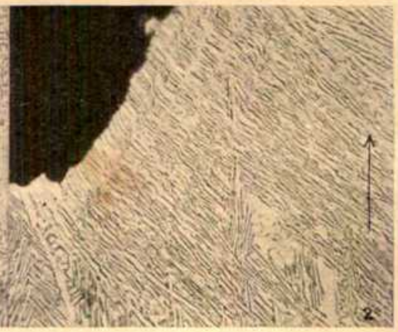

Fig. 2. Steplike twin structure near fracture in tensile specimen of *RC*-130*B* titanium alloy. × 250. Arrows show direction of tensile stress

Measurements of heat flux[5] have indicated[1] that the complete transition from forced to free convection may take place much more sharply than had previously been supposed. This is thought to be a manifestation of the tendency of the temperature profile to adjust itself to the heat flux, and in particular to adopt a form which permits a constancy of heat flux with height. From the dynamics of the columnar and planar forms of convection, it can be shown that, assuming the profile to be of the form

$$\frac{\partial\theta}{\partial z} \propto z^{-\delta}$$

the constancy of heat flux is satisfied when $\delta = 1$ and forced convection dominates, and when $\delta = 4/3$ and free convection dominates, but not in the intermediate state when both mechanisms are operative. Close to the ground will be a layer where forced convection is dominant, provided some wind is blowing. But above the level at which the effects of free convection first begin to be felt, there will be a strong adjustment bias towards the 4/3 power law which allows free convection to dominate. Under ideal conditions of test, that is, when lag and advective effects are negligible, the intermediate state should occupy only a rather narrow range of levels (under given conditions) or of conditions (at a given level) and would tend to be transient. A fuller account of this work is in preparation.

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Sept. 22.

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Metallographic Evidence of Mechanical Twinning in an Alpha-Beta Titanium Alloy

As part of an investigation of the response of titanium alloys to heat treatment, longitudinal metallographic sections were prepared through the fracture region of broken tensile specimens. Metallographic examination of the tensile fractures of commercial titanium–aluminium–manganese (92–4–4) alloy (*C*-130*AM*), heat-treated to produce acicular alpha in a beta matrix, has resulted in the discovery of structures tentatively identified as mechanical twins.

An example of the appearance of the twinned structure is shown in Fig. 1. The twinned orientation is confined to the close-packed hexagonal alpha phase, but appears to pass unhindered through the intervening body-centred cubic beta phase, so that each twin can be followed across several adjacent alpha needles. No evidence of twinning is visible in the beta phase, indicating that the twinning distortion is carried through the beta phase by a slip process.

Another example of twinning in this alloy is shown in Fig. 2. A large movement of the alpha needles is evident, forming a pronounced steplike structure. It is improbable that this amount of distortion could be developed during polishing. Therefore it is concluded that twinning occurs normally during the deformation process.

Twins thus far observed have tended to be quite broad and to be lens-shaped in appearance. This appearance has been shown by Rosi *et al.*[1] to be typical of $\{10\bar{1}2\}$ type twins in alpha-titanium.

The two structures shown were obtained during examination of standard 1-in. gauge-length round tensile specimens broken with a platen speed of 0·01 in. per min. Total elongation before fracture was approximately 8 per cent. These specimens had been heat-treated to produce a fine acicular alpha structure in a continuous beta matrix by heating into the all-beta field and cooling at a rate sufficiently slow to promote the nucleation and growth of the acicular alpha structure. With this heat treatment, the coarseness of the alpha needles can be controlled to a considerable extent by controlling the rate of cooling through the beta-to-alpha transformation.

Twinning has also been observed in specimens heat-treated to produce considerably coarser alpha needles; but, in these cases, the extent of twinning was much less. Twinning was generally most prominent in the region of fracture; but occasional isolated regions showing twinning have been observed at considerable distances from the fracture.

If X-ray examination confirms these structures to be true mechanical twins, the observation that twinning can be propagated across intervening non-twinning material without loss of continuity of the twin boundary should prove of assistance in developing a suitable theory of the twinning process.

This research was carried out as part of an investigation of the heat treatment of titanium alloys, sponsored by the Aircraft Gas Turbine Division of the General Electric Company. Permission to publish these results is gratefully acknowledged.

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Oct. 31.

[1] Rosi, F. D., Dube, C. A., and Alexander, B. H., *Trans. Amer. Inst. Min. Metall. Eng.*, **197**, 257 (1953).

Additional Records of *Haplosporangium parvum* in Mammals in Britain

THE presence of a pulmonary fungus, *Haplosporangium parvum* Emmons and Ashburn[1], has been reported recently by McDiarmid and Austwick[2] in moles, *Talpa europaea*, in England. The identity of large spherules, 100–390 microns in diameter, found in the lungs was confirmed by culture. These findings are of particular interest to me as they help solve a parasitological enigma encountered in Britain in 1945.

While on military duty in England, I examined a considerable number of small mammals which I trapped between October 22, 1944, and March 5, 1945, on the chalk downs near Camp Blandford, two miles north-east of Blandford, Dorset. The lungs of some of these mammals contained hard, discrete spherules ranging up to 250 microns in diameter. Each spherule, which was visible to the naked eye, could be removed easily with forceps. It appeared to have two walls and was filled with 'cells' resembling oil globules. When pressure was applied, it cracked audibly. In a few specimens the lung tissue surrounding a spherule was cloudy in appearance, possibly fibrotic. Some animals were infested with a large number of the cyst-like objects.

Notes made at the time (January 17, 1945) read as follows: "Today I saw Dr. H. A. Baylis of the British Museum to whom I had sent parasitic worms for identification. He is particularly interested in the cysts from the lungs of *Clethrionomys*. He cannot determine what causes them. He expected to find trematode larvæ within but was unable to demonstrate such. According to him, the interior of a cyst is composed of nothing but oil globules; therefore, when a cyst is sectioned for microscopic examination it appears to be empty. Lungs which Baylis cleared show how evenly and thickly the cysts are distributed through the tissue. As an alternative to trematode larvæ, Baylis thought the cysts might have been caused by mites or pollen grains. In favour of the mite theory he had noted in some instances a suggestion of spines within a cyst. However, the hard shell is composed of two layers: an outer one formed by the lung tissue and an inner one presumably formed by something within the cyst".

This experience closely parallels that of American workers when the large form of *Haplosporangium* was encountered and described as an undetermined parasite[3].

I have since become familiar with *Haplosporangium* in North American rodents and am certain that the spherules observed in the lungs of rodents in England are the same. The work of McDiarmid and Austwick (*l.c.*) tends to confirm this identification. The lung specimens from Camp Blandford were left with Dr. Baylis. In reply to a recent inquiry, officials of the British Museum stated that Dr. Baylis had retired and the specimens could not be readily found.

Mammals examined and infections detected at Camp Blandford were as follows: *Apodemus sylvaticus*, sixty (one infected); *Apodemus flavicollis*, three (one infected); *Clethrionomys glareolus*, thirty-eight (nine infected); *Sorex araneus*, thirteen; *Sorex minutus*, six; *Microtus agrestis*, one; *Mus musculus*, two; *Talpa europaea*, one; and *Erithacus rubecula*, one.

These records extend the host range of *Haplosporangium parvum* in Britain to three additional mammal species. The parasite is not yet known from man.

This communication was prepared at the suggestion of, and with assistance from, Dr. William L. Jellison, of the United States Public Health Service.

LLOYD TEVIS, JUN.

Department of Zoology,
University of California,
Davis, California. Oct. 17.

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[2] McDiarmid, A., and Austwick, P. K. C., *Nature*, **174**, 843 (1954).

[3] Jellison, William L., *Proc. Helmin. Soc. Wash.*, **14**, 75 (1947).

Attempts at Hybridization of Chickens and Turkeys which are Tolerant of Each Others' Antigens

IN a recent communication in *Nature*, Simonsen[1] described experiments which showed that injection of turkey blood into chick embryos both delayed the appearance of natural agglutinins and suppressed the formation of immune agglutinins when the young birds were injected with turkey blood some weeks after hatching. Moreover, turkeys injected as embryos with chicken blood proved to be susceptible to infection with Rous sarcoma virus at an age by which this species is normally resistant to it. Tests relating to his third purpose, namely, to see whether a sexual cross between species, which is not normally possible, could be made so by acquired tolerance, are summarized here. They do not, however, provide any evidence that the tolerant birds were more able to produce hybrid offspring than normal ones. Both Warren and Scott[2] and Quinn, Burrows and Byerly[3] obtained at least slight development in a proportion of the eggs in both reciprocal crosses between normal turkeys and chickens, although only about 1 per cent of the chicken eggs proved fertile.

In making the reciprocal crosses, semen was collected from the male birds, and the females were inseminated by the methods of Burrows and Quinn[4]. At first only semen from the blood-donor was used; later, in order to increase the volume per hen, that from several males was pooled. All eggs laid from one day after the first insemination to ten days after the last were incubated.

There were seven experimental Brown Leghorn hens which had been injected intravenously with 0·05–0·2 ml. of turkey blood on the ninth, tenth or eleventh day of incubation. Three of these had been immunized with turkey blood after hatching until their tolerance broke down. Five additional birds had been injected under the blastoderm, either before incubation or after one day in the incubator; they had received no post-hatching treatment. These twelve hens were inseminated from one to eight times each, the average being about four times, usually at intervals of three to four days. The volume of semen per insemination ranged from 0·025 to 0·1 ml. per hen, 0·1 ml. being most frequent. In all, eighty-two eggs were set: the minimum per hen was one (one hen only); the maximum, eighteen. The eggs were candled after five to seven days incubation when, without exception, they appeared 'clear'; forty-three were opened and it was confirmed that no fertilization had occurred.

Only three experimental turkeys and two controls were available. Two of the experimental birds had received intravenously 0·1 ml. of blood from a Brown Leghorn cock on the thirteenth day of incubation; the third had received the same quantity on the twentieth day. All five birds had been immunized with the cock's blood after hatching. They had been isolated from mature male turkeys throughout but, in view of the findings of Olsen and Marsden[5], several eggs from each (altogether forty-four) were incubated before insemination began, to check the possibility of parthenogenetic development; there was no evidence of this in any of them. Each bird was inseminated five or six times at intervals of three to four days; the volume given ranged from 0·2 to 0·75 ml. but was usually 0·4, 0·5 or 0·6 ml. Of six potentially fertile eggs from the controls, three developed small blood rings. Of thirty-three from the experimental birds, two developed small blood rings, nine showed slight embryonic development (less than two days), one died at about the three-day stage and one at about fifteen days. Thus approximately 50 per cent of each group showed some evidence of cellular proliferation at least. In view of the small numbers involved, the greater development in some of the eggs of the experimental birds cannot be considered significant, especially as previous workers[2,3] have obtained embryos of a still more advanced stage from normal parents.

These breeding tests therefore failed to indicate any positive effect of induced immunological tolerance on the chances of successful hybridization. It should be pointed out, however, that while the original treatment had suppressed the normal response to immunization, it had only delayed, not prevented, the formation of natural antibody; this may yet prove to be of some significance for the production of hybrids between species.

We are indebted to Mr. M. Pease for the provision of facilities at the Poultry Genetics Field Station, Boxworth, near Cambridge, for carrying out this work. One of us (M. R.) is in receipt of a personal grant from the Agricultural Research Council.

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Fibiger-Laboratoriet,
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Copenhagen. Nov. 10.

[1] Simonsen, M., *Nature*, **175**, 763 (1955).

[2] Warren, D. C., and Scott, H. M., *J. Hered.*, **26**, 105 (1935).

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Importance of Smaller Phytoplankton Elements

MARINE biologists have been slow to recognize that the smaller phytoplankton elements which will pass through the finest nets are of great importance in the productivity of the oceans. In order to get some quantitative data on this subject for eastern Australia (lat. 33–34° S.), we have recently conducted experiments in which 44 gallons of sea-water were pumped into a drum and filtered through a phytoplankton net having 170 meshes per inch. The filtrate was collected and the particulate matter was spun out of 2-litre aliquots using a continuous centrifuge running at 13,000 rev./min. and having a slightly coned cup of maximum internal diameter 4·5 cm. and height 3·8 cm.

Both the net fraction and the centrifugate were examined microscopically, using the fluorescence of chlorophyll, to count the photosynthetic organisms, and at the same time chlorophyll determinations were made. These determinations were carried out on acetone (90 per cent) extracts of the plankton at 665μ in a Unicam *SP* 500 spectrophotometer.

It has been found that the chlorophyll content of the centrifugate is 25–3,000 times as great as that of the net plankton, while the counts of organisms are 10–10^2 as high again.

So far, no determinations have been made during diatom blooms, and it is proposed to continue these studies over an annual plankton cycle, in an estuary, and in the open sea.

From the above figures, it can be seen that the smaller phytoplankton elements (nannoplankton) may be of far greater importance than the diatoms and dinoflagellates, a fact which has been recognized by Atkins[1], Harvey[2] and others, but concerning which quantitative data are scanty.

The work discussed in this paper was carried out as part of the programme of the Division of Fisheries of the Commonwealth Scientific and Industrial Research Organization of Australia.

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Sept. 30.

[1] Atkins, W. R. G., *Nature*, **156**, 446 (1945).

[2] Harvey, H. W., "Recent Advances in the Chemistry and Biology of Sea Water", 14 (Camb. Univ. Press, 1945).

Further Chromosome Counts in Orobanchaceae

IN addition to the chromosome counts for British parasitic plants belonging to the Orobanchaceae already published[1], three new counts have been obtained for foreign species. *Orobanche cernua* var. *desertorum* Beck (Indian material) was found to possess a diploid complement of 38, as do other members of the subgenus *Osproleon*, while *O. ramosa* L.

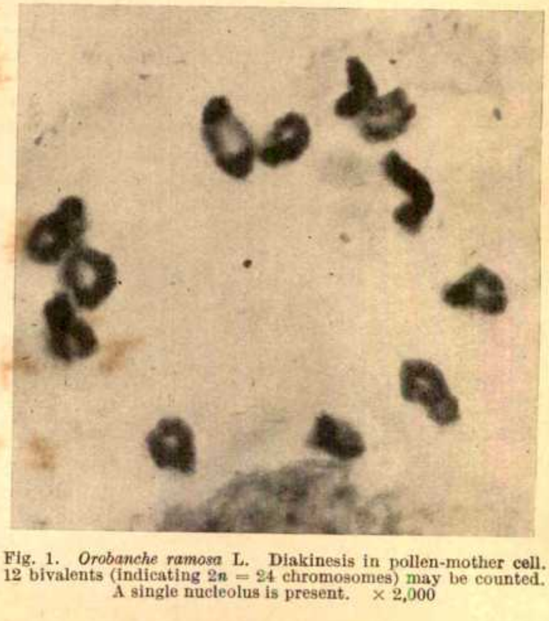

Fig. 1. *Orobanche ramosa* L. Diakinesis in pollen-mother cell. 12 bivalents (indicating $2n = 24$ chromosomes) may be counted. A single nucleolus is present. × 2,000

(German material) was found to have $2n = 24$ chromosomes, this being the number which I recorded for *O. purpurea* Jacq., another member of the subgenus *Trionychon*. *Cistanche tubulosa* Wight (Indian material) was found to have $2n = 40$ chromosomes. These three counts were made from meiotic stages in pollen-mother cells. The basic number of $x = 12$, which has been found for the two members of the subgenus *Trionychon*, may be contrasted with $x = 19$ for the members of the subgenus *Osproleon* ; it might be considered that the cytological evidence is such that the relationship between these subgenera is not so close as morphological features appear to indicate.

I am greatly indebted to Prof. Tiagi, of Government College, Ajmer, India, and to Dr. Paul Eberle, of the Botanical Institute, University of Freiburg im Bresgau, who determined, fixed and posted to me the Indian and German material respectively.

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Oct. 11.

[1] Hambler, D. J., *Nature*, 174, 838 (1954).

'Pearl-String' Artefacts in a Random Scatter of Spheres

FILAMENTS, similar to strings of pearl, are sometimes apparent in electron micrographs. This communication is to show that, unless other evidence is available, one is not justified in interpreting short formations of this kind as definite structures.

It has been previously shown (for example, Gross[1]) that particulate matter can be deposited in 'runs' on tilted electron microscope grids. The following experiment indicates that even in a random scattering of spheres, the discerning eye may see 'pearl strings' composed of as many as twenty-four units.

Glass spheres of about 0·1 mm. diameter (Ballotini, No. 14. English Glass Co., Ltd.) were scattered over a horizontal glass plate and projected in silhouette on to a screen. Such pearl-string formations as were readily apparent were noted and the number of spheres making up each one was recorded. The experiment was repeated a number of times with fresh scatterings of spheres. The results are given in Fig. 1. From this it is concluded that the eye readily aligns four to eight adjacent spheres into a string. There were very few scatterings in which no 'pearl strings' were seen, and they occurred particularly near the periphery of denser clusters of spheres, where presumably fairly regular packing can occur. The 'shadowing' common in electron microscopy practice could intensify the illusion of pearl strings, especially when applied to uneven, multilayer deposits.

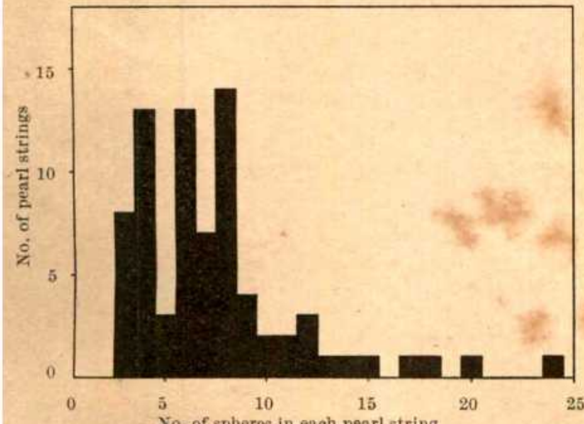

Fig. 1. Histogram showing frequency of occurrence of pearl strings of different lengths

I wish to thank Dr. A. G. Ogston for his interest, and the Medical Research Council for financial aid.

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Nov. 14.

[1] Gross, J., *Ann. N.Y. Acad. Sci.*, 52, 964 (1950).

A Simple Spinning Joint for a Rotary Film Evaporator

WHEN constructing a rotary film evaporator[1] without a rotating vessel for solvent recovery, we required a spinning joint which would remain airtight at a reduced pressure of 15–20 mm. mercury.

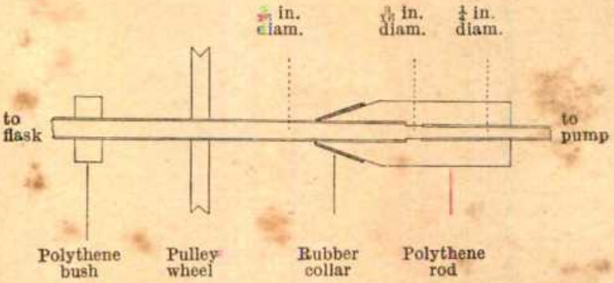

Fig. 1

A suitable joint (Fig. 1) was made using a 3-in. length of 1-in. diameter polythene rod which was drilled axially from one end to a depth of $1\frac{3}{8}$ in. with a $\frac{5}{16}$-in. bit and from the other to the same depth with a $\frac{1}{4}$-in. bit ; the bridge between the holes was drilled out using a $\frac{3}{16}$-in. bit. The rod was tapered to the larger hole and a sleeve of rubber tubing slipped over the distal part to improve the seal by constriction. A length of $\frac{1}{4}$-in. glass tubing was forced into the $\frac{1}{4}$-in. hole, the seal being improved with rubber grease ; this tube is stationary when the joint is in use. Glass tubing to fit the larger hole was carefully selected for size in order to obtain maximal ease of turning with a minimum of leaking. This was done by using a polythene washer ($\frac{5}{16}$-in. internal diameter) as a gauge. One end of the tube was carefully flamed to facilitate turning against the polythene shoulder. The flask containing the solution to be evaporated is attached to the other end. A pulley wheel to carry a belt drive was fixed part-way along this tubing. Well-constructed joints of this type when lubricated, for example, with silicone grease, will withstand the reduced pressure produced by a water pump without noticeable leaking while spinning at 120 rev./min. They have been used by us when removing hydrogen chloride and water from acid hydrolysates.

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Nature Conservancy,
Merlewood Research Station,
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[1] Craig, L. C., Gregory, J. D., and Hausmann, W., *Anal. Chem.*, 22, 1462 (1950).

A Rapid Variable-Temperature Micro- or Macro-Dialyser

Rapidity and completeness of dialysis are favoured by a high concentration gradient at the membrane, which, in turn, depends on rapid transport of dialysable material to and from the membrane. At the same time, it is desirable in certain studies to obtain the permeate in the smallest possible volume, to simplify manipulation and to minimize the relative magnitude of analytical blank values. The apparatus is based on these considerations; it is particularly suited for dialysis of suspended materials and can be used at temperatures between 0 and 100° C. We have employed it in the study of the soluble components of bacteria (in connexion with work conducted under a research contract (*NONR*–244(00)) with the Office of Naval Research), the amount of dialysable material varying between 0·1 and 40 mgm. of total nitrogen per experiment.

The essential components are a U-tube, a polyethylene-covered magnetic stirring bar, and a horseshoe magnet which is rotated by a small motor. The assembly is shown diagrammatically in Fig. 1. Interaction between the rotating outside magnet (arranged by trial) and the inside magnet moving up-and-down causes rhythmic movements of the casing and agitation of its contents. For larger assemblies the stroke of the inside magnet may be lengthened by putting two magnets end to end (UU) into the clamp. Continuous renewal of the outside fluid is provided by running water slowly through the U-tube. Temperature control is maintained by placing the assembly in a suitable bath. For temperature equilibration the water enters at the bead-filled leg of the tube. The permeate may be sampled or collected in aliquots at the other end. Connexions are made with polyethylene tubing which can be used up to 105°. 'Tygon' tubing releases ultra-violet-absorbing substances.

In order to avoid contaminations when dealing with low levels of nitrogen, rubber gloves should be used for knotting the cellulose casing, and water purified with 'Amberlite *IR*–120' for dialysis. 'Nojax' casings show no evidence of mechanical weakening after several hours in boiling water.

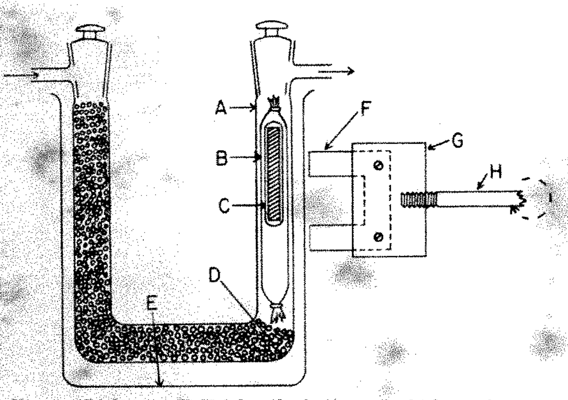

Fig. 1. Dialyser. *A*, U-tube, the bottom of which can be constricted to prevent beads from shifting into the right arm (absorption tubes, Schwartz, *T* 12/30 to 24/40 (the legs may be lengthened), No. *J*-310, Scientific Glass, Bloomfield, N.J.). *B*, dialysis casing knotted on both ends. *C*, stirring bar consisting of 2–6 cm. pieces of rod magnet slipped into polyethylene tubing, the ends being sealed by gentle heat (rod magnets, ⅛–⅜ in., Alnico grade 2 or 3, magnetized lengthwise, Permag Corp., Brooklyn 5, N.Y., covered with 'Intramedic' polyethylene tubing, wall thickness between 0·3 and 0·6 mm., No. *PE* 350 to *PE* 440. Clay-Adams, New York 10, N.Y.). *D*, 4 mm. glass beads. *E*, beaker. *F*, horseshoe magnet (rectangular U-magnet, outside length 1¾ in., inside length ¾ in., No. 71 *D* 778 *P* 4, Permag Corp.) held by aluminium clamp (*G*) and (*H*) the motor shaft (24 rev. per min. electric motor, No. 4 *K* 237, W. W. Grainger Co., Philadelphia, Pa.). The shaft should turn at about 10 rev. per min. The external water space of the U-tube ranged from 15 ml. for a 3-ml. dialysis casing ('Nojax' casing, 8/32 or 18/32 in. diameter, Visking Corp., Chicago 38, Ill.) to 100 ml. for a 50-ml. casing

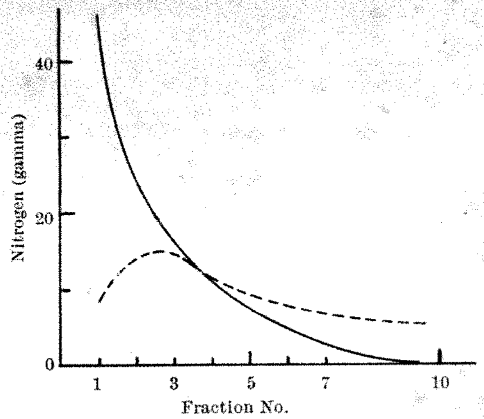

Fig. 2. Effect of agitation. Equal suspensions (43 mgm. dry) of washed lyophilized bacteria were dialysed (3 ml. inside volume) against water (1 ml. per min.) without (dash line) and with (full line) magnetic agitation at room temperature. The nitrogen content of successive 25-ml. fractions of the permeate is shown

Acceleration of dialysis by agitation has been demonstrated[1]. Fig. 2 shows the effect of inside agitation under our experimental conditions. At the time dialysis is complete with inside agitation, the yield is 50 per cent without agitation. Another example may illustrate the practical efficiency of the proposed method: 400 mgm. of dry bacterial substance suspended in 5 ml. water yielded, in 100 min. of dialysis, during the first 40 min. of which the bath was kept at 100°, a permeate of 100 ml. which contained 2·24 mgm. ninhydrin-nitrogen. Further exhaustive dialysis (250 ml.) yielded an additional 0·07 mgm.

H. Stegemann*
G. Toennies

Lankenau Hospital Research Institute
and
Institute for Cancer Research,
Philadelphia 11. Pa.

Nov. 3.

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* Present address: Medizinische Forschungsanstalt der Max-Planck-Gesellschaft, Göttingen.

[1] Kunitz, M., and Simms, H. S., *J. Gen. Physiol.*, **11**, 641 (1928).

Quotation of Titles of Papers in Review Articles

I wish to support Dr. Charity Waymouth's plea for the inclusion of titles of papers in the bibliography of a review article.

The editors of "Advances in Virus Research" asked me for a review. I looked at volume 1, the only one then published, and found a very pleasing chaos in the manner of citing references and some authors gave titles in full. I had half written my review when I realized that dull conformity had descended on the journal and that, worse still, it took the form of eliminating titles. To withdraw the article would have meant wasting the time already spent on it so I simply protested, and I welcome the opportunity of protesting again.

N. W. Pirie

Rothamsted Experimental Station,
Harpenden, Herts.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 5

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 4.30 p m.—Annual General Meeting. 5.30 p.m.—Prof. L. Rosenfeld: "Success and Failure in the Growth of Science".

University College, London (in the Physiology Theatre, Gower Street, London, W.C 1), at 5 p.m.—Prof. S. Spiegelman (U.S.A.): "The Present Status of the Enzyme-Forming Mechanism".*

Society of Engineers (at the Geological Society of London. Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. A. Fulton: "The Present Trends in Hydro-Electric Development".

University of London (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Dr. Anton Bruun (Copenhagen): "The Abyssal Fauna—its Ecology, Distribution and Origin".* (Further Lectures on March 7 and 9.)

University of London (at King's College, Strand, London, W.C.2), at 5.50 p.m.—Dr. J. M. Zarek: "Biomechanics of the Human Femur" *

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 6 p.m.—"South". (The original film of Shackleton's Imperial Trans-Arctic Expedition.)

Society of Chemical Industry, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 15 p.m.—Meeting on "The Production and Uses of Sequestering Agents".

Tuesday, March 6

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. P. R. Bell: "'Kon Tiki' and the Botanists".*

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5.30 p.m.—Mr. F. Roberts and Mr. B. T. Bell: "Horizontal Mixer-Settler Equipment".

University of London (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m —Prof. K. Kuratowski (Warsaw): "Some Topological Problems Concerning Complete Metric Spaces".* (Further Lectures on March 9 and 13.)

University of London (at King's College, Strand, London, W.C.2), at 5 30 p.m.—Prof. D. W. G Style: "Some Problems in Chemistry" (Inaugural Lecture).*

Tuesday, March 6—Friday, March 9

Ciba Foundation (at 41 Portland Place, London, W.1)—Symposium on "Influence of Ionizing Radiations on Cell Metabolism".

Wednesday, March 7

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Charles Dodds, F.R.S.: "The Debt of Chemistry to Medicine" (Pope Memorial Lecture).

Royal Aeronautical Society (in the Hall of La Société des Anciens Élèves des Écoles d'Arts et Métiers, 9 bis avenue d'Iena, Paris 16), at 5 p.m.—Mr. E. T. Jones: "A Philosophy of Aeronautical Research" (Ninth Louis Bleriot Lecture).

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. I. S. Groundwater: "The Maintenance of High Efficiencies on Economic Boilers—a Record of Operating Experience".*

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. D. N. Keep: "Frequency-Modulation Radar for Use in the Mercantile Marine".

Royal Institute of Chemistry, London Section (joint meeting with the Chelsea Polytechnic Chemical Society, at the Chelsea Polytechnic, Manresa Road, London, S.W.3), at 7 p m.—Mr. R. C. Chirnside: "Analytical Chemistry, Chemical Analysis and the Analyst".

Thursday, March 8

Royal Society (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Immunological Tolerance". Opening Speakers: Sir Macfarlane Burnet, F.R.S., and Prof. P. B. Medawar, F.R.S.

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. B. B. Boycott: "Brains".*

Society of Cosmetic Chemists of Great Britain (at the Royal Society of Arts, John Adam Street, London, W.C.2), at 7.30 p.m.—Mr. A. de Waele: "Technically Useful Rheology".

Friday, March 9

Operational Research Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Dr. B. V. Bowden, Mr. D. Owen and Dr. S. H. Hollingdale: "The Influence of Data Processing Machines on Operations".

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Influence of Size and Shape on the Testing of Materials".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. P. I. Dee, F.R.S.: "Radioactive Isotopes and Their Applications".

Saturday, March 10

Chester Beatty Research Institute, Photobiology Group (in the Chemistry Lecture Theatre, Chelsea Polytechnic, Manresa Road, London, S.W.3), at 10 a.m. and 2.15 p.m.—Scientific Papers.

Nutrition Society (at the London Hospital Medical College, Turner Street, London, E.1), at 10 30 a.m.—Symposium on "Diet and Anœmia". Chairman: Prof. Sir Stanley Davidson.

London County Council (at the Horniman Museum, London Road, Forest Hill, London. S E.23) at 3.30 p.m.—Prof. J. R. Firth: "The Uses and Abuses of Translation".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with teaching, research and/or industrial experience) in Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (March 9).

Reactor Technologists (Engineers or Chemical Engineers) at Dounreay Works, Caithness, Scotland, for work which involves providing engineering assistance to the Reactor Managers to whom they will be directly responsible—The Recruitment Officer, Industrial Group Headquarters, United Kingdom Atomic Energy Authority, Risley, near Warrington (March 9).

Lecturer (with a good honours degree and teaching experience, and preferably with industrial or research experience) in Physical or Organic Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (March 10).

Physicist or Electrical Engineer (with a first- or second-class honours degree in physics or electrical engineering, or equivalent qualifications, and experience in the development of electronic equipment) at the Ministry of Supply London Headquarters, for co-ordination of development of airborne radar equipment including liaison with Research and Development Establishments, the Services, and industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.49/6A/BN (March 10).

Senior Grade Biochemist (qualified in science (B Sc. or A.R I.C.), and at least five years experience of hospital biochemistry), at the Western Infirmary, Glasgow—The Secretary and Treasurer, Board of Management for Glasgow Western Hospitals, 10 Park Circus, Glasgow, C.3 (March 10).

Senior Lecturer (with an honours degree and teaching experience, and also research or industrial experience) in Physics, and Research Assistants (2) (with a good honours degree, or equivalent, in physics) in Physics or Electronics—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (March 10).

Assistant Lecturer or Lecturer in Mathematical Statistics in the Department of Applied Mathematics—The Registrar, The University, Liverpool (March 12).

Principal Scientific Officer (with an appropriate university degree of high standard together with extensive relevant research experience, proven capacity to initiate and conduct research, and with experience in staff control) at the Weapons Research Establishment, Department of Supply, Salisbury, South Australia, to direct a group responsible for basic studies of guided weapons systems using mathematical techniques and analogue computers, and to be responsible for the development of computers and associated techniques—The Senior Representative (AP.44), Department of Supply, Australia House, Strand, London, W.C.2 (March 15).

Senior Scientific Officer (at least 26, with a first- or second-class honours degree in mathematics, physics or engineering, or equivalent, at least three years postgraduate research experience and a keen interest in new developments) in the Research Section of the Performance Division, Aeroplane and Armament Experimental Establishment, near Amesbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.43/6A (March 15).

Lecturer in Educational and Applied Psychology—The Secretary of University Court, The University, Glasgow (March 17).

Chair of Geology—The Registrar, University College, Singleton Park, Swansea (March 20)

Assistant Lecturer in the Department of Zoology—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (March 23).

Lecturer in Biological Chemistry—The Secretary, The University, Aberdeen (March 24).

Senior Geomorphologist (with a university honours degree with considerable experience in field geomorphology, and proved research and organizational ability) in the Land Research and Regional Survey Section, Commonwealth Scientific and Industrial Research Organization, Canberra, to direct and further develop geomorphological studies in a research section concerned with the description, mapping and potential assessment of under-developed regions of Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C 2, quoting 570/39 (March 24).

Edward A. Deeds Senior Fellow at Queen's College, Dundee, for research in Engineering, Metallurgy, Chemistry, Physics, Mathematical Physics or any cognate subject—Joint Clerk to the University Court, The University, St. Andrews (March 31).

Probationary Assistant Lecturer, and a Lecturer, in the Department of Zoology—The Registrar, University College, Singleton Park, Swansea (March 31).

SENIOR LECTURER (with a higher degree in psychology) IN PSYCHOLOGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 31)

SENIOR RESEARCH OFFICER IN THE LABORATORY OF HUMAN NUTRITION—The Whitley Professor of Biochemistry, Department of Biochemistry, The University, Oxford (April 1).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (April 7).

BROWNE RESEARCH FELLOW (graduate of a university in the British Isles) IN BOTANY OR ZOOLOGY—The Provost, The Queen's College, Oxford (April 14).

LECTURER (preferably with a sound general training in geology and with experience in one or more of the following: civil engineering, geology, mining geology or geology of coal) IN ECONOMIC GEOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (April 14).

BERKELEY BYE-FELLOW (not less than 26 years of age) for research in medicine—The Registrary, Gonville and Caius College, Cambridge (April 30).

CHAIR OF CULTURAL ANTHROPOLOGY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Johannesburg, April 30).

ASSISTANT EXPERIMENTAL OFFICER (graduate, with mathematics and agricultural interests) IN THE STATISTICAL UNIT—The Secretary, Grassland Research Institute, Hurley, Maidenhead.

ASSISTANT (Grade B) to teach pure and applied mathematics to higher national certificate and degree level—The Principal, Huddersfield Technical College, Queen Street South, Huddersfield.

BIOCHEMIST, Scientific Officer or Senior Scientific Officer grade (preferably with not less than two years postgraduate research experience either in carbohydrate or protein biochemistry) to work in the PHYSIOLOGY DEPARTMENT on mammary gland metabolism—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 56/1.

CHEMIST, Superintendent Level (with a first- or second-class honours degree, with experience in the control and operation of analytical laboratories, preparative chemistry (mainly organic) and the scaling up of processes to pilot plant scale, and knowledge and experience of the control of hazardous operations and ability to organize industrial labour)—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 1027/34.

GRADUATE (metallurgy, chemistry or physics) IN THE INFORMATION DEPARTMENT for work dealing with every aspect of recording and transmission of information on the extraction, manufacture and uses of non-ferrous metals and their alloys—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

LECTURER or ASSISTANT LECTURER (with a good honours degree in metallurgy and preferably also works or research experience) IN METALLURGY—The Registrar, The University, Nottingham.

MASTER TO TEACH PHYSICS and some General Science—The Headmaster, Alleyn's School, Dulwich, London, S.E.22.

METALLURGIST (with B.Sc. (metallurgy), A.I M , or equivalent, and experience in metallographic work and mechanical testing, and preferably some experience of welding problems) AT THE CENTRAL LABORATORY, CHISWICK—Recruitment and Training Officer (F/EV.568), London Transport, 55 Broadway, London, S.W.1.

PROFESSORS OF STRUCTURAL ENGINEERING, HYDRAULIC ENGINEERING, SOIL ENGINEERING, MECHANICAL ENGINEERING, MECHANICAL ENGINEERING (with special qualifications in machine design and thermodynamics), INDUSTRIAL MANAGEMENT AND PRODUCTION ENGINEERING, ELECTRONICS, CHEMICAL ENGINEERING, AERONAUTICAL ENGINEERING, MATHEMATICS, PHYSICAL CHEMISTRY, GENERAL AND INORGANIC CHEMISTRY, at the Israel Institute of Technology, Haifa, Israel—The Secretary, The Technion Society of Great Britain, 83 Wimpole Street, London, W.1.

RESEARCH ASSISTANT (graduate, man or woman, with a special interest in plant physiology) IN BOTANY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

RESEARCH ASSISTANT IN THE FLUID DYNAMICS SECTION OF THE PHYSICS DEPARTMENT, to join a team studying dust and fume in gas streams and allied subjects—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "F.D.3".

RESEARCH FELLOW (with a zoology or veterinary degree, and preferably with postgraduate experience in protozoa) IN PROTOZOOLOGY, for duties which will include investigations of protozoan parasites of wild and domestic animals of Queensland—The Registrar, University of Queensland, Brisbane, Australia.

SENIOR PHYSICAL CHEMIST (with postgraduate degrees and extensive experience in applied research and preferably with experience in high polymers, permeability of materials, flame-proofing, rubber, textiles, and plastics, or other aspects related to the development of protective coverings) WITH THE DEFENCE RESEARCH BOARD, Ottawa, Canada—Defence Research Member, Canadian Joint Staff, Moncorvo House, 66 Ennismore Gardens, London, S.W 7.

TECHNICIAN or SENIOR TECHNICIAN (male or female, preferably with a degree in geography, cartographic skill, and some experience of photographic work) IN THE GEOGRAPHY DEPARTMENT—The Professor of Geography, University College of North Staffordshire, Keele, Staffs.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Aero Research Technical Notes. Bulletin No. 155: Patterns Cast in Epoxy Resin. Pp. 6. (Duxford: Aero Research Limited, 1955.) [21

Southern Regional Council for Further Education. Eighth Annual Report, October, 1955. Pp. 39. (Reading: Southern Regional Council for Further Education, 1955.) [21

Aluminium Development Association. Research Report No. 27: Researches into the Welding of Aluminium and its Alloys: a Summary of the Work of the A.D.A. Welding Research Team at the University of Birmingham, 1944 to 1950. Prepared by Dr. W. I. Pumphrey. Pp. 60. 7*s*. 6*d*. Research Report No. 28: Column Tests on Some Proposed Aluminium Standard Structural Sections. By R. E. Smith. Pp. 44. 7*s*. 6*d*. (London: Aluminium Development Association, 1955.) [21

Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing in the University of Leeds, for the Session 1953–4. Pp. 42. (Leeds: The University, 1955.) [21

Ministry of Education: Science Museum. Handbook of the Collection Illustrating Time Measurement, Part 2: Descriptive Catalogue. By Dr. F. A. B. Ward. Third edition. Pp. vi+102+10 plates. (London: H M. Stationery Office, 1955.) 6*s*. 6*d*. net. [21

London and Home Counties Regional Advisory Council for Higher Technological Education. Bulletin of Special Courses in Higher Technology (including Management Studies and Commerce), 1955–56 Part 2: Spring and Summer Terms, 1956. Pp. ii+45. (London: Regional Advisory Council, 1955.) 1*s*. 6*d* [21

The Registrar General's Statistical Review of England and Wales for the year 1952. Text volume. Pp. xi+256. (London: H.M. Stationery Office, 1955.) 8*s*. net. [21

Proceedings of the Royal Irish Academy. Vol. 57, Section A, No. 5: Plasma-Electron Oscillations By R. A. Bailey and K. G. Emeleus. Pp. 53–62. 1*s*. Vol. 57, Section A, No. 6: Celebration of the Centenary of "The Laws of Thought" by George Boole. Pp. 63–130. 6*s*. Vol. 57, Section B, No. 10: Antitubercular Substances—14: The Chlorination of 2-Nitrodiphenylamine. By Vincent C. Barry and J. G. Belton. Pp. 141–146. 1*s*. Vol. 57, Section B, No. 11: A Description of a New Nereid—*Nereis Southerni*. By M. K. Abdel-Moez and Carmel F. Humphries. Pp. 147–154. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd., 1955.) [21

Year Book of the Physical Society, 1955. Pp. iv+92+2 plates. (London: Physical Society, 1955.) 10*s* [21

The Registrar General's Statistical Review of England and Wales for the year 1954. Part 1: Tables, Medical. Pp. x+375. (London: H.M. Stationery Office, 1955.) 12*s* 6*d*. net. [21

The Registrar General's Quarterly Return for England and Wales. No. 427 (3rd Qtr. 1955): Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates, quarter ended 30th September, 1955. Pp. 20. (London: H.M. Stationery Office, 1955.) 1*s*. 6*d*. net. [21

Other Countries

European Co-operation in Nuclear Research. (Unesco and Its Programme, No. 11.) Pp. 26. (Paris. Unesco; London: H.M. Stationery Office, 1954.) 1*s*. net. [111

Department of Agriculture, Jamaica. Commodity Bulletin No. 1: Bananas—an Outline of the Economic History of Production and Trade, with special reference to Jamaica. By D. W. Rodriquez. Pp. 69+2 plates. (Kingston, Jamaica: Government Printer, 1955.) 3*s*. 6*d*. [161

Tobacco Research Board of Rhodesia and Nyasaland. Interim Report No. 5: Equipment and Method for Flue-curing Tobacco. Pp. 6. (Salisbury: Tobacco Research Board of Rhodesia and Nyasaland, 1955.) [161

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Twenty-fifth Annual Report for the period 1st April, 1953 to 31st March, 1954. By Dr. J. M. Marchand. (Reprint from *Commerce and Industry*, July, 1955.) Pp. 162. (Pretoria: Government Printer, 1955.) [161

Babel. (International journal of translation.) Vol. 1, No. 1 (September 1955). Pp. 40. Single issues 5*s*.; Annual subscription 17*s*. (Paris: International Federation of Translators, 1955.) [161

University College, Ibadan, Nigeria. Calendar, 1955–56. Pp. 65. (Ibadan: University College, 1955.) [161

Smithsonian Miscellaneous Collections. Vol. 128, No. 9: Distribution and Ecology of the Marine Invertebrates of Point Barrow, Alaska. By G. E. MacGinitie. Pp. iv+201+8 plates. (Publication 4221.) Vol. 131, No. 2: The Last Cruise of H.M.S. "Loo". By Mendel L. Peterson. Pp. 55+17 plates. (Publication 4224.) (Washington, D.C.: Smithsonian Institution, 1955.) [161

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1954. Pp. xvii+64. (Hyderabad–Deccan: Central Laboratories for Scientific and Industrial Research, 1955.) [161

Göteborgs Kungl. Vetenskaps- Och Vitterhets-Samhälle. Reports of the Swedish Deep-Sea Expedition, 1947–1948. Edited by Hans Pettersson. Vol. 2: Zoology, Fasc. 2. Pp. i+151–246+plate 1 15 Swedish Kr. Vol. 4: Bottom Investigations. Fasc. 1. Pp. 96+8 plates. 25 Swedish Kr. Vol. 6: Sediment Cores from the West Pacific. Fasc. 1. Pp. 49+4 plates. 10 Swedish Kr. Vol. 7: Sediment Cores from the North Atlantic Ocean. Fasc. 2. Pp. i+125–148. 5 Swedish Kr. Vol. 7: Sediment Cores from the North Atlantic Ocean Fasc. 3. Pp. i+151–184+plates 1 and 2. 8 Swedish Kr. Vol. 10: Special Investigations. Fasc. 1. Pp. 32. 8 Swedish Kr. (Göthenborg: Elanders Boktryckeri Aktiebolag, 1955.) [161

Eastern Region, Nigeria. Annual Report on the Forest Administration of the Eastern Region of Nigeria for the year ended 31st March, 1954. Pp. i+40. (Enugu: Government Printer, 1955.) 9*d*. net. [161

United States National Museum. Bulletin 208: The Honey-Guides. By Herbert Friedmann. Pp. vii+292+25 plates. (Washington, D.C.: Smithsonian Institution, 1955.) [161

United States Department of Commerce: Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours. Part 13: Kentucky. Pp. i+71. 45 cents. Part 14: Louisiana. Pp. ii+53. 35 cents. (Washington, D.C.: Government Printing Office, 1955.) [161

A Challenge to the Franklin Institute of Pennsylvania. By F. Harrison Stamper. Pp. 4. (Los Angeles: F. Harrison Stamper, 1955.) [161

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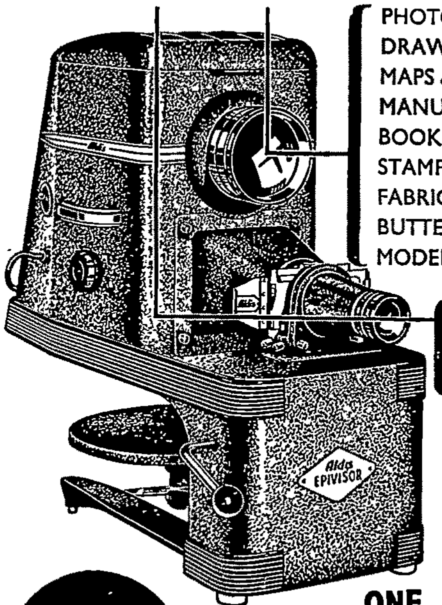

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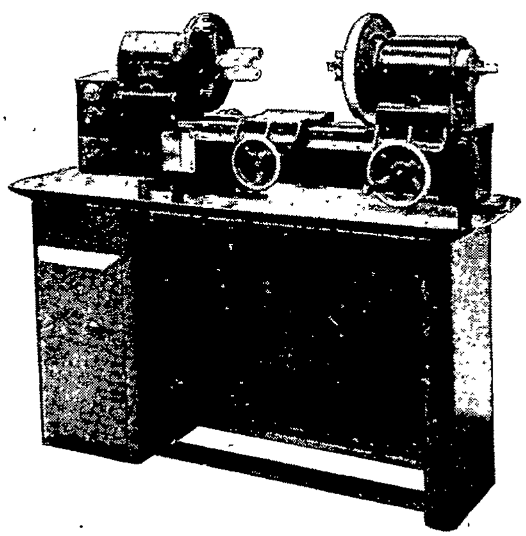

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Pamphlet and form of application may be obtained from the Registrar, Birkbeck College, Malet Street, W.C.1.

UNIVERSITY OF LONDON

A course of two lectures on "The Future of Pharmacy in relation to World Needs" will be given by Brigadier-General Sir Harold Hartley at 5.30 p.m., on March 7 and 15 at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.

Admission free, without ticket.

JAMES HENDERSON,
Academic Registrar

UNIVERSITY COLLEGE

LONDON (GOWER STREET, W.C.1)

Professor S. Spiegelman (University of Illinois) will give a Public Lecture entitled "The Present Status of the Enzyme-forming Mechanism" on Monday, March 5 at 5 p.m.

Admission free, without ticket.

E. A. L. GUETERBOCK,
Secretary.

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952.

CHELSEA POLYTECHNIC

MANRESA ROAD, S.W.3
DEPARTMENT OF PHYSICS
Head of Department: Dr. W. H. George,
M.Sc., Ph.D.(Lond.), F.Inst.P.

Applications are invited for the post of full-time Lecturer in Physics. Candidates should possess teaching, research and/or industrial experience. Research or industrial experience with electronic circuits would be an advantage. Ample time and facilities for research will be provided. The salary scale is as follows: men, £965 by £25 to £1,065 per annum; women, £799 11s. by £20 to £1,065 per annum, plus London allowance of £36 or £48 according to age. Placing on the scale will be in accordance with previous service in a similar capacity.

Further particulars and form of application may be obtained by sending stamped addressed foolscap envelope to the Clerk to the Governors. Applications must be returned not later than March 9, 1956.

UNIVERSITY OF WESTERN ONTARIO

DEPARTMENT OF PHYSICS
RESEARCH ASSOCIATESHIPS IN EXPERIMENTAL AND THEORETICAL PHYSICS

Applications are invited for postdoctoral and predoctoral research associateships in experimental and theoretical physics tenable in The Molecular Excitation Group from August, 1956.

The research interests of the group cover a wide range of excitation problems related to Astrophysics, Atmospheric Physics and Combustion.

Further information may be obtained by writing by airmail to Dr. R. W. Nicholls, Department of Physics, University of Western Ontario, London, Ontario, Canada.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Applications are invited for the post of Demonstrator in Geography for the summer term 1956 and the session 1956-57. Special interest in cartography desirable. Salary £450 per annum.

Application forms, to be returned not later than March 12, from the Registrar, The College, Keele, Staffs.

MANCHESTER COLLEGE OF TECHNOLOGY

APPOINTMENT OF FULL-TIME TEACHER IN THE DEPARTMENT OF APPLIED PHYSICS

The Governing Body invites applications for the appointment of a full-time Teacher in the workshop in the Department of Applied Physics. The work involves both teaching and instrument construction. The teaching duties involve instruction in the elements of workshop practice to students of applied optics in the college and to university science students. Experience of the specialized techniques of ophthalmic optics is particularly desirable. The assistant, who will be responsible to the professor of applied physics, will be in charge of a teaching workshop, and will have access to the departmental workshop which is fitted with a good range of machine tools. Salary scale: £525 per annum, rising by annual increments of £25 and one final increment of £20 to a maximum of £820. Subject to this maximum not being exceeded, one increment of £18 will be added to the minimum in respect of each year of approved industrial experience up to a maximum of twelve, together with one further increment (usually of £18) for each year of previous full-time teaching service. There are also certain additional training and graduate allowances.

Form of application may be obtained from The Registrar, College of Technology, Manchester, 1. Last date for the receipt of applications is Saturday, March 17, 1956.

B. V. BOWDEN,
Principal

UNIVERSITY OF GLASGOW

Applications are invited for the post of Demonstrator in Chemistry (inorganic, organic and physical). The remuneration will be £350 per annum and appointments will be made initially for one year from October 1, 1956, renewable for up to three additional years. The duties of the Demonstrators appointed will be to assist in the teaching of practical chemistry. Ample time will be allowed for the prosecution of research and Demonstrators will be expected to register for the degree of Ph.D. in this University.

For forms of application apply to the Secretary of the University Court, The University, Glasgow, W.2.

MATHEMATICIANS OR STATISTICIANS required by Ministry of Supply, Ordnance Board, London, for experimental design and analysis of trials mainly connected with A.A. weapons and fire control systems. Knowledge of calculating machines may be an advantage. Candidates should possess first- or second-class honours degree or equivalent. Salaries according to age, experience, etc., within range, Scientific Officer (minimum age 21) £513 10s. to £925; Senior Scientific Officer (minimum age 26) £1,070 to £1,245; Principal Scientific Officer (minimum age 31) £1,245 to £1,670 (superannuable). Candidates for senior posts must have some years suitable postgraduate research experience.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A70/6A/BN.

THE NATURE CONSERVANCY REQUIRE an Assistant (male) for recording vegetation changes resulting from death of rabbits through the spread of myxomatosis, to be based on London but considerable travelling involved. Minimum qualifications general certificate of education ordinary level in 4 subjects, including English language and biology; general certificate of education to advanced level botany an advantage. Starting salary between £240 and £423 according to age. The post is non-pensionable with pension prospects.—Applications, giving details of age, educational qualifications, with particulars of examinations and subjects, National Service, previous posts, relevant interests, and names and addresses of two referees, one qualified to speak for ability in the duties and one for character and health, to Establishment Officer, the Nature Conservancy, 19 Belgrave Square, London, S.W.1, before March 10, 1956.

MINISTRY OF AGRICULTURE, FISHERIES and Food requires temporary Assistant Technical Officer at Kendal. Duties concerned with (i) production and distribution of agricultural lime, (ii) fertilizer subsidy. Travelling involved. Qualifications: degree in agriculture, aged at least 21. Starting pay (men) £543 10s. if 25 or over; less below age 25. Maximum (provincial) £830; lower for women. Extra duty allowance 3 per cent.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G 238/5A.

MINISTRY OF SUPPLY

SENIOR PRINCIPAL SCIENTIFIC OFFICER

The Civil Service Commissioners invite applications from men for the pensionable appointmen of Safety Officer at the Microbiological Researc Department, Porton, Wilts. Candidates must be at least 32 on December 31, 1956. They mus have a medical qualification and a proven knowledge of, and interest, in, microbiology. They will be responsible for research in the field of ai hygiene. Experience of methods of air sampling and of air sterilization desirable. They will also be required to undertake medical duties, such as routine immunization of staff. Salary scale £1,700 to £1,950. Starting salary above minimum may be granted according to qualifications and experience.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 3 Old Burlington Street, London, W.1, quoting No S 4564/56/9. Application form must be returned by March 17, 1956.

UNIVERSITY OF LEEDS

DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for appointment as Lecturer in Civil Engineering at a salary on the scale £650 by £50 to £1,350 a year, according to qualifications and experience. Candidates should have an honours degree and practical experience in Public Works Engineering.

Applications (three copies), stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained), not later than March 31, 1956.

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)
MILE END ROAD, E.1.

Applications are invited for the post of Assistant Lecturer in the Department of Zoology. Salary scale £600 by £50 to £700 with F.S.S.U. participation and family allowance of £50 for each child.

Application forms, obtainable from the Registrar, to be returned by March 23.

SENIOR SCIENTIFIC OFFICER OR SCIENtific Officer required by Ministry of Supply at Aeroplane and Armament Experimental Establishment, near Amesbury, Wilts., for development of test methods, techniques and specialized instruments for use in trials of aircraft armament systems. Candidates should have a first- or second-class honours degree or equivalent in physics, electrical engineering or maths. Sound knowledge of electronics, light electro-mechanical equipment or armament assessment problems desirable. At least 3 years' postgraduate research experience required for Senior Scientific Officer. Salary within range: Senior Scientific Officer £1,030 to £1,185; Scientific Officer £488 10s. to £885 (superannuable). Houses become available from time to time for successful married candidates.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London S.W.1, quoting A 63/6A/BN.

INFORMATION OFFICERS REQUIRED IN London in the Public Relations Branch of the United Kingdom Atomic Energy Authority. Applicants (preferably between 24 and 30 years of age) should either be scientists or engineers, or people already experienced in public relations, journalism, lecturing or exhibition work, who have some technical background. They should be able to write and/or speak well and interpret technical information to the general public. Successful applicants will work to public relations specialists and will be able to extend their knowledge of publicity techniques. Starting salary, depending on age, experience, and qualifications, within the scale £975 to £1,188. Contributory pension scheme.—Send postcard for application form to Room 22, U.K.A.E.A., 14 Ormond Yard, St. James's, London, S.W.1.

AERODYNAMICISTS AND MATHEMATIcians required by Ministry of Supply for various Experimental Establishments and London H.Q., for research and development work on aircraft projects, performance analysis of aircraft and weapons, statistics and operational research, guided weapons, gas turbines. Candidates should have a first- or second-class honours degree or equivalent. Some research or development experience would be useful. Appointments initially as Scientific Officer (minimum age 21) within salary range, £488 10s. to £885 (Provinces), £513 10s. to £925 (London) (superannuable).—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 69/6A/BN.

OCONUT RESEARCH INSTITUTE
(CEYLON)
POST OF DIRECTOR

The Coconut Research Board of Ceylon invites pplications for appointment as Director of the oconut Research Institute of Ceylon 1. Salary: ocal candidates, Rs 18,000 by Rs.800 to s.30,000 per annum; Overseas candidates, 2,000 by £100 to £3,500 per annum at current xchange rates. A dearness allowance of 15 per ent of basic salary, a rent-free two-storey house ith heavy furniture is provided. A successful pplicant will be required to contribute to a rovident fund at the rate of 15 per cent of his asic salary and an equivalent amount will be aid by the Board A higher salary would be corded *ad personam* to a successful applicant ith eminent qualifications. The appointment ill be in the first instance for a period of four ears, inclusive of six months end of contract ave. It is terminable with three months' notice n either side. A first-class sea passage to eylon will be provided for an overseas candidate, is wife and children under the age of 18 years imilarly, return passages will be provided to the ountry of domicile at the end of the period of ervice. Leave and travelling allowances in eylon will be in accordance with the regulations f the Institute 2. Qualifications: The post calls or proved high scientific attainments, preferably fields related to soils or crops combined with dministrative experience either as head or deputy the organization and running of a research stitute or university department. Experience of opical conditions would be an advantage, but is ot an essential qualification. 3 Functions: The irector's primary responsibilities to the Coconut esearch Board will be the administration of the nstitute and the direction of the research actities of the Institute for the improvement of the eld and quality of the products of the palm. He ill also be responsible to the board for the administration of replanting, rehabilitation and new lanting schemes for the Island and for public elations. General: The laboratories of the Institute are situated in the main coconut growing area f the Island, 32 miles north of Colombo. There a scientific staff engaged in technological chemisy, soil chemistry, agronomy, plant breeding, and op protection. 4. Applications: Particulars hould be furnished by applicants of their age, arital status, academic qualifications, and research and administrative experience. They hould also provide a list of publications, copies f testimonials, and the names and addresses of e referees to whom confidential inquiries can e addressed. A medical certificate and a recent hotograph should also be annexed to the application.

Further particulars, if required, may be obtained rom the undersigned. Applications should reach he Chairman, Coconut Research Board, Departent of Agriculture, Peradeniya, Ceylon, on or efore March 31, 1956.

Chairman.
Coconut Research Board of Ceylon.

BOURNEMOUTH EDUCATION COMMITTEE
BOURNEMOUTH MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE

Required, as soon as possible, Head of Science epartment, Physics, Chemistry, Biology and Mathematics. Applicants should have a good deee in physics or chemistry Technical College aching and industrial experience are desirable. Salary in accordance with Burnham Technical cales, 1954, for Grade II Head of Department Application forms and further particulars obinable from W. R Smedley, Chief Education Officer, Town Hall, Bournemouth, returnable by March 17.

UNIVERSITY OF ST. ANDREWS
QUEEN'S COLLEGE, DUNDEE
LECTURESHIP IN ENGINEERING

Applications are invited for appointment as ecturer in Mechanical Engineering in the Department of Civil and Mechanical Engineering, Queen's College, Dundee, to commence October 1, 1956. The candidate appointed would be quired to assist with the teaching and to take part in the research work of the department Opportunities will be granted to work for a higher egree. Salary scale £650 by £50 per annum to 1,350, with efficiency bar at £1,000 and commencing salary according to experience and qualifications. F.S S.U and family allowance benefits; a grant towards expenses of removal may be made. Six copies of the application, hich should contain the names of three referees, o the undernoted not later than April 18, 1956

PATRICK CUMMING,
Joint Clerk to the University Court.
Queen's College, Dundee.

SENIOR PHYSICAL CHEMIST

Initial Salary $6,000 to $8,000 per annum
DEFENCE RESEARCH BOARD
CANADA

A Senior Physical Chemist with post-graduate degrees and extensive experience in applied research is required for location in Ottawa. Experience in high polymers, permeability of materials, flame-proofing, rubber, textiles, and plastics, or other aspects related to the development of protective coverings would be an advantage. Extensive experience in the direction of applied research with a view to the development of end items is essential.

Generous holiday, sick leave, pension and insurance benefits included.

Apply to:

Defence Research Member,
Canadian Joint Staff,
Moncorvo House,
66 Ennismore Gardens,
London, S.W.7, England.

UNIVERSITY OF MANCHESTER
I.C.I. FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Imperial Chemical Industries Ltd., tenable in the University and available for research in chemistry, physics and allied subjects, e.g., pharmacology, engineering, metallurgy. The value of the Fellowships will be within the range of £600 to £900 per annum according to qualifications and experience.

Regulations governing the award of the Fellowships may be obtained from the Registrar, the University, Manchester, 13, to whom applications should be sent not later than April 30, 1956

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for (i) a Probationary Assistant Lectureship and (ii) a Lectureship in the Department of Zoology. Salaries: Assistant Lectureship, not less than £550 per annum, Lectureship £650 by £50 to £1,350 per annum Commencing salary in each case will be at a point on the appropriate scales according to qualifications and experience. The initial salary for the Lectureship will not be higher than £1,000. Membership of the F.S S.U. and children's allowance scheme

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications (five copies) must be sent by Saturday, March 31, 1956.

THE ROYAL SOCIETY
TROPICAL RESEARCH FELLOWSHIP
(MEDICAL SCIENCES)

Applications are invited by the Council of the Royal Society for a Research Fellowship with special reference to ill health in the tropics. The Fellowship is tenable in any university, hospital or medical school or other institution approved by the Royal Society in the British Commonwealth The successful applicant, who need not necessarily hold a medical qualification will be expected to spend some part of the period of tenure in the tropics The appointment will be for two years in the first instance, from October 1, 1956, and may be renewed annually up to a total of five years It will be subject to the conditions governing Royal Society Research Appointments. The stipend will be £1,250 per annum.

Applications, which should be made on forms to be obtained from the Assistant Secretary, The Royal Society, Burlington House, London, W 1, should be received as early as possible, in any case not later than April 6, 1956.

WHITCHURCH AND ELY HOSPITAL MANAGEMENT COMMITTEE
CARDIFF RADIOTHERAPY CENTRE

This unit is situated at Whitchurch in the vicinity of Cardiff. It is an entirely new building and comprises an extensive treatment centre and ward accommodation for some 72 patients. The therapeutic equipment will include both superficial and deep X-ray plant together with rotating cobalt units. There is also a large mould room and a radio-isotopes suite.

Applications are invited for the following appointments in the Physics Department: 1 Physicist (Basic Grade): candidates should possess a first- or second-class honours degree in physics. Salary scale for a probationary period of at least two years £525 by £25 to £625. (After satisfactory probationary period appropriate scale £650 to £845.) Postgraduate study or experience may be considered in fixing the starting salary. 1 Physicist (Senior Grade): candidates should possess a first- or second-class honours degree in physics and previous experience in hospital physics Salary £910 by £40 to £1,230. The successful candidates may be required to attend at other hospitals in the region, including the United Cardiff Teaching Hospitals.

Applications, stating age, qualifications and previous experience together with the names of two referees, should be forwarded to the Group Secretary, Whitchurch and Ely Hospital Management Committee, Group Office, Whitchurch Hospital, Cardiff.

GONVILLE AND CAIUS COLLEGE, CAMBRIDGE
BERKELEY BYE-FELLOWSHIP

Founded in memory of Sir G. H. A. Comyns Berkeley and of his wife, Ethel Rose Berkeley The Council of Gonville and Caius College invite applications for a Berkeley Bye-Fellowship for research in Medicine. Candidates should be men of not less than 26 years of age. The tenure of the Bye-Fellowship is for one to three years and the emolument from £700 to £1,250 a year according to standing. Full particulars may be obtained from the Registrary, Gonville and Caius College, Cambridge.

Applications must be received not later than April 30, 1956.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Applications are invited from suitably qualified persons (male or female) for the post of Technician or Senior Technician in Geography Department. Degree in geography desirable but not essential; cartographic skill required, some experience of photographic work an asset. The successful candidate will be required to act also as meteorological observer, and the necessary training will be given Salary scales £340 to £480 (Technician), £490 to £590 (Senior Technician). Residential accommodation for a single person may be available

Application forms from Professor of Geography, The College, Keele, Staffs.

UNIVERSITY OF MANCHESTER
TURNER AND NEWALL RESEARCH FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Messrs. Turner and Newall Ltd., tenable in the University and available for research in engineering, inorganic chemistry, physics and allied subjects. The value of the Fellowships will be within the range of £600 to £900 per annum according to qualifications and experience.

Regulations governing the award of the Fellowships may be obtained from the Registrar, the University, Manchester, 13, to whom applications should be sent not later than April 30, 1956.

RAMSAY MEMORIAL FELLOWSHIPS FOR ADVANCED STUDENTS OF CHEMISTRY

The Trustees will consider in June, 1956, applications for two Fellowships, normally tenable for two years One will be limited to candidates educated in Glasgow, who can apply to be considered for either Fellowship. Value of each Fellowship £600 per annum, plus expenses grant up to £100 per annum.

Full particulars from Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, London, Gower Street, W.C.1 Completed application forms must be received by April 20, 1956.

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS

NEW SOUTH WALES, AUSTRALIA

Applications are invited from graduates (or undergraduates in their final year) in civil engineering of a recognized British or Irish university for appointment to the staff of Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges or on main road construction and maintenance either in the metropolitan area or the country Commencing salary according to qualifications and experience will be within the range £A 1,046 to £A.1,299 per annum, with annual progression subject to technical competence, to £A.1,585 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months. Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to satisfactory medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56 Strand, London, W.C 2.

UNIVERSITY OF LIVERPOOL

Applications are invited from candidates with experience in either experimental or theoretical physics for posts of Lecturer in the Department of Physics, where there are good facilities for research work in nuclear physics The initial salaries will be within the range £650 to £1,350 per annum, according to qualifications and experience and the duties of the posts will commence on October 1, 1956.

Applications, stating age, academic qualifications and experience, together with a list of publications and the names of two referees, should be received not later than March 29, 1956, by the undersigned, from whom further particulars of the conditions of appointment may be obtained.

STANLEY DUMBELL,
Registrar

WOOLWICH POLYTECHNIC

LONDON, S E 18

Principal: J S Tait, Ph D, B Sc, A.R T.C., M I.E.E., A.M I.Mech.E

Applications are invited from honours graduates and from students entering for their final honours (special) degree examination in June next for Research Assistantships in Chemistry. The assistantships will normally lead to the Ph D degree (Internal) of the University of London. Their value is £350 per annum and are tenable for two to three years.

Particulars and application form from Clerk to Governors

DEPARTMENT OF SCIENTIFIC AND INdustrial Research requires Scientific Officers at Chemical Research Laboratory, Teddington, Middlesex, 1 (a) Senior S O. with three years' postgraduate experience in chemical engineering or similar work (Ref.: F 929/5) and (b) S O, chemical engineer or physical chemist (F 930/5), for research in a new section. 2 S.O., physical chemist (Ref: F.931/5). Qualifications: first- or second-class honours degree or equivalent. Inclusive annual salary. Senior S.O. · £1,155 to £1,344; S.O £554 to £999. Somewhat less for women but subject to improvement under the equal pay scheme.—Forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting appropriate reference.

FOREMAN OF THE ROYAL GREENWICH Observatory, Herstmonceux, Sussex. The Civil Service Commissioners invite applications from men for this pensionable post Age at least 28 on January 1, 1956. Candidates must have served an apprenticeship or received equivalent training as instrument mechanics, followed by at least three years' experience on relevant work. They must also be thoroughly familiar with modern workshop methods and be able to plan and direct the work of laboratory mechanics O N C. in mechanical engineering or equivalent qualification, and experience in a drawing office or of supervision of instrument work advantageous. Starting salary according to age from £650 (at age 28) to £690 (at 30 or over) Maximum of salary scale is £812 An official residence is provided at a reasonable rent.—Further particulars and application form from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S 4563/56/8. Completed applications must be returned by March 29, 1956

ADMIRALTY

CIVIL HYDROGRAPHIC OFFICER

The Civil Service Commissioners invite applications for 5 pensionable posts. Age at least 21 and under 31 on January 1, 1956, with extension for regular service in H.M Forces. Candidates must have an honours degree, preferably first- or second-class, in either geography, mathematics, physics, engineering, geology or kindred subject. All candidates must have passed in mathematics at not less than credit standard in the school certificate or "O" level at the general certificate of education. A reading knowledge of one or more foreign languages an advantage Inclusive London salary scale. £513 to £1,245 (women to £1,155 but being increased under equal pay scheme.) Starting pay may be increased for approved postgraduate experience and for National Service in H M Forces. • Promotion prospects

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No S217/56/8. Completed applications must be returned by March 16, 1956.

UNIVERSITY OF GLASGOW

LECTURESHIP IN EXPERIMENTAL PHARMACOLOGY

Applications are invited for the whole-time academic post of Lecturer in Experimental Pharmacology. Salary scale: £700 to £1,450 with a medical qualification, £650 to £1,350 without a medical qualification. Initial salary according to experience and qualifications. F S.S U. and family allowance benefits.

Applications (6 copies) should be lodged, not later than March 17, 1956, with the undersigned, from whom further particulars may be obtained.

ROBT. T HUTCHESON,
Secretary of University Court.

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Lecturer in the Department of Fluid Mechanics, at an initial salary within the range £650 to £1,350 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than March 29, 1956, by the undersigned, from whom further particulars of the conditions of appointment may be obtained

STANLEY, DUMBELL,
Registrar.

UNIVERSITY OF ABERDEEN

Applications are invited for Lectureship in Biological Chemistry. Salary scale (c) £1,350 by £50 to £1,550 (or scale (b) £950 by £50 to £1,350), or if medically qualified scale (c) £1,750 by £100 to £2,050 (or scale (b) £1,200 by £125 to £1,700), with placing according to qualifications Superannuation (F.S.S U) and children's allowance. Part of removal expenses refunded

Conditions of appointment and forms of application should be obtained from the Secretary, The University, Aberdeen, with whom applications (eight copies), giving the names of three referees, should be lodged not later than March 24, 1956. Applicants outside the British Isles may submit one copy only.

THE INTERNATIONAL GEOPHYSICAL YEAR

A circular containing the details of 43 vacant posts in connexion with the United Kingdom programme for the International Geophysical Year has been circulated to University Appointments Boards and other University Departments.

Persons who are not able to inspect those copies may obtain further details on application to the Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W 1.

ADMIRALTY—ROYAL NAVAL SCIENtific Service Senior Scientific Officers and Scientific Officers required in Experimental Establishments chiefly in Weymouth and Portsmouth areas and home counties Majority of posts are for engineers and physicists (particularly with electronics) Candidates must normally be natural born British subjects of natural born British parents, with appropriate first- or second-class honours degree or equivalent high professional attainments. Salaries (men), Senior Scientific Officer £1,070 to £1,245; Scientific Officer £513 to £925 (London) Somewhat lower in provinces All appointments unestablished (with F S.S U) but with some opportunities to compete for established posts.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W.1, quoting A344/5A.

COMMONWEALTH of AUSTRALI

DEPARTMENT OF SUPPLY
DEFENCE STANDARDS LABORATORIES
MARIBYRNONG, VICTORIA

Applications are invited for a temporary pos tion of Senior Scientific Officer at the abov Laboratories Salary: £2,053 to £2,218 p annum Duties. Research and development wo in connection with paints, such as the study methods of measuring the properties of paint fil and changes in properties during ageing a weathering, the study of the protection of meta by primers, underwater protection of ships a anti-fouling paints. Qualifications: Degree high standard with chemistry as a major subje with several years' research experience Knowledge of paint technology would be an advanta The salaries quoted are Australian currenc Whilst the position is a temporary one, the tenu of employment is not limited. However, the su cessful applicant may choose to enter into agreement for a three to five year contract of e ployment in Australia. In this case, the Co monwealth will bear return fares, together wi cost of removing each way the appointee's fur ture and effects up to a maximum cost of £5 (Australian) (£250 (A.) each way) Under specifi conditions, first-class boat fares (if first-class ber available) for the appointee and dependants (wi and dependent children) will be paid by the Commonwealth.

Application forms obtainable from Senior Re resentative (AP 45), Department of Supp Australia House, Strand, London, W C 2, wi whom applications should be lodged by Mar 19, 1956.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

NEW DELHI

Applications invited for post of Director, Ce tral Electronics Engineering Research Institut Pilani (Rajasthan), within salary range £1,800 t £2,250 per annum. Applicants must have a hi degree in applied physics and experience in circu techniques, equipment design, and in directi industrial research programmes. Appointment o contract 3 or 5 years.

Further information and application forms fro High Commission of India, London, W.C 2, refe ence Est.201 1.4/99. Last date for receipt of a plications in India is March 15, 1956.

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for a Lectureship i Chemical Engineering. Salary on the scale £65 by £50 to £1,350 per annum; the initial sala will be fixed according to qualifications and e perience, but will not be more than £1,000 p annum. F.S.S U. benefits and family allowance

Further particulars may be obtained from th Registrar, University College, Singleton Par Swansea, to whom applications must be sent b March 17, 1956

UNIVERSITY OF LEEDS

DEPARTMENT OF MATHEMATICS

Applications are invited for appointment a Lecturer or Assistant Lecturer in Statistics at salary on the scale £650 by £50 to £1,350 a yea for a Lecturer or within the range £550 to £65 a year for an Assistant Lecturer, according t age, qualifications and experience

Applications (four copies), stating date of bir qualifications and experience, together with th names of three referees, should reach the Regi trar, The University, Leeds, 2 (from whom fu ther particulars may be obtained), not later tha April 2, 1956.

SCIENTIST REQUIRED IN MEDICA Statistics Section at N C.B.'s London H Q, a member of a team concerned with statistica planning of field and clinical trials on medical an cognate problems, and analysis of results, als collection, presentation and analysis of statistic relating to health of mineworkers. Degree i mathematics, or recognized qualification in statis tics required, postgraduate experience in applyin statistical methods (including knowledge o punched cards) an advantage. Appointmen (superannuable), according to qualifications an experience, as Scientist 3 (inclusive scale £617 t £1,124 male)—Write, with full particulars of ag education, qualifications and experience, t National Coal Board, Staff Dept. (Personne Hobart House, Grosvenor Place, S W.1, marking envelope SS/219, before March 20, 1956

SCIENTIFIC OFFICER (CHEMIST), ASSISTant Experimental Officer (Chemist), and an Assistant (Scientific) in the Metropolitan Police Laboratory.—The Secretary, Room 165, New Scotlan Yard, London, S W 1

NATURE

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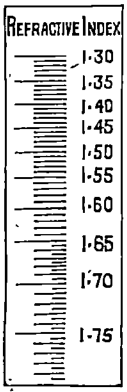

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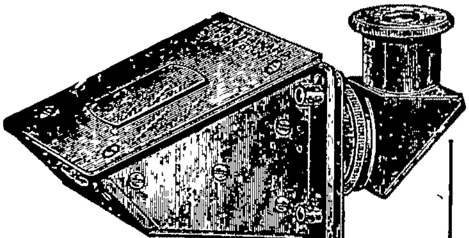

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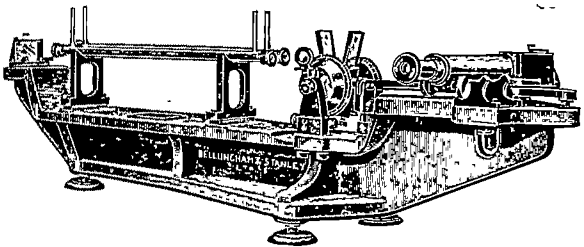

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TECHNOLOGICAL HUMANISM

THE 1955 conference of the Scottish Institute of Adult Education, which was held at Dunblane, provided Sir Eric Ashby with another opportunity to continue his inquiry into the malaise which seems to afflict adult education in Great Britain (*Scottish Adult Education*, No. 15; December 1955). It can be read with profit during the discussion of the White Paper on Technical Education in Britain just issued (see p. 461).

Adult education, he suggested, is in a dilemma of ends and means. There is, of course, a vague end in view. Although education for leisure and for personal satisfaction is now declared to be the purpose of adult education, it is a very shadowy purpose compared with that of (say) a Workers Educational Association class of forty years ago. That class was an instrument to secure social and political emancipation. Its purpose was vocational in the highest sense of the word: it was for men who believed they had a vocation. The ends were clear, but the means were on the whole inadequate for the ends. Now the means have become more adequate, but the ends have become clouded.

It is misleading to make an issue of differences between technical and cultural education. Some of our perplexities in universities, technical colleges, and further education have their origin in the antithesis which has been set up between these two groups of ideas and the consequent controversies over what should be the balance between them. A distinction between vocational and non-vocational education can be made; it is questionable whether it is worth making.

To-day a gifted man cannot play his part in society unless he is something of a specialist. Instead of fighting a rearguard action on behalf of general education against specialization, is it not more important to consider whether the benefits of humanism cannot be acquired through, and not in spite of, specialization?

Sir Eric went on to discuss whether a new concept of liberal education is desirable; and, what the new concept and interpretation should be.

One must start with the sound academic maxim that no change is desirable for its own sake; that change is justified only if there is pressure due to other uncontrollable changes which have already occurred, or in anticipation of such uncontrollable changes. In Britain personal education enjoys the greatest prestige, despite all that is being done in the way of technical education and education for economic ends. Personal education is the keynote of grammar schools, it is the traditional function of the arts faculties of universities, and it is by Government regulation defined as that part of further education called liberal adult education.

Is this emphasis on personal education consistent with the present state of Western society? The world has changed out of all recognition, and accompanying these changes there are new anxieties.

These changes have two consequences. There is a new preoccupation with resources; people worry about food, about new forms of energy, about new materials; and there is a phrenetic concern for security—secure jobs, secure status in the community, national security. Society is again living dangerously and spends most of its time thinking about means and not ends.

Do these great social changes justify a change in the concept of liberal education, a re-examination of humanism? No one would assert that the old literae humaniores are reaching the bloodstream of modern civilization. That is the problem which frustrates educators; not that the old humanism has become outmoded but that it has become impotent.

We are entering a civilization of experts and technicians. The humanism appropriate to such a civilization must be one that confers values on the automatic factory, the aeroplane, television, and the popular Press; it must have something to offer the sort of man who a century ago could neither read nor write, and who now reads only the popular Press and listens to the Light Programme of the B.B.C. For these reasons there should be a re-interpretation of humanism, and the purpose of liberal education should be to transmit this re-interpretation, which must, of course, embody the imperishable elements of earlier humanisms. Sir Eric declared his belief that the missionaries of the new humanism would not be in schools but in adult education.

As a basis for humanism, science has one insurmountable disqualification. It is of the essence of the scientific method that the human element must be eliminated. Science does not dispense with values but it does eliminate the variety of human response to values. It is concerned only with phenomena upon which all qualified observers agree. Its whole energy is devoted to describing, measuring and classifying natural phenomena in such a way as to secure agreement among all men; and this can be done only by making its values independent of man. The whole procedure of the scientist assumes that science has to be dehumanized.

Scientific humanism should therefore be ruled out as an alternative to classical humanism. There is another alternative which could be called technological humanism. The unique characteristic of our age is not the scientific way of thinking but the bewildering way in which the applications of science to society have shaken the foundations on which society has stood for centuries, and have raised not simply economic issues but also moral and ethical issues. Chemotherapy and preventive medicine, for example, have enormously altered the pattern of family life. The applications of science to industry have already created a problem of the mass production of leisure. The aeroplane and the radio have devalued the classical methods of diplomacy.

Is it not essential that liberal education should include an understanding of the social and moral consequences of technology and should concentrate upon the re-interpretation of the old values in such a way as to make them relevant to the new civilization which is upon us ?

This is not the only justification for the study of technology as part of a liberal education. The greater justification is that in the broad study of technology there are many of the ingredients which have for centuries been associated with a liberal education. Technological humanism could preserve the best of the traditional humanism: it could be catholic and continuous with the past; and at the same time it could enter the bloodstream of modern society, which the old humanism fails to do.

Technology concerns itself with the creative acts of man. To enthuse about Gothic churches and Tudor town halls and not even to glance at Viscount aeroplanes and stressed concrete bridges cannot be justified on the grounds that only the former are creative arts of man. It is simply an unwillingness to face the present.

Technology has its own standards of excellence and taste. A lot is talked about the shoddiness of mass-produced articles; fibre suit-cases compared with hand-made leather ones, gimcrack furniture compared with Chippendale. This is a weakness inherent in the public who accept these articles and not in technology. Where standards are insisted upon (as in aeroplanes, cameras, or gold watches) there is excellence. The lesson that good design is not necessarily expensive has not yet been learned. The establishment of standards for taste is an essential ingredient of technology.

Technology involves the handling of ideas and the establishing of values. In brewing, for example, there are many abstract ideas which are encountered by a man who wants to master its technology. There are the purely scientific ideas of microbiology, and there is the craft of the structural engineer who designs brewing plant. The beer has to be marketed; mass psychology, the education of public taste, diplomacy, or power politics in dealing with other brewers—all these are needed. This compels the brewer to become interested in tied public houses and hence in the architecture of public houses. If he has a mind receptive of liberal ideas he will be troubled by at least two moral problems. On one hand, he may feel under a moral obligation to put into his tied houses interesting pictures or good music. On the other hand, he could not reflect long on his job without facing the problem of the dangers of excessive drinking, and his responsibility for it; and to deal with these questions takes him into ethics and even religion.

Technology offers social coherence. One function of a liberal education is to endow people with a common heritage. In the past, technology has not been an instrument of coherence but rather of disruption. Is it not possible that technological humanism could change that ? Could the machine not be made a cement between the manager and the worker, the administrator and the employee? If both sides shared a common appreciation of machines and their function, they would become part of a common heritage. Technological humanism might achieve this end. If these ideas are pursued along the path of technology as well as along the older paths of literature, a greater number of students will acquire a liberal education, and those who take this particular path are likely to have a great influence on mass communication and propaganda, which will set the cultural standards of the bulk of the people.

EARLY HISTORY OF THE SURVEY OF INDIA

Historical Records of the Survey of India
Volume III, 1815 to 1830. Collected and compiled by Colonel R. H. Phillimore. Pp. xxii+534, and 19 coloured maps. (Dehra Dun, U.P.: Geodetic Branch of the Survey of India, 1954.) Rs. 20 or 31*s*.

THIS is the third of Colonel R. H. Phillimore's projected five volumes of "Historical Records of the Survey of India", covering the period before 1861 when annual reports were first published. The present volume takes the story from 1815 to 1830, when Everest took over both as superintendent of the Great Trigonometrical Survey and as surveyor-general of India. The period is one of great technical interest, and during it the foundations were laid or consolidated of many of the activities on which the future reputation of the Survey of India was to rest.

The arrangement is the same as in previous volumes. An introductory chapter gives a brief outline of the chief events of the period, and this is followed by detailed accounts of topographical and revenue surveys in the various provinces. Chapters are also devoted to astronomical control, the Great Trigonometrical Survey, professional details, and instruments, maps, administration, pay and allowances and personnel. Biographical notes on the principal characters take up more than a hundred pages, and there is a very comprehensive index. The narrative consists largely of extracts from the correspondence of the main characters in the story. Though this does not make for easy reading, it gives the reader an insight into the characters of the writers and the conditions in which they lived, which would otherwise be hard to convey. The advantages of the method thus more than compensate for any extra trouble in reading.

Probably the most important and far-reaching decision of the period was the recognition of the Great Trigonometrical Survey as the only sure foundation for all survey work and the priority given to it by Blacker when surveyor-general. By 1815 Lambton had extended his triangulation from southern India to Hyderabad, but he was now an old and sick man. Fortunately for the future of surveying in India, the youthful Everest joined as his assistant about three years before his death in 1823, thus ensuring continuity of his ideas and methods.

During the period, the plane-table gained ground rapidly as the main instrument for topographical surveying. It is not clear from this volume whether the method of three-point resection was then in use; and it seems possible that some of the prejudice against the plane-table was due to the earlier and unreliable method of orientation by compass, and resection from only two fixed points. Prior to 1828, Indians were only employed on revenue surveys, largely on security grounds. In that year, however, the first Indians were trained in plane-table surveying. They thus became the forerunners of that large and distinguished company of Indian surveyors whose skilled use of the plane-table was to make possible the cheap and rapid surveys which during the next hundred years covered a large part of central and southern Asia.

Geographically perhaps, one of the most interesting discoveries of the period was the heights of many of the main Himalayan peaks in the Garhwal–Kumaon region. These were so unexpectedly great that they were at first received with incredulity by the scientists of Europe. Other important geographical discoveries followed the opening of the Assam valley in 1824. This enabled the surrounding hills to be explored and opened the way for the first investigations into the identity of the Brahmaputra and Dihang Rivers with the lower reaches of the Tsangpo.

On the mapping side there was the initiation of the "Atlas of India" in 1822. This was designed to cover the whole country with maps on the scale of a quarter of an inch to the mile on a standard layout. After some uncertainty as to who should do the work, the Court of Directors laid down that the compilation and engraving should be done in Britain from material sent from India. Perhaps this decision was inevitable at the time; but few nowadays would deny that maps from original surveys are best compiled by those with first-hand knowledge of the areas concerned. The establishment of lithographic printing in India at about the same time was another great step forward in the popularization of maps. Hitherto they had been copied by hand from the original compilations, so that few maps were available for distribution; but shortly after the introduction of lithographic printing, the publication of maps for sale in quantity was started.

The production of this volume maintains the high standard of previous ones, and the beautifully reproduced maps and sketches leave the reader with a great respect for the artistic abilities of the early surveyors. Thanks are due to the Government of India for the support which has enabled Colonel Phillimore, in spite of all the changes during recent years, to carry on his great work begun on his retirement from the Survey of India more than twenty years ago. The preparation of the remaining two volumes is already well advanced, and it is to be hoped that they will be published in the not too distant future.

G. F. Heaney

LIVING MAMMALS

Living Mammals of the World

By Ivan T. Sanderson. Pp. 303 (330 illustrations). (London: Hamish Hamilton, Ltd., 1955.) 63*s*.

The publishers claim that this book "is an authoritative reference work" which will "in the words of a leading zoologist, 'fill a very important place in the literature of the subject and become a classic for many years to come'". This suggests a high standard of accuracy. The illustrations are said to be "extraordinary" and "many of them were taken in the wild". The author himself states that his main object is to describe the mammals adequately enough for the layman to be able to identify them on sight.

A well-produced and lavishly illustrated volume such as this will appeal to many who will be unaware that it falls very far short indeed of both the publisher's claim and the author's intention. The general plan is based on Simpson's 1945 classification from orders downwards. Most of the subject headings refer only to the subfamily or genus, after the popular name for the group, and very few species are identified by their scientific names. No doubt this reduces technicalities; but the result is a general vagueness, since the reader is often quite uncertain which species of a genus is being discussed. Some large groups of small mammals are dismissed in a few lines on the plea that it is quite impossible to describe them in a limited space.

The standards of accuracy are frequently low. Whether in the form of wild exaggeration, contradictions, taxonomic confusion, unreliable distributional data, surprising colour descriptions, or just unfounded statements of all kinds, mistakes abound to such an extent that it is quite impossible to recommend this book. Space permits of only a few typical examples.

The largest African dormouse is said (p. 128) to be two feet long. The largest specimen I have seen is 12 in. long overall. The masked civet, *Paguma* (p. 170), is said to be nearly four feet long with a tail of equal length. The largest I have measured is 4 ft. 4 in. overall. The ears of the false vampires (*Megadermatidae*) (p. 59) are described as twenty times the size of the head. In the largest I can find, *Macroderma gigas*, the head is 40 mm. long and 20 mm. wide, the ears are 50 mm. long and 65 mm. wide together. The elongated ankle bone of the tarsier (p. 69) is said to be longer than either the thigh or the calf [*sic*]. Actually it is shorter than either femur or tibia. We are told that the squirrel monkey (*Saimiri*) (p. 74) on reaching full maturity may be four times the size of the average adult—a remarkable statement.

Some whales are said (p. 210), while travelling at more than twenty knots ahead of a ship, to dart ahead and "vanish in a second". We are told (p. 204) that more than one of the author's captive grisons "literally burst through overeating". We also learn that two small, short-legged mammals, the brush-tailed porcupine (p. 147) and the armadillo (p. 110), are among the fastest animals on all fours. We read (p. 49) that the hedgehog when alarmed leaps into the air with all four feet to drive its spines into an attacker. The habitually solitary leopard seal is described (p. 158) as migrating "in enormous crowds".

There is often remarkable confusion in taxonomy. The specific epithets of the tamandua (p. 105) and the pygmy anteater (p. 106) are used generically (thus *Tetradactylus* and *Didactylus*). In an attempt to explain the use of the generic name *Panthera* for the great cats, and at the same time to clear up the popular confusion of the terms leopard and panther, Sanderson actually says (p. 162) "all the Great Cats that can roar are now officially *panthers* [author's italics] as the technical name implies". Under the heading Sokhors (*Myospalax*) (p. 122), which is a specialized Chinese rodent forming a separate subfamily, we find a recognizable description of an Indian mole-vole (identified beyond doubt by reference to the Quetta 'mole') of the genus *Ellobius*, a microtine referred to by name on p. 124. There is complete confusion over African otters (pp. 208–209). The spot-necked otter (*Lutra maculicollis*) is described under the name *Paraonyx*, a very different animal, after the statement that *Lutra* does not occur in

Africa. Under hartebeestes (p. 263), having started with Cooke's [*sic*] hartebeeste, we are told at the end of the section "One species is known as the Kongoni". This is, of course, the common name of Coke's hartebeeste!

Some remarkable errors of distribution occur. The grey seal (p. 158), "a shy lone animal", is said to occur no farther south than south Scotland. Both statements will interest those who have studied colonies on the coasts of England and Wales. On p. 162 we learn that the snow leopard is found in Amurland and Sakhalin Island, even down to sea-level in winter. The actual range is the Central Asian mountain region, reports from elsewhere being almost certainly due to confusion with local leopards. We are told that the African zorille (p. 205) is found in North Africa, Egypt, North Arabia, Palestine, Syria, Asia Minor and around Constantinople. In fact, there are no records for any of these areas, and the recognized northern limit is the Sudan. Among the seals, the Hawaiian seal of the mid-Pacific is ignored (pp. 155 and 158), the presence of a hitherto unknown seal in the Indian Ocean is reported (p. 158), but unfortunately without any data, and the distribution, as well as the taxonomy, of the Otariidae is thoroughly confused.

There are many other errors, but only a few can be cited here. The New Guinea three-toed spiny anteater (p. 16) is said to have a naked grey skin; it is actually thickly coated with dense black fur almost hiding the spines. On p. 55 an attempt is made to explain the principle of echo-location in bats; "supersonic" is used for ultrasonic, and the confusion of pitch (vibration frequency) with duration of sound results in complete inaccuracy. The naked bulldog bat (*Cheiromeles*) (p. 62) is said to have a pouch in the skin of the neck "in which the female carries her young". Its occurrence in the male is said to provide for the possibility of twins. But this sac is actually a very small and shallow scent gland structure. What Sanderson does not refer to is a roomy pouch at the junction of the wing membrane with the body, formerly thought by some writers to be for the transport of young, but recently shown to be a sheath for the folded wing tip at rest. The account of the habits of lions (p. 161) has little relation to fact; lions are not terrified of children, they do normally kill more often than once a month, and when not hunting they are not in the habit of "lying down back-to-back with the antelopes". The Bornean civet *Diplogale* (p. 171) is uniformly dark brown, not spotted. Palæontologists will learn with interest that the unfossilized bones of a carnivorous ungulate, the Chalcicothere [*sic*], are found in the soils of East Africa, and that this animal may be the dreaded Nandi bear. Finally, to get the record straight (a favourite phrase of Sanderson's) it should be mentioned that the 11 ft. 5 in. African elephant tusk (p. 293) does *not* weigh 293 lb. It is one of a pair the *combined* weight of which is that figure. The heaviest known tusk is 226½ lb.

Many descriptions indicate that the author has his own colour standards, and in many of the coloured plates the subjects appear to be bathed in the after-glow of a lurid sunset. Plate 98 of a lion is quite unrepresentative of the animal, both in its colour and since it is so obviously a menagerie specimen. Several of the illustrations (many of them old friends) are wrongly titled. On p. 170 the "small-toothed palm civet, *Arctogalidia*", is actually a Burmese palm civet, *Paradoxurus*. Darling's mole rat (p. 127) is a *Cryptomys*, not a *Spalax*. Plate 97 labelled grey seal is a common seal. The illustration on p. 159 is of a male elephant seal, not a female (despite the pup). Plate 146 is a warthog, not a giant forest hog, and Plate 181 shows impala, not Grant's gazelles. Less than 10 per cent of the pictures were taken in the wild; the rest are zoo animals, often posed in artificial surroundings.

Misspellings of scientific names are frequent.

I take no pleasure in directing attention to the many failings of this work, but since quite unfounded claims have been made for it I feel that the opportunity should be taken "to get the record straight". One might almost apply to this book Sanderson's own description of Melville's 'Moby Dick' (in connexion with sperm whales)—"a work of magnificent imagination and almost total zoological inaccuracy".

R. W. Hayman

TALKING ABOUT COMMUNICATION

Studies in Communication contributed to the Communication Research Centre, University College, London

By A. J. Ayer, J. B. S. Haldane, Colin Cherry, Sir Geoffrey Vickers, D. B. Fry, J. Z. Young, R. Wittkower, T. B. L. Webster and Randolph Quirk. Pp. vii+182+9 plates. (London: Martin Secker and Warburg, 1955.) 21*s*. net.

"If we are to take a hand in developing this process of communication," says Sir Geoffrey Vickers, "we must be able to talk about it; and at present we are ill-equipped to do so. . . . For the underlying issues are screened from us by what is itself a failure of communication. We have no language in which to discuss them with each other; and hence no concepts with which to present them to ourselves." The issues are screened from us, true. But they are screened not by the lack of language and concepts. They are screened by 'Babel'. This volume adds entertainingly and provocatively to the Babel. To be positively and contemporaneously correct, one should call it Meta-Babel.

The reader is given a two-dimensional *hors d'œuvres*: a dozen varieties of meaning of the word 'communication', and at least half a dozen different terminologies in which to discuss them—biological, cybernetic, administrative, neurological, æsthetic, linguistic. The terminology to end all terminologies is provided by the inevitable Prof. A. J. Ayer when he remarks: "It will be seen that there is something here for almost everyone". Prof. Ayer always says many sensible things, but one is never quite sure why he is saying one set of sensible things rather than another; and this sums up one's bewilderment about the book as a whole. One is also bewildered at the extent to which analogy and metaphor are being exploited in this new subject, if it is a subject, of communication. Thus Prof. J. B. S. Haldane writes that "Fruits signal to insects by colour" and also "Fruits advertise themselves to be eaten by mammals and birds". But perhaps these are not intended as metaphors, for he says: "A very large part of biology can be looked at from the point of view of communication theory".

Can communication theory provide a unifying language for the problems of communication?

According to Dr. Colin Cherry (who should know), the "measure of information" of Shannon and Wiener "has nothing whatever to do with meaning, nor with value, nor with usefulness of messages". There seems to be a contradiction here. Prof. J. Z. Young pinpoints the contradiction by saying that "what we still need is a greater unification of our approaches", but "The essence of the scientific approach is the realization that for each purpose we should use a different analogy". Prof. Ayer might have reminded us of the old problem of "the one and the many".

Those of us who enjoyed the hospitality of University College, London, and the stimulus of the oral delivery of these papers, will be glad to have this volume as a record. But a reviewer has a duty to appraise fulfilment of purpose. This is the first publication of the Communications Research Centre—"a first fruit of its activities" says the jacket. These individual essays doubtless contribute to the clarification of the problems of the Centre, and, in their several ways, they make excellent reading; but as a first publication of a research centre this volume puts remarkably little new research on record. This criticism is offered in no captious spirit. All who are alive to the vital importance of communication must have welcomed the establishment of the Centre. One cannot help asking whether this volume is the kind of publication which testifies to the serious research-intent of the Centre, or really furthers its object.

G. PATRICK MEREDITH

PROGRESS IN BIOPHYSICS AND BIOPHYSICAL CHEMISTRY

Progress in Biophysics and Biophysical Chemistry

Edited by Prof. J. A. V. Butler and Prof. J. T. Randall. Vol. 5. (Progress Series.) Pp. viii+231+9 plates. (London and New York: Pergamon Press, Ltd., 1955.) 55*s*. net.

THIS volume opens with a review of the reaction patterns of a coliform organism, by A. C. R. Dean and C. N. Hinshelwood. The application of kinetic principles to cellular growth, and the action of enzymes concerned therein, are lucidly surveyed and related to many different processes, of which adaptation and mutation may be mentioned. In their consideration of the physical chemistry of hæmolysis and bacteriolysis by surface-active agents and antibiotics, J. H. Schulman, B. A. Pethica, A. V. Few and M. R. J. Salton are also concerned with the application of physical chemistry to living organisms, particularly microbes. The fact that the enzyme lysozyme brings about a specific depolymerization of the cell walls of certain organisms has resulted in the preparation of protoplasts which, although deprived of cell walls, are capable of metabolizing glucose at the same rate as intact cells. It is clear that the investigation of the unclothed protoplast is likely to be of special value in research on the mechanism of action of substances which influence cellular metabolism.

For obvious reasons, the direct action of ionizing radiation on enzymes and antigens, as discussed by E. C. Pollard, W. R. Guild, F. Hutchinson and R. B. Setlow, is a matter for particular current interest, while for quite another reason the structure and function of the chloroplast (J. B. Thomas) can be of practical interest in a world looking for new sources of energy, of which sunlight is an obvious one for consideration. The theory of X-ray fibre diagrams (A. R. Stokes) is always a subject of some difficulty for the non-specialist, but the discussion given in this book is one that can be followed in general without great difficulty by those not carrying out research in this field. The last contribution in the volume is on recent studies on the reversible denaturation of proteins, by M. Joly It is natural that Dr. Joly should spend more than two pages discussing possible definitions of protein denaturation and then fail to adopt any simple definition. His ultimate conclusion, that in spite of a certain similarity between all the observed phenomena there exist several types of denaturation and reversal depending on the protein considered and the denaturing agent used, is not unexpected. But it is most desirable that this rather ill-defined state should be discussed and, together with the means whereby it can be brought about, considered in the light of present knowledge of protein structure; this Dr. Joly has attempted to do with some success. It is most unfortunate that the 252 references to the original literature cited by him have been omitted from the main index of this volume owing to an oversight on the part of the publishers. It might have been better to have re-set the index and to have delayed the appearance of the book rather than to publish it with an incomplete index.

This volume adds one more to the many books in related fields which now appear annually and include in their title either the word 'advances' or 'progress'. None of the subjects surveyed in this volume is ineligible for consideration in one of the other annual review volumes; but for those whose special interest is in the application of physical methods to biological problems, there is undoubtedly an advantage in having this collection of articles within the covers of one book.

F. G. YOUNG

THE INSTITUTE OF BREWING

A History of the Institute of Brewing

By W. H. Bird. Pp. ix+139+16 plates. (London: Institute of Brewing, 1955.) n.p.

THE author, who was secretary of the Institute of Brewing until 1951, has produced an interesting and informative book. In 1886, Dr. E. R. Moritz, consulting chemist in brewing, was in the habit of holding informal colloquia; these crystallized into the "Laboratory Club", which published transactions and by 1890 had 250 members. Similar bodies were formed elsewhere, and in 1895 all were federated and later (1903) merged into one—the Institute of Brewing. During 1895–1903 the *Journal* represented its main activity; but further projects were under consideration. The Midland Counties Institute favoured setting up a school of brewing. Agreement was not forthcoming; but the Midland brewers attained their object independently, and the British School of Malting and Brewing at the University of Birmingham resulted (1900).

The essential objects of the Institute of Brewing were defined as the promotion of such sciences and arts as are of practical application to brewing and allied industries, and the dissemination of knowledge useful in such connexion. The whole of the technical personnel of these industries were eligible for membership. Six sections (now also one in Australia) held monthly meetings. In due course committees were set up to advise on examinations, analysis and, later, research (1918). Since 1922 the Institute has conducted examinations annually on subjects ranging from fundamental physics and chemistry to brewing technologies, engineering, etc.

The research scheme has passed through three phases. At first, problems were investigated in various places by workers maintained there by the Institute: barley at Rothamsted, hops at Wye (new varieties), growing, etc., at East Malling, and the antiseptic constituents at the Manchester College of Technology, nitrogen metabolism of yeast at the Imperial College of Science and Technology, London, and Cadby Hall (J. Lyons and Co., Ltd.), and *p*H in relation to brewing at W. Younger's and Tetley's breweries. At this time a research organizer co-ordinated the work. In 1934 all laboratory work except that on hops was concentrated in the Birmingham Brewing School, all the studies being supervised by committees already in being. Finally, after many setbacks, a director was appointed, and all the work was transferred to the present Brewing Industry Research Foundation at Nutfield (1951). This is still the Institute's research scheme, financed on a vastly greater scale.

During the Second World War, contributions to the national effort included experimental work on the use of oats, flaked barley, lupulin, surplus yeast, concentration of beer, pest infestation of barley and vitamins of the B group in beer. A final contribution to brewing science and education has been the Institute's membership and support of the European Brewery Convention (1947).

The book has eight appendixes recording the names of officers of the Institute and forty-nine photographs of some of these and of scientists who have contributed to its success. The index is very comprehensive.

R. H. HOPKINS

RESEARCH ON TUBERCULOSIS AND LEPROSY

Experimental Tuberculosis

Bacillus and Host. With an Addendum on Leprosy. Edited by G. E. W. Wolstenholme and Margaret P. Cameron. (A Ciba Foundation Symposium.) Pp. xii+396+24 plates. (London: J. and A. Churchill, Ltd., 1955.) 42*s*. net.

PRESENT-DAY research in tuberculosis and leprosy continues to attract investigators of widely different disciplines, each interested basically in a limited aspect of the subject regarded from his own scientific point of view. There is thus a danger of the study of these important diseases becoming fragmented into entirely separate domains of chemistry, pharmacology, pathology, bacteriology and immunology. One of the most valuable contributions of the Ciba Foundation is its rare facility for organizing symposia in which all these separate approaches to what is fundamentally one coherent study can be blended. Reports which would normally be heard only by workers of the same scientific background are here presented in an informal atmosphere for consideration by those equally expert in other branches of the selected subject. Thus, in the published symposia, the most striking feature is not the undoubted excellence of the main contributions, but the unusually stimulating discussion on each paper, which is reported verbatim. In a symposium of this type there is far less preoccupation with specialized knowledge than is usual at any sectional meeting; the exchange of ideas, and the cross-fertilization of one speciality by another gain considerably in the process.

The present symposium begins with a series of papers on the chemical structure of Mycobacteria and the biological activity of various fractions of the bacterial protoplasm. The emphasis here may seem perhaps a little overwhelmingly academic to the medical research worker. However, a very large volume of work is skilfully compressed into short readable accounts, and the implications and objects of the researches are well brought out both in the discussions and in the well-balanced progress of the programme. In the next section attention is gradually focused on the host animal—how the tissues respond to the infecting organism, and which bacterial fractions are important in eliciting such response. Here both hypersensitivity and immune reactions are considered. Equally important is a complementary study of how the bacilli themselves may be affected by biochemical reactions of the host animal. Some of the factors concerned in resistance to infection are illustrated by *in vitro* studies with infected tissue cultures, and by observations of the immunity of animals previously exposed to non-lethal infections; indirect evidence obtained by interference with the normal host–parasite relationship by cortisone or by chemotherapy is also presented. In the addendum on experimental leprosy, the common denominators in the two diseases and in the tissue responses of the infected host to either organism are underlined.

In a symposium of this size, it is perhaps invidious to select individual contributors for special mention. It suffices to say that, whatever the special interest of the reader, here he will find his acknowledged leaders; however well he considers he 'knows the literature', he will still learn much from reading each contributor undergoing the only satisfactory test—trial by his peers.

DEREK HOBSON

METEOROLOGY OF THE FALKLAND ISLANDS AND DEPENDENCIES

The Meteorology of The Falkland Islands and Dependencies

By J. Pepper. Pp. vi+249. (London: Crown Agents for Oversea Governments and Administrations, 1954.) 42*s*.

THIS large, beautifully produced book contains a discussion and tabulated summaries of the surface meteorological observations made between 1944 and 1950 at Port Stanley, Falkland Islands, and at nine stations in the Dependencies constituted by the Graham Land Peninsula on the Antarctic Continent and the islands in the Antarctic Ocean to the north of Graham Land. The station farthest south, Marguerite Bay on Graham Land, is some nine hundred miles from Port Stanley. All are at or near sea-level. Besides meteorological data, the book includes a description of the sea–ice variations observed in 1950.

The Dependencies stations, except for the one at South Georgia operated by an Argentine whaling company until 1949, were originally set up by the

Royal Navy in 1943–44, and since 1950 they have formed part of the Falkland Islands Dependencies Survey Meteorological Service, which has its headquarters at Port Stanley and performs all the usual functions of a meteorological service, including weather forecasting. The book, which was prepared in the Climatological Division of the Meteorological Office, is in three parts: a general discussion, written by Dr. J. Pepper; a gazetteer of stations; and climatic tables.

The publications of the meteorological work on Antarctic expeditions include some of the classics of meteorology but, on the whole, they are restricted in time and space. This is the first publication to survey the weather of a large area of the Antarctic for so long a period. The weather of the area is controlled by the continual passage of depressions and the intervening ridges of high pressure; and so it is very changeable, with relatively small seasonal variations but large changes associated with the passage of fronts. Mean pressure is low—about 900 mb. at the Dependencies and 1,000 mb. at the Falklands. Mean monthly temperature varies between about 35° F. in summer and 15° F. in winter over the Dependencies, and 48° F. in summer and 35° F. in winter at the Falklands. Rises and falls of temperature of up to 40 deg. F. occur in the Dependencies with the passage of warm and cold fronts respectively. An interesting comparison with northern-hemisphere stations at the similar latitudes and situations (for example, Godthaab in Greenland) shows the Antarctic ones to have warmer winters and cooler summers, demonstrating the more intense circulation of the Antarctic. Interesting details are the very high frequency of visibility exceeding 40 km. and the 'burning' of sunshine cards at solar elevations less than 2°—exemplifying the purity of the air—the observation of iridescent clouds by moonlight, and the exactness with which the rise of temperature in air descending from the 5,000-ft. plateau to Marguerite Bay corresponds to the adiabatic value.

The tables include monthly summaries of all the meteorological elements, and frequency tables for many of them for all the stations. Special praise must be given to the gazetteer, with its photographs and detailed topographical descriptions. It is regrettable that no index is provided.

OPTIMAL SPAN OF WORKING LIFE

Ageing in Industry

An Inquiry based on Figures derived from Census Reports into the Problems of Ageing under the Conditions of Modern Industry. By F. Le Gros Clark and Agnes C. Dunne. Pp. xi+149. (London: The Nuffield Foundation, 1955.) 6s.

THE only people who seem to have solved the problem of their senescent members seem to have been the mythical Hyperboreans whose aged, when they wished to retire from life, performed a "joyful suicide" by decking themselves with garlands and precipitating themselves from a rock into the sea. Non-mythical peoples have found various other solutions. The Tibarini used to hang their old on gibbets, the Hircanians and Bactrians cast them, while still living, to the dogs, and the Scythians buried them alive.

In Great Britain such drastic measures have never been contemplated, although the plight of the aged has often given cause for much distress. During the past two or three decades we have become increasingly conscious of the wider repercussions of our ageing population and the resulting social and economic disadvantages. The highly complex situation was fully examined by the Royal Commission on Population (1949). The Commission's report was particularly concerned with the growing 'burden of dependency', that is, the decline in the proportion of producers per consumer, and it emphasized the desirability of prolonging the productive capacity of workers beyond the age of sixty-five. At that time, however, it was not possible to give anything like a precise answer to the question: "At what ages are men compelled, by reason of their age alone, to leave the occupations in which they have spent their working lives?" This is the important question to which Mr. F. Le Gros Clark and Miss Agnes Dunne address themselves in this book. Their inquiry is based on figures derived from the Census Reports for 1921, 1931 and 1951 and relates to four million men in thirty-two occupations, representing about a quarter of the occupied male population of Britain in 1951. The principal method of analysis employed by them is that of the 'moving cohort'; they have taken a decennial age-group from each of the thirty-two occupations at 1921 and followed it through until 1951.

They define the 'survival-rate' of working men as the proportion of men who reach their mid-sixties in a given job and are physically capable of remaining in it until their late sixties or beyond. The survival-rates for the different occupations range from 75–85 per cent among watch- and clock-makers to 5–15 per cent among workers at the coal face. Agricultural workers and men in certain building trades have relatively high survival-rates as compared, for example, with tobacco workers, compositors, foundrymen, bus conductors and constructional engineers. By appropriately weighting the thirty-two occupations and making allowance for the proportion who would have to cease work because of impaired health, the investigators estimate that alternative jobs would have to be found for 20–30 per cent of those aged 55–64 in 1951. For the country as a whole, this amounts to forty thousand alternative jobs to be found every year over the relevant ten years.

A second analysis shows the ratio of those aged 65 and over to those aged 35–64 in each of the thirty-two occupations. This reveals considerable variation between the occupations in respect of their employment of older men, a variation which suggests an incapacity on the part of many workers to remain in certain occupations under present conditions. In a third analysis the investigators show the changes in age structure of the occupations which took place between 1931 and 1951 in relation to the contraction or expansion of the occupation.

This is a most valuable study which will provide industry, the trade unions and many government departments with much-needed food for thought and perhaps a first guide to action. The authors' efforts will not have been in vain if their report leads at least to serious research into possible alternative jobs for older people and into methods of reducing the stresses which make them leave their work at an age earlier than they might otherwise do. The Nuffield Foundation has rendered another public service in sponsoring this report

JOHN COHEN

The Pathogenesis of Poliomyelitis

By Prof. Harold K. Faber. (American Lecture Series—No. 257. A Monograph in American Lectures on Pediatrics.) Pp. xvi+157. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, 1955.) 36*s*.

EXACTLY where the virus of poliomyelitis first invades the body has long been the subject of speculation, as also has the problem of its subsequent dissemination. These topics have for many years afforded a fruitful field for collaboration between anatomists and pathologists. The concept of the axonal transmission of poliomyelitis, first clearly formulated by Fairbrother and Hurst in 1930, soon met with the approval of Prof. H. K. Faber, who has staunchly advocated it ever since. The present work is a re-statement of his views, in the face of evidence which in recent years has appeared to cast doubt upon them.

His main thesis is that virus first enters the mucosa of the mouth and pharynx, and then spreads centripetally along the axons of sensory nerves to reach their ganglia, in which 24–48 hr. after exposure it begins to multiply. Two to three days later, the virus then reverses its direction and passes centrifugally to be excreted into the oropharynx, whence axonal re-invasion with further centripetal spread of virus may occur, while in addition varying amounts of virus are swallowed. Virus particles in the intestine, he suggests, may be absorbed in exactly the same way as undigested protein; and only thus do they reach the liver, or the intestinal and mesenteric lymphoid tissue, and the blood stream. Virus obtains access to the central nervous system either from the blood stream, or from the peripheral ganglia if they are severely infected.

Prof. Faber considers that the tissue culture experiments of Enders and his colleagues have no relevance to his argument. For though they showed that virus in tissue culture could grow outside the nervous system, and possibly in the complete absence of nervous tissue, Faber maintains that conditions *in vitro* and *in vivo* are fundamentally different. It is all the more surprising that he does not mention the experiments of German and Trask, which are especially pertinent in this connexion; nor does he seriously consider the possibility of cellular transport of virus mediated through the lymphoid tissues.

J. M. Yoffey

A Manual of the Dragonflies of North America (Anisoptera)

Including the Greater Antilles and the Provinces of the Mexican Border. By Prof. James G. Needham and Prof. Minter J. Westfall, Jr. Pp. xii+615. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 94*s*. net.

MORE than twenty-five years after the publication of his earlier book on the dragonflies of North America, Prof. J. G. Needham, in collaboration with Prof. M. J. Westfall, has now written the first part of a new and enlarged work, dealing with the sub-order Anisoptera. The need for it is evident from the fact that, since his first work, the list of species in the North American Anisoptera has grown from 245 to 332.

Most of the book naturally deals with the taxonomy of the group, but there are chapters devoted to the structure and life-history of the Anisoptera, to the methods employed for collecting adults and nymphs and for studying them in the field and laboratory. In the systematic part, keys and tables are given for the identification of families, genera and species (both adults and nymphs, where known), and under each species are given not only a description but also the principal bibliographic references, distribution and the period of flight of the adults.

The whole book is lavishly illustrated with line and half-tone illustrations of venation, genitalia and nymphs, all of a high level of excellence. Most of the photographs were taken by Prof. Westfall and were produced by the methods outlined in a joint paper with A. L. Smith (*J. Biol. Phot. Ass.*, 19, No. 2, 74; 1951). The manual will certainly be of great value, not only to American students of Odonata but also to others interested in these flies, and the publication of the companion volume on the Zygoptera, which is in preparation, is eagerly awaited.

D. E. Kimmins

Optical Instrumentation

Edited by Prof. George S. Monk and W. H. McCorkle. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 4—Plutonium Project Record: Vol. 8.) Pp. xxv+262. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 30*s*.

THIS book is not of sufficient quality to justify the claim that it may be used as a text-book. The editorial advisory board finds it necessary to warn the reader to expect discrepancies and duplication on the plea that promptness of publication seemed more important: this is scarcely a recommendation for a reference book. Even so, it is a little too much to find that a smoke tester mentioned on p. 49 as being developed for particles 0·04 cm. in diameter is actually intended for particles $\frac{1}{4}\mu$ diameter according to paper 5.2 (not paper 5.3 as given by the reference). This paper makes the illuminating statement that cigar-smoke is the limit of precision of the method—the reader being left to draw his own conclusions. Techniques are mainly experimental and restricted both by time and to available lenses. It is thus not surprising to read on p. 15 "the best definition was not always obtained".

Theory is but briefly considered. In section 1.2, on brightness of images, it is stated that if the size of the entrance pupil is sufficiently larger than the exit pupil to compensate for light losses in the system, the intensity of a point object will be increased. The influence of the diameter of the pupil of the eye is not discussed. The book is not without interest, however: the problems encountered are outlined; the replacement of optical glass, darkened by high-energy radiation, by plastics is mentioned; and some valuable work on evaporation in vacuum is recorded.

G. W. Hamstead

The Ocean Floor

By Hans Pettersson. (Silliman Memorial Lectures.) Pp. xv+181. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1954.) 3 dollars; 24*s*. net.

ALTHOUGH the sea-floor covers approximately two-thirds of the Earth's surface, our knowledge of its morphology, structure and composition is meagre. For many years after the *Challenger* Expedition (1872–76) there was little progress, largely due to the lack of improved apparatus for investigating the deep-sea floor. Although the *Challenger* took cores 2 ft. in length, there was little improvement until Dr. B. Kullenberg, during the Second World

War, developed a piston core-sampler capable of taking cores 60 ft. in length. Prof. Hans Pettersson, realizing the significance of this and other recently developed geophysical techniques, organized with great success the Swedish Deep-Sea Expedition (1947–48).

This book, based on Prof. Pettersson's Silliman Lectures at Yale University, is a fascinating description of the scientific results of the Expedition, together with a summary of the results of other recent expeditions. Few technical terms have been used, and the book is intended for the non-specialist. The author's style is vigorous and clear, and his critical examination of theories is of great interest. There is an interesting chapter on deep-sea radium and the geochronology of the ocean floor. Since Pettersson's pioneer work on radium determinations, published in 1930, a possibility has existed of developing a time-scale for deep-sea cores based on radioactive decay. Piggot and Urry were first in this field. It would now seem from the detailed radium, ionium and uranium measurements that the problem is far more complicated than suggested by the investigations of Piggot and Urry.

J. D. H. Wiseman

Birds and Mammals of Shetland

By L. S. V. Venables and U. M. Venables. Pp. xii + 391 + 8 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 30*s*. net.

This is an ambitious book, the authors setting themselves the formidable task of describing the birds and mammals of that interesting northern group of islands known as the Shetlands; not content with this wide field, they give appendixes on the introduction of the common frog and common toad to Shetland, and they wind up with a list of plant flowering dates.

The volume begins with a short account of Shetland naturalists and visiting naturalists, goes on to consider Shetland habitats and then proceeds to status changes in Shetland birds. It is obvious that the authors take a keen interest in the waxing and waning of species and have found these islands an excellent place for population studies. After this, they work through the list of Shetland mammals and follow with the birds, dealing with them species by species in a very thorough manner.

They are to be congratulated on a painstaking effort and on a book that will be of much assistance to visitors to the islands.

Frances Pitt

Introduction to Virology

By Dr. Gilbert Dalldorf. Pp. ix + 102. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, 1955.) 25*s*.

Dr. Gilbert Dalldorf's little book sets out to tell the practitioner and hospital pathologist the simpler facts about viruses and virus diseases of man. His hope is to convince them that virus infections can be studied, from the routine and even the research point of view, with the aid of comparatively simple equipment. He is very right to try to dispel the notion that it is an esoteric subject, only comprehensible to a select few. The commoner virus diseases are discussed from the clinical and laboratory aspects. Measles and chicken pox appear, oddly enough, under skin diseases and not under "Poxes and Rashes". "The Simple Common Techniques" are described, but scarcely in sufficient detail to allow of their being performed without reference to larger works, and unfortunately there are very few references. The word "subspecies" is used erroneously on p. 11; and on p. 59 and again on p. 87 the author makes the astonishing statement that latent infection with herpes simplex virus occurs frequently in normal rabbits.

Michelangelo

A Study in the Nature of Art. By Adrian Stokes. Pp. 154 + 24 plates. (London: Tavistock Publications, Ltd., 1955.) 25*s*. net.

This book is of somewhat unusual character, and perhaps valuable on that account. It is a brave effort to get beneath the surface of a tempestuous and majestic personality, that of Michelangelo (1475–1564). Unluckily, the author's style is often so obscure as to baffle the reader considerably, even if he is able and willing—as many readers will be—to see their subject in terms of Freud's psychology. The advantage, however, of this analytical study is, of course, that the basic nature of art—as a sensitive function of environment—is revealed stripped of adventitious material and is thus of æsthetic significance.

After some introductory matter, there is a discussion of the master's visual works, followed by an able analysis of his poems. There are copious notes, and a couple of appendixes, one concerned with iconography and the other with the Medici chapel. In addition, there are several illustrations.

All this leads to an appraisal of the unique contribution of Michelangelo to humanist art. Painting, sculpture, architecture, all bore witness to this tireless mind, melancholic and 'prickly', wearing itself out in superhuman feats of bodily endurance. His mannerisms were rugged, and as Lomazzo declared in 1590, Michelangelo reached the knowledge of harmonic proportions by way of music. Even his own body (on this showing) was built harmonically.

F. I. G. Rawlins

B.B.C. Handbook, 1956

Pp. 287. (London: British Broadcasting Corporation, 1955.) 5*s*.

This handbook, besides giving a general picture of broadcasting in Britain during the year ended March 31, 1955, and lists of representative programmes broadcast during that period, constitutes a very convenient reference work on the B.B.C. as well as a guide to its working. An account of the constitution is followed by notes on controversial and political broadcasting, and compared with last year's handbook there are fuller accounts of the External Services and of the re-broadcasting of the B.B.C. programmes throughout the world. More information is also included about the advisory councils and committees. Of particular interest to the scientist are the section describing the work and responsibilities of the Engineering Departments and that discussing some problems of reception, particularly very high frequency.

Details are given of the membership of the various councils and committees and of the senior staff, the balance sheet and accounts for the year, some analyses of income and expenditure, and tables of the totals and distribution of broadcasting licences, etc. The handbook includes the text of the royal charter, licence and agreement; and a good bibliography and index add to its value as an accessible and comprehensive source of information on the B.B.C. and its activities.

CYTOLOGICAL IDENTIFICATION OF RADIATION-CHIMÆRAS

By Dr. C. E. FORD, J. L. HAMERTON, D. W. H. BARNES and Dr. J. F. LOUTIT

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Harwell, Berks

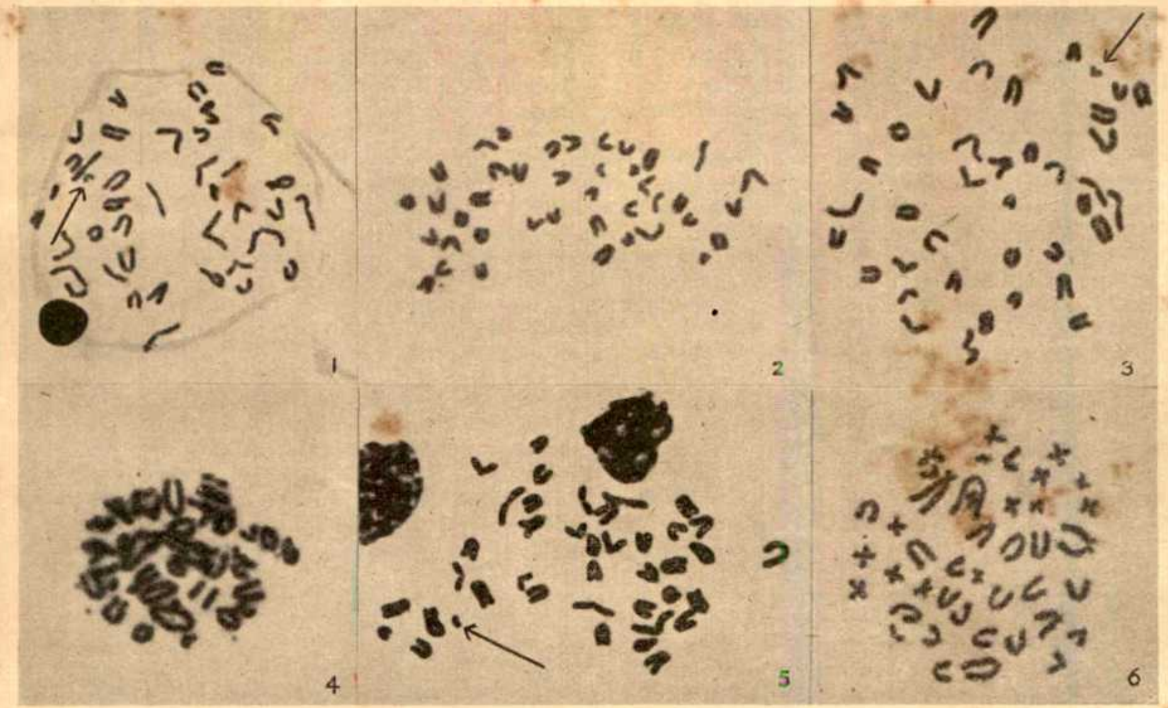
THE term chimæra, long used in botany, has recently been adopted by zoologists to denote an animal the constituent cells of which are of more than one genotypic or antigenic lineage. The state may occur naturally, as the freemartin in cattle. An example has even been reported in man[1]. It may be induced by the injection of foreign cells into the developing fœtus[2]. In all these instances it is believed that cells from one individual are grafted into another during fœtal life when the immunological mechanisms are immature. In these circumstances the natural and the foreign stock appear to be able to develop side by side. After the birth of the animal the effect of administering homologous cells or tissues changes and the homograft reaction occurs; following a preliminary 'take', the host develops an immune response and as a result sheds the graft.

It has been shown by Jacobson *et al.*[3], and soon after by Lorenz *et al.*[4], that adult mice irradiated with an expectedly lethal dose of X-rays could recover if grafted or injected with hæmopoietic tissue from a normal mouse. Consequently it was not surprising that they postulated recovery to be due to a 'humoral' or chemical factor in the material given, rather than to replacement of the damaged tissues of the host by foreign cells. Furthermore, Lorenz and his group showed that even heterospecific material from guinea pigs and rats could in some circumstances produce a similar result[5,6]. No example of the compatibility of a heterograft had been recorded, so the humoral theory seemed almost established. It received additional support from the investigations of Cole and his collaborators[7], who showed that homogenates in which the splenic material had been subjected to severe trauma were as effective as suspensions. On differential centrifugation of these homogenates the active fraction was the heaviest, consisting almost wholly of nuclei. The activity of this fraction was destroyed by solutions of crystalline deoxyribonuclease and trypsin, which were believed to act specifically on naked nuclei and not to damage any intact cells which might have been left after homogenization[8]. Cole and Ellis[9] considered the active principle to be macromolecular, particulate and probably deoxyribonucleoprotein.

On the other hand, there are the observations from our laboratory. Inbred mice irradiated and treated with homologous cells survive for short periods only compared with similar mice given isologous cells[10]. The material used for injection, normally very labile, is preserved by glycerol at -79° C.[11], as are some cells; and prior administration of homologous cells to elicit an immune response destroys the therapeutic effect of a second, post-irradiation injection of identical material[12]. When a single injection of homologous cells is made after irradiation, the donor's antigens persist and apparently increase in the host, and antibodies previously induced in the donor appear in the host and increase in titre (Mitchison, N. A., unpublished work). Recent experimental results obtained in the United States point in the same direction. A mixed population of erythrocytes with antigens derived either from host or from donor appears in the peripheral blood of irradiated rats given homologous bone-marrow[13]. Also, irradiated mice treated with homologous cells will tolerate selected skin grafts which normally they reject[14]. These experiments collectively give very strong support to the hypothesis that the damaged hæmopoietic tissues of the host are replaced by the injected foreign cells or their descendants. They fall short of proof, however, since they do not exclude the possibility that immunological properties may be transferred by a process akin to transduction in bacteria.

This objection would be overcome if dividing cells with one or more distinctive chromosomes characteristic of the donor could be identified in the host. The possibilities of such an experimental approach had long been appreciated in principle. The problems were technical and complementary; first, to find a suitable chromosome-marker, and second, to make preparations of a standard which would enable it to be recognized. There are forty chromosomes in a normal mouse. They show little differentiation, varying continuously in length and all having effectively terminal centromeres[15,16]. The sex chromosomes cannot be identified in somatic mitoses by present methods. It seemed, therefore, very unlikely that a satisfactory marker could be found in the mouse. However, in the course of a survey of the cytological properties of a series of semi-sterile stocks raised by Carter, Lyon and Phillips[17], one stock (*T*6) was found to be heterozygous for a very unequal reciprocal translocation between two of the smallest members of the normal chromosome-set. One of the two re-arranged chromosomes was thus much smaller than any of the normal complement and showed up prominently in spermatogonial metaphases. A potential marker having been obtained, the next step was to develop a really satisfactory technique for making preparations of bone-marrow. This proved more successful than had been anticipated and will be described elsewhere. It is sufficient to say here that it is an adaptation of the Feulgen-squash method, in which colchicine pretreatment is used and the tissue is handled as a cell-suspension. The small marker chromosome was found to be even more distinctive in bone-marrow cells than in spermatogonia (Fig. 1). It usually appears as three dots arranged in a triangle, suggesting the presence of an under-stained ('heterochromatic') region close to the centromere. Similar under-stained regions are found in five other chromosomes of the normal set. The chromosomes of a cell in metaphase from the bone-marrow of a normal *CBA* mouse are shown in Fig. 2.

Male *CBA* mice were used for the experiments. They were exposed to 950 r. of X-rays and then injected intravenously with a cell suspension prepared from the spleens of infant mice heterozygous



All the photographs are of cells in metaphase from bone-marrow, except Fig. 5, which is from spleen. Arrows point to the marker-chromosomes. Magnification × 960, except Fig. 4. Fig. 1: *T*6/+ mouse. Marker-chromosome present. Fig. 2: Normal *CBA* mouse. No marker-chromosome. Fig. 3: *T*6/+ cell in *CBA* mouse 14 days after irradiation (950 r.) and injection with *T*6/+ cells. Fig. 4: *CBA* mouse 5 days after irradiation (950 r.) and injection with *T*6/+ cells. Host cell showing dicentric chromosomes and acentric fragments. × 1120. Fig. 5: *CBA* mouse 28 days after irradiation (950 r.) and injection with *T*6/+ cells. *T*6/+ cell in spleen. Fig. 6: *CBA* mouse 19 days after irradiation (950 r.) and injection with cells from rat bone-marrow. Cell with normal rat chromosomes

for the *T*6 translocation. Eight animals in all have now been killed, at 5, 14, 19, 28 and 49 days after injection, and in every one the characteristic *T*6 marker-chromosome has been found in dividing cells of the bone-marrow. A typical cell from an animal killed 14 days after injection is shown in Fig. 3. In such a cell it is possible to count the chromosomes accurately and to be quite certain whether the marker-chromosome is, or is not, present. Cells descended from those injected are in any event positively identified by the marker-chromosome, whether the chromosomes are countable or not. A disadvantage inherent in the squash-technique is that one can never be quite sure when a cell has been broken and some of the chromosomes lost. The firm identification of a host cell therefore requires the presence of a full and normal set of mouse-chromosomes (that is, a count of 40 and no marker). No such normal cell has yet been found. However, structural changes of the kinds well known to be induced by irradiation have been observed in a few cells. It is reasonable to attribute these changes to the high dose of radiation delivered to the host-animal and so to identify the cells containing them as host cells. An example is shown in Fig. 4. This cell is broken and only thirty-six of the centromeres can be accounted for. Nevertheless, eight dicentric chromosomes, fourteen acentric fragments, and four pairs of minute (isodiametric) fragments were found. It may be noted in passing that if a cell such as this is able to complete division the daughter-cells would be so unbalanced genotypically that the possibility of their survival must be very remote.

The marker was readily identified in the great majority of cells with well-spread chromosomes. Many of these cells contained forty chromosomes; none had more; some had less. Most of the latter had clearly been broken during the making of the preparations. The relatively few cells lacking a marker had counts of less than forty. In addition, dividing cells with chromosomes insufficiently spread for accurate counting were present in all preparations. The marker was identified in many of these also, although a careful search was often necessary. No essential difference was noted between animals killed at different times. These results show that at least a large part of the host's bone-marrow had been replaced by cells originating from the donor, and that there is no evidence of recovery of the host's own tissue even seven weeks after injection.

Dividing cells containing the marker-chromosome have also been identified in spleen (Fig. 5), lymph node and thymus. The information for these tissues is not yet as extensive as for bone-marrow. Nevertheless, it suggests that the situation in these organs is essentially the same, that is, virtually complete replacement of the host's tissue by donor-cells. It is significant that, in comparable experiments, Mitchison (unpublished work) found antigenic activity attributable to the donor to be present in spleen and lymph node for as long as seven weeks after injection.

One series of irradiated mice was injected with a suspension of bone-marrow cells of the Wistar rat and killed 5, 11 and 19 days afterwards, two at each time. Dividing cells with normal rat-chromosomes were easily identified in bone-marrow from all the animals (see Fig. 6). The chromosome complements of the rat and the mouse are strikingly different, and almost all cells at metaphase could be firmly identified one way or the other. Of 1,400 cells examined, none was identified as a mouse-cell and only fifteen were classed as uncertain; all the remainder contained rat chromosomes. This result confirms and extends the conclusion to be drawn from the experiments with the *T6* marker, namely, that replacement of the host's bone-marrow by injected donor-cells is effectively complete.

These results would seem to establish finally that cellular repopulation is the mechanism by which spleen and other tissues bring about their therapeutic effect. They do not, however, specifically exclude the possibility of simultaneous operation of a humoral factor. The role that such a factor might take is now problematical, since it could scarcely still be maintained that it was concerned with recovery of the host's hæmopoietic tissue, as originally postulated by Jacobson. Recovery by cellular repopulation is not incompatible with the reports that suspensions of free nuclei are active; but consideration of the way in which free nuclei might exercise a therapeutic effect is unnecessary until it is conclusively demonstrated that the action cannot be attributed to the presence of some intact cells in the preparations. Although the main question, we believe, is now firmly answered, it remains to be determined whether there is some measure of recovery by the host's own cells at an even later stage than we have yet been able to examine.

That a therapeutic effect could be obtained by injection of heterologous material has been known for several years[5,6]. In fact, this was at one time considered by some workers to be almost decisive evidence in favour of the 'humoral' hypothesis. Those who preferred the alternative view must have been prepared to accept the unorthodox concept of the co-operation, at least temporarily, of the cells of two distinct species in one individual. Although the very term chimæra points to the antiquity of the idea, it is believed that the experiment reported here provides the first decisive evidence in animals that normal cells of one species may, in special circumstances, not merely survive and multiply in another, but even replace the corresponding cells of the host and take over their functions.

The possible applications of the chromosome marker technique are worth noting. In principle, it provides a biological 'tracer' method which should be applicable to all questions where the origin in development or regeneration of a particular group of cells is at issue, provided the cells concerned undergo mitosis naturally, or can be persuaded to do so. It may also find applications in connexion with problems of carcinogenesis and transferred immunity. The method might be applied in two ways: by injection or implantation of cells already carrying a marker, or by localized irradiation to produce a detectable, viable chromosome rearrangement *in situ*. The latter method has already been employed in plants by Brumfield in an attempt to determine the number of primary generative cells in the root meristem of *Vicia faba*[18].

We have been greatly helped by the advice and interest of many of our colleagues, especially Dr. R. H. Mole and Dr. E. V. Hulse. The heterozygous *T6*/+ mice were kindly provided by Dr. T. C. Carter, Dr. M. F. Lyon and Miss R. J. S. Phillips.

Addendum. A report[19] received after this manuscript was completed describes the detection of alkaline phosphatase activity characteristic of the rat in cells from irradiated mice injected with rat bone-marrow. Although the authors regard repopulation of the host's bone-marrow by cells from the donor as the most likely explanation of their results, they point out that induction of the observed changes in the host's own cells is not excluded.

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THE *ATLANTIS* MARINE GEOLOGICAL EXPEDITION TO PERU AND CHILE

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THE research vessel *Atlantis*, of Woods Hole Oceanographic Institution, explored the deep trenches that lie off the coast of Peru and northern Chile during November and December 1955. The expedition collected a hundred cores of sediments along twelve profiles between Talara in lat. 5° S. to a point eighty miles south of Antofagasta, Chile, in lat. 25° S. Continuous soundings of the water depth were made with the new Woods Hole sensitive sonic sounder whenever the ship was under way. In addition to the profiles on which sediments were collected, six traverses solely for sonic sounding were made across the deepest part of the trenches. Numerous bathythermograph readings were made of the Humboldt Current, and twelve runs were made with the geomagnetic electrokinetograph south of Iquique, Chile, in lat. 20° S. in an effort to determine the strength and character of the Humboldt Current. These are among the first runs of this character that have been made south of the magnetic equator, which passes near Lima, Peru. The results have not yet been calibrated to indicate the actual character of the current.

One of the most interesting features of the Expedition was the delineation, by means of the sonic sounder, of a trench 500 miles in length and one to three miles wide, and 24,000–26,000 ft.—mostly more than 25,000 ft.—deep extending between Arica in lat. 19° S. and lat. 25° S. The sides of this trench in each of the seven places where it was crossed are remarkably steep and range in height from 1,000 to 4,000 ft. In one place in lat. 25° S., the wall of the trench, as indicated by the fathometer trace, rose 1,500 ft. in a quarter of a mile. This trench was only forty miles from shore at this locality. The trench is balanced by mountains 20,000 ft. high scarcely 125 miles away. North of lat. 19° S. this trench is shallower and evidently is offset on echelon by a shallower trench to the west.

The sea floor seaward from shore descended more or less progressively to the bottom of the trench. In many places remarkably flat benches were observed in water from a few hundred to several thousand feet deep. These benches in places were terminated by more or less pronounced scarps, some of which were steep and as much as 5,000 ft. in height. Seaward from the deepest part of the trench the bottom rises more or less progressively upward to a depth of 2,200–2,000 fathoms. The tracings of the sonic recorder give the impression that the deep trench represents a graben within other downfaulted blocks, such as is found in the Red Sea.

A profile was run parallel to the coast between lat. 12° S. and 26° S. in shallow water. One large submarine canyon with walls 3,000 ft. in height was found. It is located a short distance north of Arica, about lat. 18°. Elsewhere only occasional minor notches are observed in the profiles parallel to the coast.

The primary objective of the Expedition was to study the sediments. The deepness of the troughs suggests that the area represents a geosyncline in the making. The land that is the source of the sediments for the area is arid and supplies relatively little sediment to the sea. It is hoped that the results will throw light on the origin of greywackes. Details of sedimentation cannot yet be given as the sediments were kept in the core tubes until return to the laboratory; but many of the samples, particularly in water of shallow and intermediate depth, consisted of muddy sands strongly suggestive of greywacke. Certainly the pattern of sedimentation does not accord with the concept of increasing fineness from shore. In many places the sediments at some distance from shore are much coarser than those nearer the coast. The deep samples consisted of clays in all cores except one, which was sandy. The cause of the variation in texture is not apparent from the field-observations. Perhaps bottom configuration is a factor.

Three cores were placed in a refrigerator as soon as collected to prevent decomposition of possible hydrocarbons. It is hoped that studies of the organic content of these frozen samples will throw light on the origin of oil.

The Expedition was conducted under the auspices of Woods Hole Oceanographic Institution of Woods Hole, Massachusetts. The Esso Research and Engineering Co. and Socony-Vacuum Laboratories have also contributed to the support of the project. The Esso Research and Engineering Co. hopes to assist with the studies of the hydrocarbon content of the sediments. Henry C. Stetson, research oceanographer of Woods Hole Oceanographic Institution and Alexander Agassiz Fellow in Oceanography, Museum of Comparative Zoology, Harvard University, was chief scientist in charge of the Expedition until his unfortunate death at sea on December 3. Parker D. Trask, research associate of Woods Hole Oceanographic Institution and lecturer in geologic engineering of the Department of Engineering of the University of California, was chief scientist for the remainder of the trip. Other members of the scientific staff included Bernhard Kummel, associate professor of stratigraphy and palæontology, Harvard University, and the following staff members of Woods Hole Oceanographic Institution: William D. Athearn, Robert Lufburrow, Herbert Small and John Zeigler. Victor Benavides, geologist of the International Petroleum Company of Peru, Lieut. Jose Carvajal of the Peruvian Navy, and Jose Stuardo of the Chilean Marine Laboratory at Valparaiso, also participated in the work.

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RESEARCH STUDENTS IN THE UNITED STATES OF AMERICA

By H. N. V. TEMPERLEY
Riversdale, Grantchester, Cambridge

THIS article is written after three extended visits to the United States. I spent seven months at Yale, a whole academic year at the University of Nebraska and about six months at the Bureau of Standards, Washington. In addition, I made shorter visits to about fifteen other universities and research institutions. In Britain I have had a total of about ten years experience in directing small research groups in the Admiralty and at Cambridge.

So far as physics and chemistry are concerned, it seems to me that standards for a Ph.D. degree do not vary greatly as between different universities, nor are there very wide differences as between Britain and the United States. It is widely recognized by employers that these letters guarantee a considerable innate ability and capacity for hard work. It is, I think, fairly generally agreed that the American freshman is not nearly so well prepared for college as is his English cousin, but some of the difference has already been made up at the 'bachelor' stage, because of the fact that the degree course lasts four years instead of three; the remaining small difference, if any, is probably wiped out during the Ph.D. course, which can seldom be completed in less than four years even by a very brilliant student. Many universities encourage even their very good undergraduates to do their graduate work elsewhere, in contrast with the inbreeding tendency at British universities. This means that several months may be spent in moving a home and getting used to new conditions; but this is not the main reason why the course tends to be longer than in Britain. The American graduate student is usually forced to complete a relatively large number of lecture-courses and examinations before he can even apply for permission to submit a thesis. Some of this work represents material that the British undergraduate would have covered in his last year; but a considerable difference remains in practice, even when full allowance is made for this fact. Indeed this is one of the main differences in the 'conditions of work' of graduate students in the United States and Britain; and it is arguable that the British tendency to leave the research student to plan his own attendances at lectures goes too far to the other extreme.

The differences in the arrangements for choosing graduate students, looking after their welfare, providing them with advisers, and for the refereeing and evaluation of their theses are not great and call for correspondingly little comment. The methods by which a scholar of distinction sets up and organizes a school of research workers have probably not greatly changed down the ages, since the main requirements of attracting recruits and of creating and maintaining a satisfactory personal relationship between the research director and the members of his team have always existed. The problems which it leads to, such as keeping temperamental people working happily together, avoiding bullying and yet seeing that everyone has a worth-while problem to work on, and seeing that everyone gets proper credit for his special contributions, are more difficult to-day, because of the increasing tendency to work in large teams, which is itself a result of modern trends in research. (Disaster occasionally results from too great an expansion of a flourishing team.) The other really striking difference in 'conditions of work' is a purely material one. The American graduate student in the physical sciences can confidently expect better offers than can his British cousin, once the 'period of apprenticeship' is completed; but, during this period, he has a decidedly harder and rougher time. The newly qualified Ph.D. can expect several offers from industry in the region of 5,000–7,000 dollars, while a teaching post in a school, or a government post, might pay around 3,000–5,000 dollars, and a post-doctoral fellowship or junior instructorship would be worth about the same. (In purchasing power 4 dollars are roughly equivalent to £1.) As in Britain, there is considerable competition for the junior academic posts and post-doctoral fellowships; but the number of industrial vacancies far exceeds the supply of men, and, since the Second World War, quite a number of firms have been forced into a quite new line of 'sales-talk': 'Come and look at us and at the splendid laboratories and fine conditions of work we offer you'. All this may seem to compare very favourably with the £500–£700 which seems to be the market value of the newly qualified British Ph.D. Various other factors have also to be considered, such as the fact that Americans marry younger, the differing incidence of taxation and the existence of a National Health Service in Britain; but, taken all together, they probably do not greatly change the overall picture. (The fear of a sudden illness and a large hospital bill is a very real one to many young American families, and numerous insurance schemes exist with the object of lessening this source of worry.)

The British graduate who wants to do research and can get himself accepted by a university at all can nearly always cover his living expenses and fees by means of scholarships or a government grant, without being specifically required to do any teaching or other work outside his research. Indeed, strict limits are usually set on the amount of teaching he may do, and other work is often forbidden altogether. This contrasts very strongly with the position of the American graduate student. There are, of course, innumerable endowed scholarships and loan funds: but these are usually for quite small amounts, and roughly speaking, there are three ways by which a graduate student can hope to cover the main expenses of his research course. He may become a member of a team in his department that is working on some specific research project financed from outside, usually by the government. He may take a part-time job in the same way as an undergraduate student; or, finally, he may be appointed a 'graduate assistant' by his department. This last type of post resembles the British one of student-demonstrator. A typical stipend would be 1,500 dollars, for which he is expected to give almost as much time to teaching as does a full member of the staff. This will usually consist mainly of laboratory demonstrating and the conducting of 'recitations' (that is, supervising examples classes held in conjunction with the lectures) but nearly always includes some formal lecturing. Add to this the fact that, as we have seen, he also has to pass various examinations and to pile up a fairly impressive record of attendance at advanced lectures as well as keeping himself informed on his own special field, and the wonder is that he has time for original thought at all. It is possible for a single man to live on his stipend; but, if a graduate assistant is married and without private means, it is practically essential for the wife to take paid work. This she fully expects to do, and she will often earn more than her husband! It is probably fair to say that the average American Ph.D. thesis contains more 'padding' and undigested material and fewer original ideas than does its British counterpart; but it has almost certainly been produced under more difficult conditions.

It is not easy to compare the merits of the two systems. They are conditioned partly by the differences in the raw material that the colleges receive from the schools, which ultimately means that certain ground that is covered by undergraduates in Britain has to be left until the graduate student stage in America. Apart from this, any university that reduced its requirements for the Ph.D. degree to any great extent would lay itself open to the very damaging gibe of being a 'degree pedlar'. The fear of 'losing face' in this way is obviously a very real one, and makes any big change in standards difficult, even if it were desirable. I am fairly sure that I did not visit, or even hear of, any institution where a Ph.D. was obtainable without a great deal of hard work. One problem seems to be common to both systems, and in fact both systems handle it in a rather haphazard and piecemeal way, probably because no simple solution has ever been found. Although it may seem strange to say it, the problem is that of making the best use of the 'pure researcher', once he has qualified for his doctorate. How is he to be found an honourable and reasonably secure place in society, and at the same time prevented from becoming a crank or charlatan, or an inventor of impossible gadgets or a mere drone? Many solutions to this problem have been tried in the past, such as private patronage of learning, monastic communities of various kinds, life-fellowships of colleges. Probably we are in the process of evolving a new arrangement on both sides of the Atlantic, something in keeping with the enormous expansion of research.

How does such a man fit into the American scene? He is probably good enough to be considered for a post-doctoral fellowship, but these seldom last for more than a few years. He may get congenial work as a member of a research group working in a university laboratory but financed by one of the big government agencies such as the Atomic Energy Commission, the Office of Naval Research or the National Science Foundation. The difficulty here is that funds are usually allocated annually and Congress can, and often does, impose cuts in the budgets of such agencies. Even apart from this, there is the fundamental difficulty that, before each year's money is handed out, there must have been a contact, somewhere along the line, between someone who understands just what the particular research project is all about and someone who does not but who may have power to reduce or withhold the next grant, or to divert the money to some other project. Much time and effort is obviously spent in trying to be fair about 'evaluating' reports on the work of the past year and also 'projects' for fresh research, which seems to be done mainly on the basis of referees' reports (I was asked to make a few myself); but it all produces a decided sense of insecurity for the people who are doing the work, knowing, as they do, that a grant may easily be cut next year for reasons totally unconnected with the merits of the work or its value to the community. Another possibility is an industrial or government post. Here, the short-term position is more secure; but most employers, quite understandably, expect a research department to perform a considerable amount of 'bread-and-butter work' which may be anything from routine testing to the development of a new plant on the pilot scale or the designing of circuits for a special requirement. Much depends here upon the director of the laboratory and on his ability to act as a buffer between his staff, who want to investigate interesting long-term problems, and his board, who naturally expect some visible return for the expenditure they are asked to approve. The final possibility is the traditional one of an academic post; but this is far from an ideal solution in present conditions. In these days of rapid expansion of demand for engineers, physicists and chemists the young instructor is likely to be faced with a heavy load of elementary teaching, and the fact that he has research ability does not necessarily mean that he has interest in, or aptitude for, pure teaching at an elementary level; nor does the fact that he is an expert at designing and using apparatus necessarily mean that he is capable of keeping a practical class running smoothly. If he has a young family, he is likely to find his stipend barely enough to live on, and he will be forced to take on yet more teaching during the 'summer sessions', or else to do other paid work during the three summer months. (I knew one young professor, in this position, who was selling copies of a famous encyclopædia as a sideline.) A few universities do have research professorships, while others will arrange that a distinguished scholar has a very light teaching load; but, with nearly all his time occupied, how can the young instructor hope to do the work that will gain him the reputation that would win him one of these coveted posts?

Be all this as it may, there can be no doubt that the 'lure of the ivory tower' is still immensely strong, and that one of the dearest wishes of many a bright student is to be asked to return to his university or college as a junior instructor. Anyone who doubts this must explain how it is that even quite small and obscure colleges seem to have little difficulty in filling their vacancies. Very little formal advertising is done, deans usually notifying one another of vacancies by means of circular letters. Contrast this with the fact that industrial firms who are in a position to offer better pay, probably coupled, as we have seen, with more time for research, are resorting more and more to publicity stunts in order to attract applicants. The explanation is probably two-fold. The scholar who has a real vocation for teaching and pride in training future leaders of men is, as he always has been, willing to work for less than his true market value and to face the drudgery of teaching large elementary classes. The scholar whose main ability lies in research feels sure that, in the long run, the universities will always be the real homes of fundamental research, and that, in due course, some of the very real difficulties outlined above will be sorted out. It does seem certain that the financing of research at the universities by outside bodies has come to stay, and that, in time, reasonable means will be evolved for regulating the inflow of money. The phrase 'going industrial' is often applied to a scientist who leaves academic life. It seems to convey not so much a feeling of superiority, but a subtle tinge of sorrow that one more good man has sold part of his soul.

A more disturbing point concerns the number of British physicists and chemists who are tempted, by the higher pay and lower taxation, to settle in the United States on a long-term basis. There is everything to be said for interchanges and visiting posts; but, in present conditions, it is hard to see how a prolonged stay can benefit either country in the long run.

OBITUARIES

Prof. Hermann Weyl, For.Mem.R.S.

Among all the mathematicians who began their working lives in the twentieth century, Hermann Weyl was the one who made major contributions in the greatest number of different fields. He alone could stand comparison with the last great universal mathematicians of the nineteenth century, Hilbert and Poincaré. So long as he was alive, he embodied a living contact between the main lines of advance in pure mathematics and in theoretical physics. Now he is dead, the contact is broken, and our hopes of comprehending the physical universe by a direct use of creative mathematical imagination are for the time being ended.

Weyl was fortunate in the manner of his death. On November 9, 1955, he celebrated his seventieth birthday, in full and robust health of body and mind. At the banquet which was given in his honour in Zurich, he received messages of goodwill and homage from all over the world. Less than a month later, on December 8, he walked out of his house to post a letter, suffered a heart-failure, and died instantly.

The beginning of Weyl's scientific life cannot be better described than in his own words. "I came to Göttingen as a country lad of eighteen, having chosen that university mainly because the director of my high school happened to be a cousin of Hilbert's and had given me a letter of recommendation to him. In the fullness of my innocence and ignorance I made bold to take the course Hilbert had announced for that term, on the notion of number and the quadrature of the circle. Most of it went straight over my head. But the doors of a new world swung open for me, and I had not sat long at Hilbert's feet before the resolution formed itself in my young heart that I must by all means read and study whatever this man had written. And after the first year I went home with Hilbert's 'Zahlbericht' under my arm, and during the summer vacation I worked my way through it. These were the happiest months of my life, whose shine, across years burdened with our common share of doubt and failure, still comforts my soul." The words "read and study whatever this man had written" are the key to Weyl's breadth and versatility. Hilbert's method of work was to choose a field of mathematics, study it intensely for a few years, revolutionize it with a basic new idea, then drop it and look for another field. Weyl followed the same method, and was equally successful.

The following is a very incomplete chronological summary of Weyl's activity. Between 1908 and 1917 he worked on problems in classical pure mathematics, in particular the theory of numbers, singular integral equations, and functions of a complex variable. His book "Die Idee der Riemannschen Flache" created a new branch of mathematics by uniting function-theory and geometry; the influence of this book led directly to a synoptic view of analysis, geometry and topology which has become a central theme in the mathematics of to-day. During 1917–23 he worked on the logical foundations of mathematics, and simultaneously took an active part in the development of Einstein's relativity theory and its generalizations. He discovered the first 'unified field theory' in which the Maxwell field appears along with the gravitational field as a geometrical property of space-time. This theory he soon rejected as being without empirical foundation; but it remains at least as plausible as any of the other unified theories which came later. Between 1923 and 1938 he created a general theory of matrix representations of continuous groups, which powerfully assisted the growth of quantum mechanics. He discovered that a large proportion of the regularities of quantum phenomena in atomic physics can be understood most simply by means of group theory. By bringing group theory into quantum mechanics he led the way to our modern style of thinking in physics. To-day the instinctive reaction of every theoretical physicist, confronted with an unexplained regularity in the behaviour of elementary particles, is to postulate an underlying symmetry-group.

After taking his degree at Göttingen, Weyl occupied chairs successively at the Federal Technical College in Zurich (1913–30), at Göttingen (1930–33), and at the Institute for Advanced Study in Princeton (1933–51). He was elected a foreign member of the Royal Society in 1936. He was twice married, and is survived by a widow and two sons.

Characteristic of Weyl was an æsthetic sense which dominated his thinking on all subjects. He once said to me, half joking, "My work always tried to unite the true with the beautiful; but when I had to choose one or the other, I usually chose the beautiful". This remark sums up his personality perfectly. It shows his profound faith in an ultimate harmony of Nature, in which the laws should inevitably express themselves in a mathematically beautiful form. It shows also his recognition of human frailty, and his humour, which always stopped him short of being pompous. His friends in Princeton will remember him as he was when I last saw him, at the Spring Dance of the Institute for Advanced Study last April: a big jovial man, enjoying himself splendidly, his cheerful face and his light step giving no hint of his sixty-nine years.

FREEMAN J. DYSON

Prof. H. Oertel

PROF. HORST OERTEL, who died on January 9 at the age of eighty-two, was formerly Strathcona professor of pathology in McGill University. Since leaving Canada in 1938, he had lived a retired life at his club in London.

Although born in Germany, near Dresden, Oertel received most of his education in the United States and took his medical degree at Yale in 1894. Shortly afterwards, he returned to Germany for postgraduate studies, first at Berlin, where he was much influenced by Virchow and Senator, and later, at Wurzburg and Leipzig. His interest in philosophy, which continued throughout his life, was greatly strengthened by his contact with Wundt, whose reputation as an exponent of physiological psychology was then drawing students and research workers from many parts of the world.

Soon after his return to the United States in 1897, Oertel became the director of a department of pathology—later the Russell Sage Institute—that was then being developed in a large municipal hospital under the auspices of the New York University School of Medicine. In 1911, political changes in the city brought this association to an end, though Oertel maintained for some time longer his connexion with the Russell Sage Foundation. Much of his work at this time was upon nephritis, to the study of which he had been stimulated by Senator, and in 1910 he published a series of lectures on Bright's disease. It was this interest, too, that brought him to London in 1913 to work at Guy's Hospital—near Bright's own wards—on experimental nephritis and the embryology of the kidney. This "delightful and profitable departure", to use his own words, brought him into association with Laidlaw, Boycott, Keith and Assheton. In 1914, while still in London, Oertel received an invitation to an associate professorship at McGill University under J. G. Adami. Almost at once, he assumed full direction of the Department, for Adami left Montreal soon afterwards, first for war service and later to become vice-chancellor of the University of Liverpool.

At McGill, Oertel quickly developed an active pathological institute in close association with the Royal Victoria Hospital, and it was here that his most productive work was done. His previous experience in the United States, Germany and England had led him to a critical appraisal of the objectives of medical education at a time when the scope of the curriculum was being widened at an unprecedented rate. His tenure at McGill gave him the opportunity to put some of his views upon teaching into practice. These ideas soon gained a wider audience through the publication in 1921 of his "General Pathology", a book which was followed in 1927 by "Outlines of Pathology" and in 1938 by "Special Pathological Anatomy". All three bear the distinctive marks of Oertel's personality—his absorption with the historical development of pathology and its emergence as an independent biological science. Although addressed to undergraduates, their scholarly character can only be properly appreciated by those of wider experience and fuller knowledge of the progressive emancipation of this medical science from its pragmatic origins.

The formative period of Oertel's life was at the time when many young graduates in the United States had come to realize the impact on medicine of the remarkable developments that had taken place during the later nineteenth century in Germany as a result of the mutual fertilization of the medical and fundamental biological sciences. Although to him a problem in pathology always appealed as a scientific inquiry that took origin from a wish for a better understanding of causal phenomena in disease, he showed none of that lack of appreciation, not unknown among medical scientists, of the humanitarian demands of medicine. But, like some of the more far-seeing of his contemporaries in his country of adoption, he came early to realize that natural philosophy does not necessarily lose its interest by possessing useful applications, and that efforts to solve the problems presented by disease are not necessarily without intellectual attraction. It was the effort to combine the searchings of the philosopher with the responsibility of the physician that distinguished Oertel's contributions to pathology.

G. Payling Wright

Mr. Sidney G. Starling

Sidney G. Starling died on December 16, at the age of eighty-two. He was born in Bradford and received his early education at the Grammar School and Technical College. Having obtained an exhibition and national scholarship, he entered the Royal College of Science, London, in 1891 under Prof. Rücker. Here he secured first-class honours, prizes and medals and worked as assistant and demonstrator during 1893–95. Working under C. V. Boys, he undertook the calculations required for the determination of the Newtonian constant of gravitation. Between 1895 and 1898 he was assistant lecturer in mathematics and physics at Battersea Polytechnic, during which time he graduated at the University of London and was awarded the Neil Arnott Exhibition and Medal. At the opening of the West Ham Technical Institute in 1898, he was appointed the first head of the Department of Physics and Mathematics, a post he held until his retirement in 1932. In 1899 he married Miss M. Briggs, who was an assistant in the Art Department at Battersea.

Throughout his lifetime, he was an active member of the Board of Studies in Physics in the University of London and a member of the Faculty of Science. In his earlier years he was an extensive abstractor of Continental papers for the Institution of Electrical Engineers and the Physical Society of London. In 1920 he was elected Fellow of the Institute of Physics.

Starling is probably most widely known as a writer of text-books of physics. The association of Duncan (the engineer) with Starling (the physicist) in the production of their "Text Book of Physics" (1918) was suggested by Sir Richard Gregory, of whom Starling was a great friend. Starling's own "Electricity and Magnetism for Advanced Students" (1912) has been a standard text-book throughout the years, appearing in many editions, the latest being revised in collaboration with A. J. Woodall in 1953. During his retirement there have appeared "Mechanical Properties of Matter" (1935), "Physics" (in collaboration with A. J. Woodall, 1950) and a revision of "Science in the Service of Man—Electricity" (in association with his son-in-law, H. J. Gray, 1949).

Staff and students respected Starling for his sympathetic understanding, scientific integrity and the quiet efficient way he solved technical and organization problems. There was not the slightest procrastination or duplication of effort. He was a strict disciplinarian and a stickler for punctuality. The ease with which he could erect apparatus for research or demonstration was particularly noteworthy. His published researches and writings do not convey his skill and versatility in this direction. In particular, he did pioneer work on aeroplane compasses (theoretical and experimental) at the time of the First World War.

All his hobbies were characterized by high achievement with apparently little exertion, ranging from shooting, golf and photography to silver smithing. From 1912 he had taken a very active part in Freemasonry. Only his closest friends will have appreciated his keen sense of humour, and even they can scarcely realize the many kindly acts of sympathy and encouragement he rendered to those in adversity. He is survived by a son and daughter.

William Swaine

Dr. George Slater

Dr. George Slater, one of the leading glaciologists of Great Britain, died at the age of eighty-one on January 27. He started his geological career when a schoolboy at St. John's College, York. Later, he continued as an amateur geologist while a schoolmaster at Haltwhistle, Northumberland (1895–97), and at Ipswich (1897–1918). He showed an early interest in palæontology, but at Ipswich, to quote Dr. F. A. Bather, he "became entangled with the complicated drifts of Suffolk". Patiently he mapped and recorded the structures seen in these disturbed drifts, in temporary sections, on successive faces in sand-pits and, during the First World War, in trenches dug for Army training. Though he published little during this early period, he became recognized as an authority on the glacial drifts of East Anglia, and in 1907 and 1911 led field excursions of the Geologists' Association at Ipswich.

He entered the Imperial College (Royal College of Science) in 1918 and remained a member of the geological staff until his retirement in 1939, having obtained the degree of D.Sc. (London) in 1926. The Geological Society awarded him the Murchison Fund in 1928, and in 1950 he received the Foulerton Award of the Geologists' Association.

Slater's research work was predominantly concerned with glaciology; and in 1921, when he accompanied the Oxford University Expedition to Spitsbergen as glaciologist, he was able to compare the structures seen in living glaciers with those that he had observed in the drift deposits of East Anglia. The results of his Spitsbergen work were published in the *Journal of Geology* (**33**, 408; 1925), and the next year he enunciated his ideas on "Glacial Tectonics as reflected in Disturbed Drift Deposits" (*Proc. Geol. Assoc.*, **37**, 392; 1926). Between 1925 and 1932, at least fourteen papers dealing with various aspects of this theory were published. In them he described, often in meticulous detail, the structures seen in disturbed drifts and in glaciers. His theory that these drift structures were actually formed within the ice-sheets, and now represent pseudomorphs of the original glacial structures, was not readily accepted by many workers when it was first proposed. In recent years, however, the hypothesis has been viewed in a much more favourable light. The evidence that he used to support his ideas was gathered from widely scattered sources: East Anglia, Wallasey, the Isle of Man, Møens Klint and Lønstrup (Denmark), Mud Buttes and Tit Hills (Alberta), drumlins near Toronto, the Rhône Glacier, and South Africa. Much of this material was collected for his D.Sc. thesis, but unfortunately his most remarkable work is, and probably will remain, unpublished. This is his detailed measured profile along the Cromer Cliffs, plotted on a scale of 1 in. to 100 ft. (1 : 1,200). The sections, mounted together to form a continuous strip many feet in length, are now housed in the Geological Survey Library.

Those of us who were privileged to know and work with George Slater will remember him for his kindness and the sympathetic assistance he was always prepared to give. He was a first-class instructor, especially to those who were taking geology for the first time, and many recognize the debt they owe him for his encouragement.

GILBERT WILSON

NEWS and VIEWS

Chemical Engineering at Manchester : Prof. F. Morton

THE honours degree course in chemical engineering in the Department of Applied Chemistry of the College of Technology, Manchester, has been in existence since 1933, when the Chemical Engineering Section was started under Mr. W. Cowan, and since that time the Section has grown in importance both as an undergraduate and postgraduate school. With the recent expansion of the College the opportunity has been taken to raise it to the status of a separate Department of Chemical Engineering, and Prof. Frank Morton, at present professor of chemical engineering in the University of Birmingham, has been appointed to the newly created chair of chemical engineering in the University of Manchester and in the College. The Department will include fuel technology and metallurgy, and it is hoped later to include courses in nuclear engineering and corrosion engineering.

Prof. Morton graduated in applied chemistry from the Manchester College of Technology in 1930, and for a period was a member of the teaching staff of that Department, before entering industry in 1936 as research chemist to Trinidad Leaseholds, Ltd., of Trinidad. After being successively superintendent of research and development and chief chemist in the Company, he was appointed in 1948 to a readership in chemical engineering in the University of Birmingham, and in the following year became professor of chemical engineering there. Prof. Morton's research work has been concerned with the constitution of petroleum, with methods of separation of hydrocarbons, particularly in the middle-distillate boiling range, and with the mechanism of oxidation and combustion of hydrocarbons in a diesel engine. While at Birmingham he extended his investigations to the constituents of coal tar and, in particular, to a study of liquid–liquid extraction methods for the separation of tar acids and bases. He is a vice-president of the Institute of Petroleum and chairman of the Research Committee. In this latter connexion he has been concerned with co-operative research sponsored by the petroleum industry at a number of universities and with the work on the biological activity of petroleum sponsored jointly by the Institute of Petroleum and the Medical Research Council.

Linen Industry Research Association : Dr. A. J. Turner, C.B.E.

DR. A. J. TURNER, who is retiring from the post of director of research of the Linen Industry Research Association at the age of sixty-seven, has had a most distinguished career. A graduate of the Universities of London and Cambridge, his first research was done under Sir William Pope. Afterwards, working on aircraft and airship materials at the National Physical Laboratory, he was appointed in 1915 head of the Fabrics Research Section of the Royal Aircraft Factory (later Establishment). Immediately after the First World War, he became the first professor of textile technology in Manchester, holding this post until 1923, when he went to India to become director of research for the Indian Central Cotton Committee. Dr. Turner was personally largely responsible for the planning of the Committee's Bombay laboratories, and for the valuable technological reports which flowed from them in succeeding years. He returned to England to become head of the Spinning Department at the Shirley Institute, Manchester, in 1931, and remained there until he accepted in 1940 the post he is now vacating. During Dr. Turner's tenure of the directorship, the scope and volume of the work of the Linen Industry Research Association have increased enormously, and through his devoted service it has come to be accepted as the research centre of almost the whole linen industry and trade. As director, he has also represented the Association on numerous government committees. Dr. Turner's well-earned honours include the presidency of the Textile Institute (1952–54), an honorary associateship of the Manchester College of Technology (1951) and various offices of the Worshipful Company of Weavers; in 1950 he was appointed C.B.E.

Mr. D. A. Derrett-Smith

MR. D. A. DERRETT-SMITH, who succeeds Dr. Turner, has been a member of staff of the Linen Industry Research Association since 1928, head of the Chemistry Department since 1938, and has had additional duties as deputy director for the past four years. He received his early training under Prof. G. T. Morgan at the City and Guilds Technical College, Finsbury, and afterwards graduated in The Queen's University, Belfast, with first-class honours in chemical technology. During his long period of service with the Linen Industry Research Association, he has made notable contributions to the chemistry of linen processing, which have been incorporated in the modern practice of bleaching, dyeing and finishing. Mr. Derrett-Smith is well known in textile circles, and will have the good wishes of all in his responsible new post.

Division of Fisheries and Oceanography, C.S.I.R.O., Australia: Dr. G. F. Humphrey

Dr. G. F. Humphrey has been appointed chief of Division of Fisheries and Oceanography of the Commonwealth Scientific and Industrial Research Organization, Australia, in succession to Dr. H. Thompson, who retired last year because of ill-health. The headquarters of the Division are at Cronulla, New South Wales. Dr. Humphrey is senior lecturer in the Department of Biochemistry, University of Sydney, having been a member of the University staff since 1941, and the bulk of his published research papers are on marine biochemistry, a field in which he has collaborated with the Division of Fisheries. His studies outside Australia have included work at the Molteno Institute, University of Cambridge, at the Universities of Glasgow and London, and at the marine laboratories at Plymouth, England, and Roscoff, France. It is intended to give increasing attention to the physical examination of the ocean as contrasted with the studies in marine biology, which have been the major concern of the Division of Fisheries in the past; and to reflect this change in emphasis the Division has been renamed the Division of Fisheries and Oceanography. For the development of Australian fisheries more accurate and complete information is needed about the factors which lead to fluctuations in the abundance of fish in the surrounding seas; this will involve the Division in more comprehensive studies of ocean currents, temperature distribution, salinity of the sea and its content of phosphate, and the influence of these physical factors on the reproduction, growth and distribution of fish populations.

Uranium for Peaceful Uses of Atomic Energy

Replying to questions in the House of Commons on February 28 regarding President Eisenhower's offer to supply uranium for developing the peaceful uses of atomic energy, the Prime Minister said that how this offer could best be utilized by the countries of the world, individually or in association, would need careful thought. A start had already been made in the Colombo Plan and in the Bagdad Pact as well as in bilateral arrangements between Great Britain and the United States and certain countries in Africa and Asia to help them in training in the peaceful uses of nuclear energy, and he thought that their first need would be to form a nucleus of trained technicians. British supplies of uranium, he added, are very limited, and he could not hold out hopes that we could follow the lead of the United States in that respect, although we have been working closely with the United States in such matters as technical help for countries which produce uranium. He agreed that it might be wise to consider channelling these supplies through the United Nations to all countries rather than through bilateral agreements.

Industrial Uses of Nuclear Energy in Britain

In replying to questions in the House of Commons on February 22 regarding the industrial uses of nuclear energy, the Lord Privy Seal, Mr. R. A. Butler, said that the Government intends to press ahead with this new source of power. For nuclear reactors which British firms might build in foreign and overseas territories, the Atomic Energy Authority is confident that natural uranium will be available as soon as it is required. Supplies of enriched uranium are limited and must be shared between defence and civil needs, but some of the civil share will be reserved for export. The output of enriched uranium is limited by the capacity of the Authority's diffusion plant at Capenhurst, and this is being watched with a view of meeting the needs of the nation. Mr. Butler also said that the Atomic Energy Authority will supply the necessary nuclear fuel, on a rental basis, for the reactor which Associated Electrical Industries proposes to construct. The terms for this loan, which are being very carefully watched, will cover the cost of fabricating the fuel elements; a percentage of the total cost of the fuel, including an element for research and development; the cost of fuels spent during the running of the reactor; and the cost of reprocessing spent fuel elements. Associated Electrical Industries intends to make the reactor available for educational research work by a group of universities in south Britain; but while paying tribute to the public spirit of this firm, Mr. Butler asked for notice of the further question as to what the firm is paying for the information and techniques supplied by the Atomic Energy Authority. He promised to consult the Lord President of the Council as to the best means of making full information on all these arrangements available to the House of Commons.

Technical Education in Britain

The promised White Paper on Technical Education (Cmd. 9703. H.M.S.O. 1*s*. 6*d*. net) includes a review of the position of technical education in England and Wales to-day against the background of the educational system as a whole, with a short account of the role of the universities, particularly in regard to technological education. The plan now announced proposes to raise the capacity of advanced courses at technical colleges as soon as possible from 9,500 to about 15,000, and to make increasing use of 'sandwich' courses for these advanced courses, backed by an adequate system of financial aid. Students proposing to attend courses leading to a technological award will be eligible for Technical State Scholarships, and the number will be raised as these courses develop, while the Government also proposes to allow ordinary State Scholarships awarded on the results of the General Certificate of Education examinations to be held not only for honours courses at universities but also for courses leading to a technological award. The Government also proposes to develop as many as possible of the twenty-four colleges at present receiving 75 per cent grant for some of their advanced work into colleges of advanced technology, with strong governing bodies and independence appropriate to the academic level of their work, and within the framework of a five-year programme of building development to cost £70 million, with a further £15 million for equipment over the period to 1960–61, inclusive, of which £59 million is to be started during the first three years. These colleges will be expected to develop their advanced work considerably and to divest themselves of work below the advanced level, as well as to undertake a substantial amount of research.

As regards technicians, five or six of whom may be required to every technologist, and craftsmen, while the Government is prepared to take its part in providing the additional facilities for technical education required to match any rise in numbers, industry must play the leading part in increasing the output of craftsmen. Besides adjustment of the terms of apprenticeship and education to suit changing needs, the Government looks to see the numbers of boys and girls under eighteen released by employers for part-time day courses doubled; and, as industrial techniques develop, it will be for the technical colleges to provide short courses designed to explain the principles involved. The White Paper points out that it is in the national interest that more girls should be encouraged to study science or mathematics at the universities or training colleges and to take courses in technical colleges; but the Government gives no indication as to how the supply of teachers for the programme is to be found, beyond expressing the hope that industry will be ready to release yet more of its employees for part-time teaching during the day. The importance of adequate libraries in technical colleges and of co-operation between college, public and other libraries is also recognized.

The situation in Scotland is discussed separately. Here the great need is for better provision for local technical colleges run by education authorities, and the Government is ready to authorize a programme of building for technical education, to be started within the next five years, to the value of £10 million, with a further £2 million for equipment. A major increase in the recruitment of teachers will be required to man the new local technical colleges, and it is also pointed out that a further 15,000 students will be needed if Scotland is to attain proportionately even the same level of day-release students as in England to-day. As in England and Wales, much remains to be done to encourage girls with a practical or scientific bent to grasp the opportunities before them.

Notes on the United States, the U.S.S.R. and Western Europe are appended to the report, and also a report on 'sandwich' training and education from the National Advisory Council on Education for Industry and Commerce. Referring to the White Paper in the House of Commons on February 29, the Minister of Education said that the capital programme will be exempt from cuts, delays or postponements of any kind. Undue resources would not be devoted to one part of the education system, and he anticipated an early statement of the plans of the universities for the quinquennium 1957–62.

Design and Application of Small Digital Computers

The first Joint Computer Conference, sponsored by the Association for Computing Machinery, the American Institute of Electrical Engineers and the Institute of Radio Engineers, was held in December 1951 at Philadelphia, Penn., and consisted of a review of electronic and digital computers. This was followed in the two succeeding Decembers by conferences in New York and in Washington, D.C., where the problems of input–output equipment and of reliability, respectively, were discussed. Meanwhile, the Western Section of the Joint Computer Committee organized similar conferences during February 1953 and 1954 and a third during March 1955, but the only conference so far held by the Eastern Section was at Philadelphia, Pasadena, during December 8–10, 1954, the proceedings of which have now been published (pp. 92. New York: American Institute of Electrical Engineers, 1955; 3 dollars). The subject under discussion was the design and application of small digital computers, and the opening address, entitled "Small Computers in a Large World", was delivered by C. W. Adams (Massachusetts Institute of Technology), the conference chairman. Seventeen technical papers were presented, and in addition to the full texts of these papers and the discussions on them, the proceedings contains reports on three panel discussions on the following: small digital computers and business applications; redundancy checking for small digital computers; and small digital computers to assist large digital computers. Individual computers or systems dealt with include the National Cash Register Company's decimal computer (*CRC* 102-*D*), the Marchant MINIAC system, the TRADIC transistor digital computer, the Burroughs *E*101 computer, and the *IBM* 650 magnetic drum data-processing machine; many different forms and applications of magnetic drum storage are described. Of particular interest is the growing use of solid-state devices—transistors, magnetic cores and ferro-dielectrics—with their great potentialities for improved reliability, decreased power, space, heat and weight, and probably also increased capacity and decreased cost when they are utilized in quantity as components in digital computers.

Chemical Background of the Aluminium Industry

In connexion with the celebration of the centenary of the foundation of the aluminium industry by Henry Ste. Claire Deville, the Royal Institute of Chemistry has published a review entitled "The Chemical Background of the Aluminium Industry" (Monograph No. 3 of the Institute, 1955), prepared by Dr. T. G. Pearson, director of research of the British Aluminium Company. This monograph, which is a model of what such a publication should be, starts off with the raw material, no less than fourteen pages being devoted to bauxite itself. The purification of the mineral by the Bayer process is then considered, and this section provides an excellent summary of the underlying chemistry. Having now obtained the pure alumina, the smelting process is next considered, and this again is an admirable discussion. The refining of this product, for which a number of processes have been developed or suggested, completes the treatment of the normal production of the metal. Two short chapters dealing with the attempts which have been made to replace the Bayer process by the production of alumina of sufficient purity, on one hand, and by the Hall-Héroult electrolytic process on the other, both of which have their own fascinations, conclude the work.

Earthquakes during August 1955–January 1956

The two greatest earthquakes during August 1955–January 1956 attained magnitude 7½, one being on January 10 in the Tonga Islands and the other on January 16 near the coast of Ecuador; the latter caused heavy property damage at Portoviejo and at Bahia de Caraquez. Six earthquakes attained magnitude 7¼. The greatest depth of focus of any earthquake during the period was 650 km. Earthquakes from this depth occurred on August 19 at Acre, Brazil, on October 21 and 30; on January 9 in the Fiji Islands region; on October 31 near the Tonga Islands; and on January 13 in the Samoa Islands. During the period two shocks were reported felt in Great Britain. That on August 22 was at Aberdovy, Merionethshire, and that on January 10 near Derby. Some sixteen shocks were felt in the European Alps, four in Turkey, two in Haute-Saône, France, and one in Spain; on January 12 an earthquake caused heavy casualties and minor damage to property in Hungary. On January 8 an earthquake at Guerrero in Mexico caused many injuries and heavy damage to property at Acapulco, while on September 1 an earthquake in Costa Rica caused heavy damage in Toro Amarello, where ten people were killed and five hundred rendered homeless. On September 12 an earthquake of magnitude 6½ from an epicentre at lat. 32·9° N., long. 29·8° E. occurred at 06h. 09m. 29s. G.M.T. and was felt over a wide area including Egypt, Palestine and Cyprus. In the region of the Nile Delta forty-five houses were wrecked and twelve schools collapsed. Twenty people are reported to have lost their lives as a result of this earthquake, including several children who died at Daher (Cairo) kindergarten girls school.

The Morphology of the Head of the Hawfinch

THE ability of the hawfinch, *Coccothraustes coccothraustes*, to crack open the stones of cherries, damsons and olives in order to feed on the kernels is generally well known; but the modifications which are present in the structure of the head and enable this comparatively small bird to perform such a feat have apparently received little attention. The method employed to crack open the fruit stones is noteworthy because each stone is held between the mandibles and is broken solely by the force applied by the jaw muscles; and no 'artifice', such as that employed by the thrush to smash snail shells, or the woodpecker to split almond stones, is used. The behaviour of the bird when feeding on fruit-stone kernels appears to follow a definite pattern. The bird usually selects fallen fruit, apparently discarding the soft parts. Observations and photographs by R. W. Sims, of the Department of Zoology, British Museum (Natural History) (*Bull. Brit. Mus.* (*Nat. Hist.*), 2, No. 13; August 1955), show that a cherry stone is arranged in the mouth by the combined movements of the head and tongue until it is held lengthways between the mandibles at the back of the horny palate of the mouth with the suture of the stone lying in the median sagittal plane of the head. A quick snap of the jaw and the shell is neatly cracked along the suture or 'seam'. The halves of the shell are rejected and the kernel is swallowed whole, usually without being crushed. Experiments on breaking open cherry and olive stones show that pressures in the region of about 100 lb./sq. in. are required to perform this feat.

Schizaeaceae of the South of England in Early Tertiary Times

A BULLETIN of the British Museum (Natural History) by Marjorie E. J. Chandler, on the "Schizaeaceae of the South of England in Early Tertiary Times" (*Bull. Brit. Mus.* (*Nat. Hist.*), *Geol.*, 2, No. 7; 1955. Pp. 24+6 pl.; 15*s*.), describes fertile specimens of three species of each of the Schizaeaceous genera *Anemia* (= *Aneimia*) and *Lygodium* from various freshwater clays of Eocene age from Hampshire and neighbouring counties. The specimens are small fragments of lignite extracted by washing. Previously the genera were known from the European Tertiary as a few ordinary compressions, but mostly without detail. The technique (which involved modifications of the usual maceration and microtoming methods) was partly due to the late W. N. Croft. The specimens are identified by matching with corresponding bits of recent leaves, and though the information is limited by the small size of the fragments, it extends to many points and is convincing. It is pointed out that the occurrence of these ferns (characteristic to-day of the wet tropics of the Old and New World) in southern England and preserved where they grew accords with the conclusions on climates reached from the Eocene seeds. Of perhaps greater significance is that, in this work, we have a study of Tertiary plants pressed, regardless of trouble, to what seems the ultimate extent and detail the material allows.

The Field Studies Council

AFTER twelve years of existence, when it was known as the Council for the Promotion of Field Studies, this well-known society issues its annual report for 1954–55 under its shorter and new name of the Field Studies Council. The report is again a record of considerable development and, except for one disquieting feature, indicates that the activities of the field centres at Dale Fort, Flatford Mill, Juniper Hall and Malham Tarn, as well as the bird observatory at Skokholm, are now accepted as an important part of the national provision for the teaching of natural history. Bookings this year have reached the highest figure, while the quality of work done continues to improve. The disquieting feature is that, despite the intense activity at the centres, the Council remains stretched to the limit of its financial resources. The appointment of more staff and the accumulation of a small sum as reserve are essential if work is to be properly planned and developed. During the year the centres were inspected by the Ministry of Education. It is to be hoped that when the full report of H.M. Inspectors is available the position of the Council will be considerably strengthened.

Scientific Problems of Humid Tropical Regions

THE study of tropical vegetation will form the subject of an international symposium to be held in Ceylon at the University of Colombo during March 19–21 under the sponsorship of the United Nations Educational, Scientific and Cultural Organization. The symposium will be attended by specialists from Belgium, Ceylon, Great Britain, India, Indonesia, Malaya, the Netherlands, Pakistan, the Philippines and the United States. Afterwards, during March 22–24, twelve scientific workers will hold a preparatory meeting on the subject of humid tropics research in order to examine specific activities for the near future. Among the projects proposed are the production of badly needed maps of humid tropical regions, the classification of vegetation within these regions, the organization of a zoological survey of Ceylon, and the organization of a Unesco-sponsored advisory committee for humid tropics research.

University of Leeds

THE following gifts have been made to the University of Leeds: £2,500 (under deed) to the Building Fund of the Chemistry and Physics Extension, from Boots Pure Drug Co., Ltd., Nottingham; £500 a year for two years to the Department of Inorganic and Structural Chemistry, from Tootal Broadhurst Lee Co., Ltd., Manchester, for research on nuclear magnetic resonance; £700 to the Department of Physical Chemistry, from BP Trading, Ltd., London, for research; and £3,500 to the Department of Coal Gas and Fuel Industries, from the British Coke Research Association, to support research on the disposal of effluents.

The following have been appointed to lectureships in the University: Dr. P. Grosberg (textile engineering) and Dr. E. V. Truter (textile chemistry).

"Quotation of Titles of Papers in Review Articles"

DR. KENNETH M. SMITH writes: "As one of the Editors of 'Advances in Virus Research' to which Mr. N. W. Pirie makes reference in his letter in *Nature* of March 3, may I make a brief comment? As I pointed out to Mr. Pirie at the time, the only reason we had reluctantly decided to omit full titles of papers in the bibliographies was the growing disinclination of authors to supply them".

Announcements

DR. J. S. WEINER, honorary assistant director of the Medical Research Council Unit at Oxford on Climate and Working Efficiency, has been awarded the Vernon Prize for 1956 of the National Institute of Industrial Psychology. This Prize is awarded every second year to the investigator who, being a British subject and under the age of forty-five, has done, in the opinion of the Council of the Institute, the most valuable research work in the subject of industrial psychology or physiology.

THE Hinchley Medal for 1955 of the British Association of Chemists has been awarded to Mr. T. McLachlan, vice-president of the Association and also president of the Association of Public Analysts. The Medal will be presented at 6 p.m. on March 16 in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, London, W.1, after which Mr. McLachlan will give an address on "The Analyst—Chemist, Technician or Magician?". Visitors will be welcome to the meeting. Further information can be obtained from the British Association of Chemists, Hinchley House, 14 Harley Street, London, W.1.

PROF. F. R. WINTON, professor of pharmacology and dean of the Faculty of Medicine in University College, London, has been appointed the first visiting professor of pharmacology in the University of Sydney. The appointment has been made possible by the contributions to a special fund by pharmaceutical manufacturers in Australia whereby a guest professor of pharmacology will be invited to the University each year.

MISS N. M. GOODMAN has been appointed by the Medical Research Council to the Mapother Bequest Research Fellowship for the year 1956–57. The Fellowship is provided from a fund established by the late Mrs. B. M. A. Mapother for research in psychiatry, and is held by arrangement with the University of London at the Institute of Psychiatry, Maudsley Hospital, London.

WHEN the Inorganic Nomenclature Commission of the International Union of Pure and Applied Chemistry met last July in Zurich to consider world-wide comment on the Tentative Rules for Inorganic Nomenclature, it was able to deal with about a third of the material before it. A further session will be held in Reading in April, when it is hoped to complete the work in order that a revised document may be available for publication well before the meetings of the Union next year in Paris.

To commemorate the centenary of the discovery of mauveine by W. H. Perkin, the Huddersfield Section of the Society of Dyers and Colourists is holding an exhibition in Room 65, New Extension, of the Huddersfield Technical College during March 8–11 (Sunday excluded). The exhibition consists of four sections: dyestuffs used before Perkin's time; the discovery of mauveine and the developments made from this discovery; the process of dyestuff manufacture; and the impact of colour on women's fashions throughout the world.

A ONE-WEEK course on acoustics for aeronautical engineers will be held in the University of Southampton during April 15–21. Intended for engineers with no previous formal training in acoustics, the course will include the generation of aerodynamic noise and properties of sound waves; silencing methods and the effects of noise on people; electro-acoustic measuring techniques; and the effect of noise and vibration on aircraft structures. Further information can be obtained from D. M. A. Mercer, Physics Department, University, Southampton.

A CONFERENCE on "Chromosomes" is to be held in the State Agricultural University at Wageningen, Holland, during April 16–19. The following will read papers, which will be afterwards discussed: Prof. E. Heitz, Prof. H. D. Springall, Prof. T. O. Caspersson, Mr. N. W. Pirie, Prof. A. Gustafsson, Prof. A. Müntzing and Prof. C. D. Darlington. Further information can be obtained from Prof. R. Prakken, State Agricultural University, Wageningen, Holland.

A CONFERENCE on "Scientific Ability: its Detection and Development" will be held in the Anatomy Theatre, University College, London, on March 17. The speakers will include Prof. F. Grundy, Prof. N. F. Mott, Mr. Alec Rodger, Mr. M. A. Brimer, Prof. E. M. Delf Smith, Prof. R. M. Barrer, Mr. W. Llowarch and Mr. W. H. Dowdeswell. Further information can be obtained from the Secretary, British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1.

THE European Section of the Research Committee of the International Gerontological Association will meet in Basle during April 4–7, when the following topics will be discussed: ageing of cells and tissues; basic chemical and physical changes in ageing tissues; adaptation to changing conditions of life; autointoxication; resistance to infection; blood circulation (vascular) disorders in ageing; ageing of the central nervous system; nutrition and old age; genetic problems of ageing; and statistical treatment in research on old age. Further information can be obtained from Prof. F. Verzar, Institute of Physiology, University of Basle.

A ONE-DAY conference on "The Development of Sandwich Courses", dealing with the future organization of technical training for young men in British industry, has been arranged jointly by the Ministry of Education and the British Association for Commercial and Industrial Education and will be held in the Royal Festival Hall, South Bank, London, S.E.1, on March 22. 'Sandwich' courses consist of alternate periods, usually three to six months each, of theoretical education in a technical college and practical training in industry, and the course usually lasts for four or five years, leading in some cases to an honours degree or its equivalent; at the end of last year some fifteen hundred students in Britain were attending such courses in engineering and applied science. Between three and four hundred delegates, directors of training and similar officials, representing the major industries in Britain, are expected to attend the conference. Admission will be by ticket, applications for which should be made to Mrs. Kelly, Organizing Secretary, British Association for Commercial and Industrial Education, 8 Hill Street, London, W.1.

DETECTION OF SEED-BORNE PARASITES IN SEEDS

By PROF. A. E. MUSKETT and DR. J. P. MALONE
Ministry of Agriculture for Northern Ireland

DETAILS of the Ulster 'Method' used for the routine examination of samples of flax seed for the presence of fungal seed-borne parasites were published in 1941[1], when the parasites mainly under consideration were *Polyspora lini* Laff., the cause of stem break and browning, and *Colletotrichum linicola* Pethybr. and Laff., the cause of seedling blight. Since then it has been shown[2] that this method can equally well be used for other seed-borne parasites of the flax crop, such as *Phoma* sp., the cause of foot rot, *Alternaria linicola* Groves and Skolko, the cause of *Alternaria* seedling blight, *Botrytis cinerea* Fr., the cause of grey mould, and *Fusarium lini* Bolley, the cause of wilt, as well as for the identification of moulds which may contaminate the seed. The method is extremely simple and consists of plating out the seeds on 2 per cent malt extract agar contained in Petri dishes, incubating the dishes at 22° C. for a period of five days and then examining the seeds for the production of colonies of the parasites. It is speedy and accurate, can be readily carried out by members of a laboratory staff trained in the elements of mycology and plant pathology, while the general technique fits in well with that used for seed purity and germination tests where it is necessary to deal with large numbers of seed samples as quickly as possible. The aim of the method is to determine with accuracy the percentage of seeds in any sample which are contaminated with the parasite in a viable condition.

In 1938 the details were published[3,4] of a laboratory method which had been devised for the routine examination of seed oat samples for contamination with *Helminthosporium avenae* Eidam, the cause of seedling blight and leaf spot in the oat crop. This method consists of plating out the seeds on damp filter paper contained in Petri dishes, submitting them to irradiation from a mercury vapour lamp, incubating at 22° C. and examining them after a period of eight days for the presence of conidia of *H. avenae* produced *in situ* on contaminated seeds. It has been used continuously since then for the examination of seed samples required for work with seed disinfection and in seed health survey investigations.

Although it has been found to be of great practical value, its general use has been handicapped by the fact that higher values for contamination are nearly always obtained when the seed samples have been stored in the laboratory for some time before examination. This has been shown to be due not to the spread of the parasite in any way from seed to seed during storage, but to the fact that the storage period conditions the fungus in some such way as to cause it to sporulate more freely. Whereas this method can be relied upon to provide accurate results for seed which has been stored for some time, it cannot be regarded as so reliable in the case of freshly harvested seed. This limitation proved to be a drawback to the use of the method for seed health survey work, and it was decided to see whether the use of the Ulster Method could be extended to cover the oat crop. As had been expected, the first results were discouraging, for in the case of some seed samples the heavy growth of moulds and bacteria rendered difficult the immediate recognition of colonies of *H. avenae*. Although it is the general practice in Northern Ireland to avoid, whenever possible, the pre-treatment of seed prior to testing in order that the results obtained may refer directly to the seed sample as received, yet this was obviously an instance demanding special consideration. The pre-treatment of seeds with a mild disinfectant such as a weak solution of chlorine has been frequently recommended for the purpose of surface sterilization[5-7], and, after further experimentation, it was found that with such pre-treatment—'Chloros' was used in this instance—much better results were obtained in the case of seed oats which were freshly harvested. It is believed that by using this modified technique an accurate assessment can now be made of the degree of contamination of an oat seed sample at any time from harvest onwards.

The Ulster Method, with this modification, has also given promising results for the determination of the degree of contamination of seed oat samples with species of *Fusarium*, the most commonly occurring of which are *F. avenaceum* (Fr.) Sacc., *F. graminearum* Schwabe, *F. nivale* Auct., *F. culmorum* (W.G.Sm.) Sacc., and *F. poae* (Peck) Wollenw. The results given for *F. nivale* have been of particular promise and it is probable that when minor difficulties, such as those which sometimes arise in distinguishing between *F. graminearum* and *F. culmorum*, have been overcome the method will be readily applicable for all species.

More recently the use of the Ulster Method has been extended to apply to the health examination of seeds of other crops, and both accurate and speedy results have been obtained in the following cases: *Phoma betae* Frank, the cause of black leg in sugar beet; *Fusarium* spp. as contaminants of the seeds of wheat and barley; *Helminthosporium sativum* Pamm., King and Bakke, the cause of foot rot of wheat and barley; *Alternaria brassicicola* (Schwein) Wiltshire, the cause of dark leaf spot of cabbage; and *Phoma lingam* (Fr.) Desm., the cause of canker of cabbage.

In all the work which has been carried out so far it has only been found necessary to apply a pre-treatment of the seed in the case of oats, when the occurrence of a copious growth of moulds is, in some cases, apt to make the identification of fungal pathogens more difficult. As already stated, any kind of pre-treatment is avoided wherever possible in order that the sample of seed may be tested as received. Where such treatment is found to be necessary, it is proposed to use the term 'Modified Ulster Method', leaving the term 'Ulster Method' to cover all those cases where no pre-treatment of the seed is applied.

With rising cultivation costs throughout the world, the need for using seeds and planting stocks of the best quality in order to obtain the highest possible yield and keep production costs as low as possible is very real[8]. For this reason it may be necessary in the future to pay more attention to seed health than has been given to this problem in the past, and the need of having techniques available for this purpose which are both speedy and accurate and capable of international acceptance is clearly of some importance. The use of such techniques will greatly facilitate the carrying out of seed health tests whether they be required for international trading, internal trading within a country or for the carrying out of seed health surveys. That seed health surveys may yield results which are both of interest and importance has already been shown by that made for the health of flax seed produced in the United Kingdom. Although other techniques may be found to be more convenient in some instances, as, for example, in the case of blind seed disease of ryegrass caused by *Phialea temulenta* Prill. and Delacr.[9], yet the Ulster Method and the Modified Ulster Method would appear to have a wide application and are likely to prove of considerable value where the measurement of seed health is achieved by the direct examination of the seed for the presence of fungal pathogens.

[1] Muskett, A. E., and Malone, J. P., *Ann App. Biol.*, 28, 8 (1941).
[2] Muskett, A. E., and Colhoun, J., "Diseases of the Flax Plant" (W. and G. Baird, Belfast, 1947).
[3] Muskett, A. E., *Ann. Bot.*, N.S , 1, 763 (1937).
[4] Muskett, A. E., *Ann. Bot.*, N.S., 2, 699 (1938).
[5] Wilson, J. K., *Amer. J. Bot.*, 2, 420 (1915).
[6] Noble, M., *Nature*, 168, 534 (1951).
[7] Groves, J. W., and Skolko, A. J., *Canad. J. Res.*, 22, 190 (1944).
[8] Muskett, A. E., *Trans Brit. Mycol. Soc.*, 33, 1 (1950).
[9] Muskett, A. E., *Trans. Brit. Mycol. Soc.*, 30, 74 (1948).

DOCUMENTATION OF SCIENCE

In place of the usual annual report, the International Council of Scientific Unions has this year arranged for its Abstracting Board to issue a paper by its secretary, Prof. G. A. Boutry, which was read at the International Congress on Documentation of Applied Chemistry, held in London during November 23–25. The paper describes this venture in international co-operation from its origin at an international conference on scientific abstracting which was held in Paris in June 1949, organized by the Department of Exact and Natural Sciences of the United Nations Educational, Scientific and Cultural Organization. Twenty-four countries were represented, and eight of the eleven scientific unions federated with the International Council of Scientific Unions. One of the recommendations in the Final Act emphasized the importance of establishing good co-operation between existing scientific abstracting services; another urged that all original articles appearing in scientific periodicals should include an author's abstract prepared according to an agreed set of rules; and a third recommendation proposed the establishment of a single *International Journal of Physics Abstracts*, preferably bilingual. As a result of these three recommendations, a joint commission was formed by the Council to discuss further this problem of co-operation in physics abstracting. The Commission first met in Paris on December 20, 1949, and it was at once realized that any practical measures involved the co-operation of those concerned with producing *Science Abstracts* and the *Bulletin Analytique du Centre National de la Recherche Scientifique*. A meeting between representatives of the joint commission and of these two abstracting journals was arranged in London in September 1950.

At this meeting it was agreed to urge all leading periodicals publishing original papers in physics to undertake to publish authors' summaries prepared according to rules set forth by the Royal Society and by the Unesco conference of 1949, and that these summaries, irrespective of the language in which the original papers were written, should be printed either in English or French. It was also agreed that some responsible international organization should ask the publishers of periodicals, whenever advisable, for special rates of subscriptions and, in addition, to ask the editors of important periodicals to send corrected page-proofs of their issues, or at least clippings of the synopses, to the offices of *Science Abstracts* and of the *Bulletin Analytique* at the time of going to press. Finally, the editors of these two abstracting periodicals agreed to co-operate and remain in close contact, and to speed up and increase the efficiency of their work, by whatever means they thought best; it was also agreed that some responsible permanent international organization should be able to help them if they needed such assistance. Accordingly, when the joint commission considered these proposals at its next meeting in July 1951, it decided to ask the International Council of Scientific Unions to dissolve the joint commission and constitute a Board for the International Abstracting Service, on which would be represented, besides the Council itself, the abstracting journals admitted as members (initially *Science Abstracts* and the *Bulletin Analytique*).

This suggestion was studied by Unesco and the International Council of Scientific Unions, and on May 16, 1952, it was agreed to establish such an Abstracting Board, maintained by funds originating from Unesco and the International Council and with the general secretary of the latter body as a permanent member. The Board formally began to operate on June 1, 1952, and its first general assembly met at Strasbourg in July 1953, when rules and by-laws were adopted and an executive committee appointed, the composition of which for 1953–56 is: *President*, Dr. P. Bourgeois; *Secretary*, Prof. G. A. Boutry; *Members*, Dr. E. Hutchisson, Prof. A. V. Hill and Prof. J. Wyart.

As a result of the Board's work, with the exception of a few publications printed in the United Kingdom, all periodicals containing original articles on physics and published in Australia, Belgium, Canada, France, Italy, the Netherlands, the United Kingdom and the United States have agreed to publish authors' summaries in English or French or both, written according to approved rules. Moreover, editorial co-operation has been so thorough that usually the member-journals print these summaries verbatim. Attempts to obtain the same co-operation in Scandinavian countries and in Germany continue, and the four main Japanese journals of physics have also been approached.

Fifty-five periodicals printed in the United Kingdom, the United States, the Netherlands, France, Germany, Italy, Sweden, Japan and the U.S.S.R. send to the Board or its associates, generally by air-mail, complete page-proofs, or, in a few cases, clippings of authors' summaries. In 1954 the Board arranged with the director of the Institute of Documentation of the U.S.S.R. Academy of Sciences to exchange proofs of six Russian and eight American periodicals for purposes of documentation, and this exchange started in February 1955. The proofs of the Russian periodicals are microfilmed in Paris and forwarded to the editors of the member-journals. The periodicals exchanged are as follows:

U.S.S.R.

Journal of Experimental and Theoretical Physics
Journal of Technical Physics
Communications of the U.S.S.R. Academy of Sciences
News of the U.S.S R. Academy of Sciences
Progress in the Physical Sciences
Applied Mathematics and Mechanics

UNITED STATES

American Journal of Physics
Journal of Chemical Physics
Journal of the Acoustical Society of America
Journal of Applied Physics
Physical Review
Journal of the Optical Society of America
Review of Scientific Instruments
Reviews of Modern Physics

The Board has also conducted an inquiry in twelve European countries as to the feasibility of a comprehensive Russian-to-English translating service in physics, and as an outcome of this inquiry the American Institute of Physics has announced the initiation, in November 1955, of a complete English translation of the Russian *Journal of Theoretical and Experimental Physics*.

Together with the Publication Committee of the International Union of Pure and Applied Physics, the Board has also promoted the publication of articles reviewing the work of the principal schools of research in physics in the U.S.S.R. and other Slavonic countries, and it is co-operating with the same body in the revision of the Universal Decimal Classification in physics. Steps have also been taken to facilitate the abstracting of non-periodical publications in physics.

As early as 1950 the Executive Committee of the International Council of Scientific Unions had expressed the opinion that the joint commission should be concerned with the abstracting of both chemical and physical literature, and this view was endorsed by the Council in October 1951, though later a proviso was added that work on chemical documentation should not be attempted before sufficient progress had been made in the field of physics. It was only in 1954, accordingly, that the Abstracting Board was ready to extend its activities into chemical literature, and this extension was authorized by the Council in October of that year. When notified of this decision, the International Union of Pure and Applied Chemistry, now represented on the Board by Dr. L. H. Lampitt, recommended *Chemical Abstracts* and the *Bulletin Analytique* as member-journals for chemical abstracting in English and French, respectively. These journals were unanimously elected to the Board and remain the only member-journals for chemistry. The editors of a number of important chemical periodicals have already been approached with the view of organizing the exchange of page-proofs. The International Union of Mechanics and the International Union of Biology have also expressed interest in the work of the Board, and Prof. Boutry concludes his paper with a warning that the time may be due when full-time salaried officials will be required for the work of the Board in place of honorary officials.

CONNECTIVE TISSUE AND ITS CHANGES WITH AGE

THE British Society for Research on Ageing held a meeting in the Littlewood Hall of the General Infirmary, Leeds, on January 20, under the chairmanship of Prof. R. E. Tunbridge, at which four papers were read and discussed. The first, by Dr. M. K. Keech, Dr. R. Reed and Miss M. J. Wood, dealt with the characterization of elastic tissue by means of the electron microscope. They presented evidence that the variable morphology shown by normal elastic tissue fibres from various sites indicates that elastin, the fibrous protein entity assumed to be present in all forms of elastic tissue, is a complex system, consisting of fibres coated with a dense, amorphous material. They also produced evidence that dermal collagen fibrils, either fresh or prepared substantially free from ground substance, when treated at 37° C. with alkaline buffer solutions of pH 8·8, or with periodate solution, pH 5·0, transform into structures closely resembling those in naturally occurring elastic tissue (see *Nature*, 176, 966; 1955; and *J. Gerontol.*, 10, 388; 1955). These structures stain like elastica and also are attacked by the enzyme elastase.

The so-called dense, moth-eaten fibres (*Ann. Rheumat. Dis.*, 14, 19; 1955), which result from the action of bacterial collagenase on collagen fibrils, also transform, when heated in water, to similar elastin-like structures (*J. Path. and Bact.*, in the press). The importance of these findings lies in the fact that the moth-eaten fibres are an index to the age of the collagen from which they arise. In the age range 0–20 years, collagen, when treated with collagenase, forms many such fibres. From collagen of ages 20–50 years, however, their number gradually decreases, while above the age of 50 none is produced. It is concluded, therefore, that the products of collagen breakdown become coated with a dense amorphous material to form the elastin-like structures. Apparently the coating material is present in young collagen, but gradually decreases in amount with age. Elastic fibres from ox ligamentum nuchæ, when treated with boiling 1 per cent acetic acid solution for 1 hr., are apparently devoid of collagen fibrils as judged by the electron microscope. Collagenase action, however, reveals that they still contain many short fibrils of degenerate collagen. In general, therefore, there are strong morphological grounds for believing that material resembling elastic tissue can originate from the breakdown of collagen.

In the second paper, Dr. P. F. Lloyd discussed some problems relating to the polysaccharide components of connective tissue, and dealt with these under three headings: the type of polysaccharide(s) present; the nature of the linkages binding polysaccharides to other components; and the function of the polysaccharides or polysaccharide-containing complexes. Knowledge of the first two is essential for a full understanding of the third, and all three need to be studied before the wider problems concerning the nature of the changes which occur in connective tissue on ageing can be seen in true perspective.

To facilitate work on connective tissue in general, and on elastic tissue in particular, paper ionophoretic and infra-red analytical methods have been developed. Paper ionophoresis on an apparatus fitted with 'Perspex' condensers above and below the paper appears to give excellent separations of mucopolysaccharides (potential gradient 18 V./cm.). It has been found that chondroitin sulphuric acid-A moves at a faster rate than chondroitin sulphuric acids-C and -B. The mobility of the latter polysaccharide is increased after treatment with testicular hyaluronidase. Extraction of ligamentum nuchæ with 5 per cent saline followed by fractionation leads to the isolation of chondroitin sulphuric acid-B and a hyaluronic acid, the nature of which has been demonstrated by chemical and physical methods. In addition, this elastic tissue contains probably chondroitin and also a new type of connective tissue polysaccharide which is either a sulphated hyaluronic acid or a sulphated polysaccharide containing both glucosamine and chondrosamine in approximately equal amounts.

Extraction with 10 per cent calcium chloride has led to the separation of an insoluble mucoprotein containing about 8 per cent polysaccharide. In its behaviour on treatment with elastase, it resembles elastin (0·5 per cent polysaccharide); and Dr. Lloyd expressed the opinion that it would serve as a convenient model for further enzymatic studies. The results of an examination of the action of pancreatic elastase on crude polysaccharide suggest that elastase is an oxidizing enzyme.

Dr. H. Saxl and Dr. G. N. Graham, in the third paper, gave details of an interesting histochemical and biochemical study of the Ehlers Danlos syndrome. The work has been carried out during the past five years on biopsy specimens from two patients suffering from this condition. One biopsy from each of these patients afforded the material for electron-microscope studies previously reported. Histological examination of a lesion from one of the patients (a boy aged 3½ years) showed an increased amount of elastic-staining material, paralleled by a decrease of collagen. The lesion was highly metachromatic and the periodic-acid – Schiff reaction was very positive. The elastic tissue from the lesion and that of the "apparently healthy skin" surrounding it was found to be resistant to elastase. Drs. Saxl and Graham directed attention to the fact that elastase can be inhibited by a component of normal serum. The elastase-inhibiting effect of the serum of Ehlers Danlos patients was found to be quantitatively increased over that of normal serum.

Although attempts to isolate the component or components of serum responsible for such inhibition of elastase by means of chromatography on an ion-exchange resin column have been made, the results so far obtained have been rather equivocal. However, there are indications that the inhibitory agent is a high-molecular-weight component associated with the globular serum proteins. Drs. Saxl and Graham have also made a study of the effect of the inhibitor using fresh ox ligamentum nuchæ as the elastic substrate and have found a loss of metachromasia if the enzyme, the substrate and the inhibitor are incubated together. There is, however, no loss of metachromasia if each of these components is permitted to act in turn on the ligamentum nuchæ. There is an increased susceptibility of elastic tissue to elastase in senile elastosis, and the elastic fibres of the human carotid artery and of the aorta are dissolved by elastase at a greater speed with advancing age. In the serum of patients belonging to the age-group in which there is a high incidence of arteriosclerosis, there is a reduced concentration of serum inhibitor for elastase which is related to a low concentration of the enzyme in the pancreas.

In vitro experiments have indicated that the inhibitor has a twofold biological action: first, the control of the enzyme elastase in the formation of degradation products; and secondly, the absorption of metachromatic mucoid and elastic-staining substances. From the work of Karczmar and S. M. Rose, who have shown that, *in vivo*, differential development can be correlated with inhibition, it would not seem too unlikely to suggest that the elastase inhibitor can be an essential factor in the formation of elastic fibre.

The final paper, by Dr. David Hall, dealt with the dependence of equilibria between connective tissue components on age. He said that the structural components of connective tissue are particularly resistant to metabolic reactions, but must be maintained at their normal concentration by the simultaneous presence of anabolic and catabolic enzyme systems and their appropriate inhibitors. Age changes in the susceptibility of the various structures to attack by their specific enzymes can be coupled with variations in concentration of those few enzyme systems which have as yet been identified. A full assessment of the equilibria between the various components can only be made when studies of tissue, enzyme and inhibitor from the same animal and from the same age-group are made. As a preliminary to these studies, it has been necessary to examine the chemical reactivity of the tissue components.

Alkali treatment of collagen results in the extraction of small quantities of protein under conditions which give marked production of elastin-like material when examined under the electron microscope. The protein is, in certain circumstances, rich in hydroxyproline and arginine, two amino-acids which one would expect to be extracted, if collagen were to change to elastin. In the case of young collagen, this hydroxyproline-rich material is extracted during the early period of treatment, whereas the extract from old collagen does not contain a high hydroxyproline content until longer periods of extraction have occurred.

Based on these results, and those stemming from the observations of the other workers in the group, it is possible to devise a hypothesis for a similar *in vivo* synthesis of elastin via collagen. If this is done, many of the hitherto unexplained questions concerning connective tissue can be solved: for example, the absence of an elastoblast, the variations in chemical composition of elastins of various age-groups, and the appearance of elastic staining materials which are really dissimilar, in senile elastosis and the Ehlers Danlos syndrome. It was stressed by Dr. Hall that this is only a hypothesis, but that it would act as a starting-point for the discussion of age relationships of collagen and elastin, by permitting them to be considered as a single unit rather than as two diverse structures which merely share a common site.

G. H. Bourne

NON-DESTRUCTIVE TESTING OF MATERIALS AND STRUCTURES

The French and English editions of the report* on the symposium on "Non-Destructive Testing of Materials and Structures", held in Paris in January 1954 by the Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions, include thirty-nine papers from fourteen countries, some of the discussion and a bibliography containing references to fifty-five papers on non-destructive testing. The symposium was very largely concerned with the testing of concrete, and the scope of the report is not therefore as extensive as the title suggests. There are, however, four papers in the report, by M. Mamillan, G. Dawance, A. Moles and J. Jacquesson, of France, which deal in particular with the testing of materials other than concrete, namely, stones, rock and soils.

The three sections of the report cover vibration methods (*A*), hardness methods (*B*) and radiographic methods of test (*C*), respectively. The numbers of papers dealing with these methods vary considerably: there are twenty-six papers in section *A*, nine in section *B* and four in section *C*. The papers are prefaced by short summaries introducing the sections of the report and a general note on research matters requiring further investigation, based on a report prepared by a working-group appointed during the symposium. The summary of section *A* contains a useful review in tabular form of types and applications of resonance and pulse velocity tests with their advantages and disadvantages. Like most of the papers, however, this summary is more concerned with laboratory tests than with field-tests, and an important omission in regard to the latter is mention of the practical difficulty of measuring path-lengths sufficiently accurately in testing cast in-situ concrete structures by the pulse velocity method. Some of the statements in the second table of this summary should also be interpreted with reserve, particularly the point that the variability of the quality of the concrete within a test specimen or structure can be obtained using the pulse velocity method. This has not yet been satisfactorily established: the variability of the pulse velocity may indicate the variability of the concrete in a structure, since a reduction of the pulse velocity usually indicates a reduction in strength, but relationships between pulse velocity and strength are not closely definable in the field.

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* International Union of Testing and Research Laboratories for Materials and Structures (RILEM). Proceedings of the International Symposium on Non-Destructive Testing of Materials and Structures. Vol. 1, pp. x+1–208; Vol. 2, pp. ii+209–404. (Paris: RILEM, 12 rue Brancion.) 2,000 fr.

The first six papers, from France, South Africa, Japan, United States and Italy, describe apparatus and techniques for measuring the elastic properties of concrete by resonance tests on laboratory specimens in longitudinal and transverse vibration. The paper by N. Stutterheim, J. P. A. Lochner and J. F. Burger (South Africa), including the results of corrosion studies on concrete and cement mortar, is of particular interest, while C. E. Kesler and Y. Higuchi (United States) also contribute a useful paper on experimental problems. The remaining seven papers on resonance tests, from Japan, France, Switzerland and Great Britain, consider the interpretation of test data. A topic common to the majority of these papers is the relationship between the elastic properties and the strength of concrete. The dynamic and static moduli of concrete are compared by J. P. Daxelhofer (Switzerland), R. H. Elvery (Great Britain) and A. Lazard (France), and further remarks on this matter are included by R. Cabarat (France), T. Takabayashi (Japan) and F. Arredi (Italy). Daxelhofer's contribution includes observations on the use of resonance tests in studying frost damage to concrete at the Lausanne Polytechnic.

The succeeding thirteen papers of section *A* are concerned with pulse velocity measurements and their interpretation. Relationships between pulse velocity and the strength of concrete are dealt with by R. Jones (Great Britain), J. Andersen and P. Nerenst (Denmark), Y. Kameda, K. Awaya and I. Yokoyama (Japan), G. Magnel and G. Huyghe (Belgium) and M. Okushima and Y. Kosaka (Japan), while some information on relationships for stones is given by M. Mamillan. Jones's paper is noteworthy as a summary of much basic research at the Road Research Laboratory, Harmondsworth, and Andersen and Nerenst give a detailed account of their experience using the condenser chronograph developed at the State Testing Laboratory, Copenhagen. These two papers and those by Kameda, Awaya and Yokoyama, by A. Voellmy (Switzerland) and by Magnel and Huyghe, will probably be the papers of most interest to readers concerned with field-work on concrete, and a paper by G. Dawance to readers concerned with field-measurements on rocks. A section in the paper by J. Chefdeville (France) on the detection of faults and cracks supplements Jones's remarks on this subject, and the detection of fire damage is considered by Andersen and Nerenst and in the joint paper by Kameda and his colleagues.

In section *B*, on hardness testing, papers are contributed from Yugoslavia, Germany, Switzerland, Brazil and France, in which countries hardness tests on concrete have received greatest attention. K. Gaede (Germany) and E. Schmidt (Switzerland), prominent workers in this field, present papers describing the use of the Franck, Einbeck and Schmidt hammers, while G. Weil (Germany) points out that the Franck hammer is favoured in Stuttgart. Papers by G. Dawance and D. Jetvic, R. Peltier and P. Meynier describe experience of the use of the Schmidt hammer in France, and P. Vassitch (Yugoslavia) discusses general problems associated with hardness tests and considers both indentation and rebound measurements. A. Voellmy compares results obtained using different types of hammer and by penetration tests, and implies that the Schmidt hammer is preferable to other types. This point is clearly a matter of controversy among workers with experience of hardness testing, however.

The four papers of section *C* describe radiographic testing techniques that are still in their infancy. With one exception—a short note by G. Huyghe (Belgium)—they deal with research in France. J. Brochard describes and discusses density measurements by gamma-radiation at the Centre Expérimentale de Recherches et d'Études du Bâtiment et des Travaux Publics and the measurement of water content by neutron bombardment. J. P. Fackler's paper is a detailed account of gamma-ray tests on concrete at the Centre Scientifique et Technique du Bâtiment for the specialist, and J. Jacquesson's paper considers a problem in the technique of measuring soil densities.

The report is a useful and informative account of progress and investigations prior to 1954. It appears that it was decided to omit some of the discussion in the report, presumably in view of the large number of papers. Presentation of a large number of papers during the symposium had the effect of reducing the time spent on discussing the difficulties attending application of the methods of test and the practical significance of field-test results obtained by them. These matters are vitally important, and determine the value and promise of existing techniques of non-destructive testing in regard to concrete construction.

A. E. SEDDON

TEXTILE INDUSTRIES IN THE UNIVERSITY OF LEEDS

REPORT FOR 1953–54

THE eightieth report, to the Worshipful Company of Clothworkers of the City of London, of the Advisory Committee of the Departments of Textile Industries and Colour Chemistry and Dyeing, University of Leeds*, covering the session 1953–54, notes that the new building to house the man-made fibres division of the Department was rapidly approaching completion. A third chair, that of textile technology, has now been instituted in the Department, and the research school in the Department of Colour Chemistry and Dyeing has been further strengthened by the appointment of an Imperial Chemical Industries, Ltd., Research Fellow. The graduates of both Departments are in keen demand by many branches of industry. In textile physics further work has been carried out on the examination of fibre surfaces by replica methods, and a study of the fine structure of keratin fibres disintegrated by various techniques has shown that super-contraction is molecular rather than fibrillar in origin. A study has been made of the pigment granules isolated from various wools and hairs, and of their location in the fibres. In textile chemistry good progress is reported in the synthesis of polypeptides and related compounds, and in the search for new cross-linking agents it was found that reductone undergoes a unique type of polymerization in aqueous solution and that the polymer so formed is deposited inside the fibres. Further work was carried out on the initiation of the polymerization of vinyl compounds inside wool fibres with persulphates, on the formation of polyacrylonitrile in wool and on suint and wool wax ; a strikingly novel approach has been developed to the problem of dimensional stability, and a mixture of fluorescent dyes has been devised which gives different colours with wool, cellulosic fibres, cellulose acetate, nylon, 'Terylene' and 'Orlon'. In textile engineering, work continued on the development of the new type of cap designed to give uniform spinning tension, on the drying of wet fibrous materials and theoretical studies on the use of felts in removing water in the manufacture of paper. In textile technology the electronic mule was being used with great success for studying the behaviour of fibres during the drafting of condensed slivers, and a comprehensive investigation was in progress on the effects of weaving tensions on cloth characteristics with special reference to rayon fabrics. Changes occurring in the setting of nylon were being studied, and further progress has been made in work on the proofing of viscose rayon against bacterial attack.

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* Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing in the University of Leeds, for the Session 1953–54. Pp 42. (Leeds. The University, 1955.)

The Department of Colour Chemistry and Dyeing made further progress in its studies of the basic reactions of anthraquinone chemistry, completing the direct hydroxylation of *peri*-naphthalimide and the quinoxaline derived from acenaphthenequinone, and pyranthrone, *amphi-iso*pyranthrone, and 6-phenyl-*meso*benzanthrone. Other work has related to the mode of formation of the anthraquinone carbazole dyes from derivatives of 1 : 1′-dianthraquinonylamine, the reactions involved in the reconversion of sulphuric esters of reduced forms of vat dyes into the parent compounds, and on the nature of the products formed by the 'over-reduction' of indanthrone. Work on the action of Grignard reagents and dialkylcadmiums on alkylquinolinium salts was completed, and a relation found between the basic strength of anions and their orientation in nuclear substitution reactions. Work on the properties of the N-methyl-derivatives of anthraquinone–acridine dyes, the chemistry and dyeing properties of hæmatin, the colouring matter of logwood, and quantitative studies on the dyeing characteristics of chlorinated wool continued, while the dyeing of blends of wool and 'Fibrolane', and the dyeing characteristics of wool–nylon, wool–'Ardil' and nylon–'Ardil' for mixtures of acid and pre-metallized acid dyes were also investigated. Lists of publications are included.

HIGH-ENERGY PARTICLE ACCELERATORS IN THE UNITED STATES

ONE of the most noteworthy features of the International Conference on the Peaceful Uses of Atomic Energy held in Geneva last August was the series of evening lectures delivered by distinguished scientists. In particular, Prof. E. O. Lawrence's talk on August 11, in which he outlined the research programme in the United States concerned with the production of large currents of high-energy sub-atomic particles by means of accelerators, was especially interesting and provoked much discussion. The illustrated article, "High-Current Accelerators", which is contributed by Prof. Lawrence to the December 9 issue of *Science* (122, 1127 ; 1955), is based on his talk to the Geneva conference, and in it he emphasizes the importance of the problem of the production of intense beams of high-energy particles for future progress in nuclear physics. This is illustrated by the remark that the particle current has steadily decreased as the energy has increased—milliamperes for the 1940 cyclotron, microamperes for the 1943 synchrocyclotron, millimicroamperes for the present cosmotron and bevatron—and that, extrapolating on this basis, currents of only two protons per hour will be produced by accelerators giving particles of 10^{16} eV. energy. Reference is made to the work of L. H. Thomas and to the later approaches of V. Veksler and E. M. McMillan to the problem of a suitable magnetic field for a high-energy cyclotron. The basic similarity between the solutions in providing an azimuthal variation in the magnetic field to achieve focusing of the particles is pointed out.

Prof. Lawrence then describes briefly experiments that have been carried out in the Radiation Laboratory of the University of California, Berkeley, where he is director, with an electron model of a clover-leaf (this refers to the shape of the magnet pole-pieces) cyclotron. The model operated in complete agreement with theoretical expectations and showed that the Thomas-type field can provide the necessary axial and radial stability and that the accelerated electrons can stay in phase with the constant-frequency accelerating voltage. In addition to producing high currents of high-energy particles, equivalent to 300-MeV. deuterons, with very low voltages on the accelerating electrodes the clover-leaf cyclotron possessed the admirable property of easy extraction of the beam. Mention is also made of recent novel approaches that have been suggested to the problem of adapting cyclotrons and betatrons to produce high currents of high-energy particles, and these are now being put to practical test by the accelerator design group of the Mid-western Universities Research Association under the direction of Prof. D. W. Kerst.

During the past four or five years, along with the development of the clover-leaf cyclotron, the Radiation Laboratory has concentrated much effort, in collaboration with the California Research and Development Co., on the construction of a linear accelerator of the cavity-resonator type devised by L. W. Alvarez. The objective is to produce a particle accelerator capable of delivering thousands of kilowatts of high-energy protons. Details are given by Prof. Lawrence in his article of this *A*-48 linear accelerator, including the ion-injector, the beam focusing and steering magnet, the 24-Mc./s. buncher and quarter-wave accelerator already completed, and the two 48-Mc./s. resonant-cavity accelerator sections, each 20 ft. long, which are still under construction. The injector consists of an arc source, in a solenoidal magnetic field, mounted on insulators in a vacuum envelope, and a focused ion beam of up to ¾ amp. has been obtained. Deuterons are accelerated by the quarter-wave machine from 140 keV. to about 1 MeV., at which speed they enter the two resonator-cavity sections. It is hoped finally to obtain an output from the complete accelerator of ¼ amp. of 7·8 MeV. deuterons, and it is expected that the accelerator will be in operation early this year.

EFFECT OF UREA ON TRYPSIN AND ALPHA-CHYMOTRYPSIN

By Dr. J. IEUAN HARRIS*

Carlsberg Laboratorium, Copenhagen

MANY simple organic substances such as urea are known to modify the specific stereochemical configuration of protein molecules in aqueous solution, and it is now well established that the increase in intrinsic viscosity encountered when native globular proteins are dissolved in concentrated urea solutions may be interpreted in terms of an increased molecular asymmetry associated with the unfolding of polypeptide chains from their specific 'native' configurations[1]. Viscosity measurements carried out in urea solutions have thus been frequently used as an experimental index of protein denaturation[1]. A more complete characterization of such a complex and ill-defined phenomenon is, however, obtained when viscosity changes are correlated with changes in other and entirely different properties of the protein molecule measured in the same chemical environment[2]. Although such an opportunity presents itself in the case of the biologically active proteins, a survey of the literature dealing with the effect of urea on a number of proteolytic enzymes reveals that in many instances the measurement of enzymatic activity has been used as the sole criterion of denaturation[3-7].

The assumption that protein denaturation and enzymic activity are mutually exclusive phenomena can be valid only if activity measurements are carried out under conditions which are not in themselves conducive to denaturation or to a reversal of a previously established denaturation effect, and although this crucial condition was stated by Anson and Mirsky[8] in their classical studies on the reversible denaturation of proteins, it has not always received the attention that it deserves. Thus in some cases the effect of urea on an enzyme has been evaluated on the basis of activity measurements carried out by the addition of an aqueous solution of the enzyme to a substrate dissolved in urea[3,9], and in others, urea solutions of an enzyme have been assayed under conditions which involve a dilution of the urea concentration in the assay medium[3-7]. These experimental procedures frequently lead to equivocal conclusions, since the possibilities that the 'active centre' of an enzyme molecule may be shielded from urea denaturation by formation of a stabilized enzyme/substrate complex, or that an inactivated denatured molecule may be subject to reversible reactivation, are not taken into consideration.

The crucial importance of relating changes in enzymic activity to changes in one or more of the physical properties of the enzyme protein measured in the same chemical environment received further emphasis when it was shown in this laboratory[2] that urea-denatured ribonuclease retains the catalytic functions of the native enzyme. Alternative explanations therefore become possible for the results obtained in previous studies on the action of urea on chymotrypsin[3], papain[4], pepsin[5], catalase[6] and trypsin[7]. For example, in a recent communication, Viswanatha and Liener[7] report that trypsin forms a stable active system in the presence of 8·3 *M* urea at *p*H 7·6; in an endeavour to explain this apparent retention of activity, it was postulated that the native active trypsin molecule is prevented from unfolding by formation of a stable protein/urea complex. The alternative possibilities, that the enzyme retains activity in an unfolded form, or that it is reversibly unfolded in 8·3 *M* urea, are not considered, despite the fact that activity was always measured under conditions which involved a five-fold dilution of the urea concentration. In view of such considerations, the effect of urea on the enzymic activities of trypsin and α-chymotrypsin has been re-investigated.

Freshly prepared 1 per cent solutions of a dialysed, recrystallized preparation of trypsin (obtained through the courtesy of the Novo Terapeutisk Laboratorium) in the appropriate concentrations of urea (A.R. grade, recrystallized from aqueous ethanol before use, and dissolved in glass-distilled water containing 0·1 *M* potassium chloride) at *p*H 4·0, were subjected to viscosity studies in a capillary viscometer maintained at 20° (± 0·01) C. Aliquot portions of the same freshly prepared solutions were diluted twenty times with the corresponding urea solution and assayed[10] against α,N-toluenesulphonyl-L-arginine methyl ester (0·005 *M*) (*a*) in the appropriate concentration of urea, and (*b*) in aqueous solution, at *p*H 7·8 and 25°. Activities expressed as zero-order velocity constants were calculated from the initial slopes of alkali uptake curves automatically recorded by means of a Jacobsen–Léonis *p*H-stat[11]; for purposes of comparison the activity of a control aqueous trypsin solution (1·72 m*M*/min./mgm. trypsin nitrogen) is expressed as 1. The results obtained are summarized in Fig. 1.

The intrinsic viscosity of trypsin increases as a function of the concentration of urea and approaches a maximum value in 8 *M* urea; and a corresponding decrease in enzymic activity is observed when assays are carried out in the presence of the appropriate concentrations of urea. Thus, contrary to previous results[7], trypsin is not active in 8 *M* urea; and furthermore, an aqueous solution of trypsin is rapidly inactivated (75 per cent inactivation during 2 min.) in 8 *M* urea at *p*H 7·8 even in the presence of α,N-toluenesulphonyl-L-arginine methyl ester. In 4 *M* urea, where the viscosity increase is 55 per cent of the maximal, trypsin retains 48 per cent of its initial activity, and similar correlations between increase in viscosity and loss of activity are observed at other concentrations of urea. When assayed in aqueous solution, however, urea solutions of the enzyme are found to regain full activity (Fig. 1).

These results suggest that at each concentration of urea a mobile equilibrium exists between native active trypsin and unfolded inactive trypsin (cf. refs. 12 and 13); equilibrium is rapidly attained at 20° and *p*H 4, is independent of trypsin concentra-

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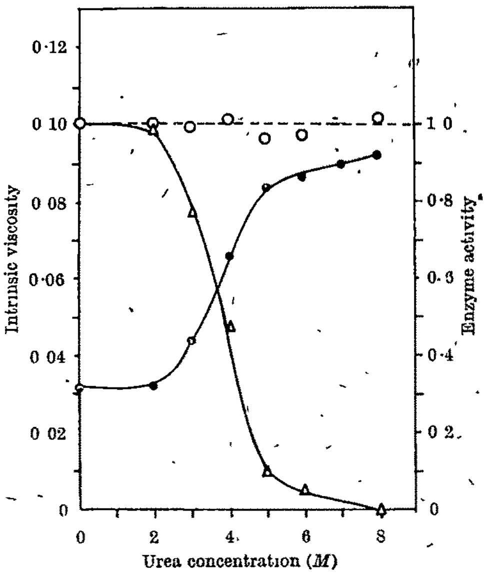

Fig. 1. Effect of urea on trypsin. ●, Intrinsic viscosity (gm./100 ml.)$^{-1}$, 1 per cent trypsin in urea *p*H 4, 20°. Esterase activity (α,N-toluenesulphonyl-L-arginine methyl ester, 0·005 *M*) *p*H 7·8, 25°. △ in urea; ○ in aqueous solution (1·72 m*M*/min./mgm. enzyme nitrogen = 1·0)

tion, and is completely reversible on dilution. In 8 *M* urea, trypsin exists entirely in a stable, unfolded inactive form which regains its former active configuration in aqueous solution. At intermediate concentrations of urea, however, the initially formed reversible equilibrium states are subject to a secondary, irreversible inactivation process which is maximal in 4 *M* urea where, according to the equilibrium hypothesis, the solution contains equimolar concentrations of active enzyme and of potential substrate in the form of unfolded enzyme molecules. Furthermore, although the composition of the equilibrium mixture is independent of the initial trypsin concentration, the kinetics of the subsequent inactivation reaction suggest that it is an enzyme-catalysed reaction which depends on residual trypsin concentration, *p*H and temperature (Harris and Linderstrøm-Lang; to be published). No increase in non-protein nitrogen could be detected (as measured by ultra-violet absorption at 280 mμ of fractions soluble in 10 per cent trichloracetic acid) in 4 *M* urea, but preliminary end-group studies are nevertheless consistent with the view that inactivation is due to a limited enzyme-catalysed autolysis at *p*H 4. Similar explanations have been proposed[12,13] to account for the irreversible inactivation of trypsin in neutral and alkaline aqueous solutions, and for the enhanced autolysis of trypsin in 4 *M* urea at *p*H 7·6[7].

In the case of α-chymotrypsin (recrystallized, salt-free preparation), viscosity studies were carried out on 1 per cent solutions at *p*H 5·0 and 20°, and enzyme activities were determined by the esterase procedure[10] (L-tyrosine ethyl ester, 0·02 *M*, *p*H 7·8, 25°). Results are summarized in Fig. 2. The viscosity of chymotrypsin increases sharply as a function of urea concentration, and the close correlation between increase in viscosity and loss of enzyme activity suggests that α-chymotrypsin also forms equilibrium mixtures of native active molecules and unfolded inactive molecules in urea solutions.

At *p*H 5 and 20° equilibrium is attained very rapidly; but in contrast to trypsin the extent of unfolding is markedly influenced by *p*H. Thus in 4 *M* urea at *p*H 5·0, chymotrypsin appears to exist entirely in the native state and retains full activity when assayed in the presence of 4 *M* urea at *p*H 7·8. At *p*H 4·0, on the other hand, an equilibrium mixture is formed which contains about 30 per cent of unfolded inactive molecules and the extent of unfolding increases further as the *p*H is lowered. In addition, the equilibrium which is rapidly established in urea solutions at *p*H 5 and 20° is not reversed to any appreciable extent in the presence of substrate in aqueous solution at *p*H 7·8 and 25°, that is, under conditions which lead to quantitative recovery of activity in the case of trypsin. Equilibrium mixtures of chymotrypsin are also subject to a secondary, irreversible enzyme-catalysed inactivation reaction; for example, although chymotrypsin is initially 80 per cent active in 5 *M* urea, the activity is reduced to 40 per cent on standing for 30 min. at *p*H 5·0 and 20°.

From the results of this investigation, it may be concluded that, unlike ribonuclease[2], trypsin and chymotrypsin do not retain activity in an unfolded form, and that covalent cross-linkages are in themselves not sufficient to maintain the integrity of the specific geometrical configurations which are essential for catalytic activity. Nevertheless, for practical purposes it is possible to take advantage of the fact that both enzymes are stabilized to a considerable extent against urea inactivation in the presence of a substrate, and can thus be used to degrade proteins which are themselves susceptible to denaturation in urea but which resist digestion in their native configurations[14,15]. The well-known hæmoglobin assay procedures for both trypsin[16] and chymotrypsin[8] are in fact based on this principle, while, more recently, similar considerations were found to apply in the case of carboxypeptidase[17].

I wish to thank Prof. K. Linderstrøm-Lang and Dr. M. Ottesen for their stimulating interest, helpful suggestions, and generous hospitality, and Dr. W. F.

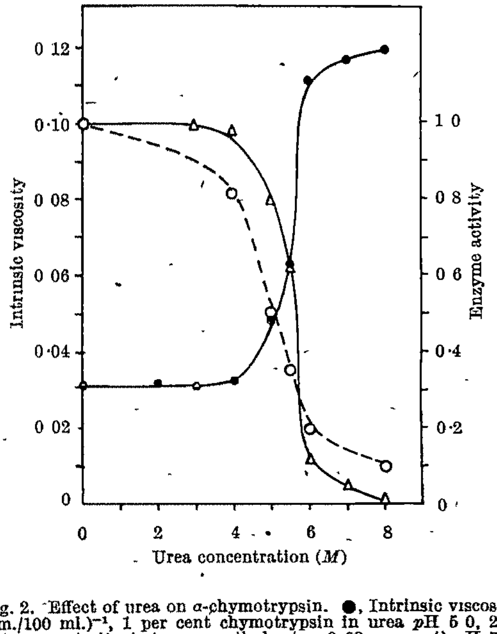

Fig. 2. Effect of urea on α-chymotrypsin. ●, Intrinsic viscosity (gm./100 ml.)$^{-1}$, 1 per cent chymotrypsin in urea *p*H 5·0, 20°. Esterase activity (L-tyrosine ethyl ester, 0·02 per cent) *p*H 7·8, 25°: △ in urea; ○ in aqueous solution (0·045 m*M*/min./mgm. chymotrypsin nitrogen = 1·0)

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STRUCTURE OF SMALL VIRUSES

IT is a striking fact that almost all small viruses are either rods or spheres. The purpose of this article is to explain this observation by means of the following simple hypothesis: a small virus contains identical sub-units, packed together in a regular manner. It has been suggested before[1] that viruses are constructed from sub-units; but the idea has not previously been described in precise terms or put forward as a general feature of all small viruses.

We believe that there is conclusive evidence for this hypothesis in two cases and suggestive evidence in a number of others. As most of the present evidence comes from the plant viruses, we shall restrict our discussion to these, except for a few remarks on animal viruses at the end of the article.

Plant Viruses

Notice first that all plant viruses which have been studied carefully are extremely regular in their shape and size[2]. In electron micrographs their dimensions are constant. One particle of turnip yellow mosaic virus, for example, is the same size as another, to within the errors of measurement. Moreover, the 'spherical' viruses have shapes very close to that of a sphere—there seem to be no ellipsoidal plant viruses. All cases where they have appeared as flattened spheres have been shown to be due to the surface tension caused by drying prior to electron microscope examination. In good photographs there are sometimes suggestions that the 'spheres' are more nearly regular polyhedra, which, as we shall see, is what one might expect.

The great regularity of plant viruses is shown even more strikingly by their ability to form crystals (or paracrystals) which give good X-ray photographs[3], often with reflexions extending to small spacings. From this we can infer that a very high degree of order exists within such viruses, and that, to a resolution almost at the atomic level, one virus particle appears identical, or at least very similar, to all its sister virus particles. A plant virus can thus be considered a 'molecule' in the sense used by protein crystallographers—an entity, the major part of which has its atoms arranged in definite (relative) positions in space.

All known plant viruses consist of two chemical components only: protein and ribonucleic acid. It seems likely that there is a general plan for their relative positions and that the majority of the protein lies on the outside of the virus, surrounding a central core composed largely, if not entirely, of ribonucleic acid. This arrangement is well established for only two viruses—the spherically shaped turnip yellow mosaic virus (by Markham[4]) and the rod-shaped tobacco mosaic virus (by both the Tubingen[5] and Berkeley groups[6])—but we believe that it is likely to apply to all simple viruses. That is, the protein component of a round virus is a spherical shell, and of a rod-shaped virus, a cylindrical shell. Our hypothesis is that in both cases these shells are constructed from a large number of identical protein molecules, of small or moderate size, packed together in a regular manner. Our hypothesis may apply, though in a slightly different form, to the ribonucleic acid component. This is discussed in more detail later.

Tobacco Mosaic Virus

This rod-shaped virus is the best studied and we shall therefore consider its structure in detail.

Tobacco mosaic virus contains 94 per cent protein and 6 per cent ribonucleic acid[7]. The characteristic particle, which is closely connected with the infectivity, has a 'molecular weight' of about 45 million, a length close to 3000 A. and a diameter of about 170 A. The early X-ray work[3] showed clearly that this particle is made up of sub-units of some sort. More recently it was realized that the basic feature of the structure is its helical nature[8]. The protein part of the virus is constructed from a large number of structurally equivalent sub-units (small globular proteins) set in helical array about the central axis. The pitch of the helix is 23 A. The number of sub-units per turn is more difficult to establish—the most probable value (Franklin, R. E., and Holmes, K. C., personal communication) gives a molecular weight for the sub-unit of about 20,000.

A very similar value is suggested by the chemical evidence. Harris and Knight[9] first examined the carboxyl end-groups of the polypeptide chains, and found that the virus particle had about 2,500 terminal groups, all threonine. This suggested that the virus contains 2,500 identical polypeptide chains, an idea which has been further strengthened by the recent work of both the Tubingen[10] and Berkeley[11] groups, who have identified the terminal three residues at the carboxyl end of this polypeptide chain.

Some additional feature is obviously needed to determine the length of the protein shell, and we would guess that in the intact virus this is controlled by the length of the ribonucleic acid core. This would explain why rods of indefinite length are produced when undenatured protein sub-units are re-aggregated in the absence of ribonucleic acid[12]. Moreover, when the re-aggregation occurs in the presence of ribonucleic acid, it is reported by Fraenkel-Conrat and Williams[13] that rods of 3000 A. in length occur very frequently.

The structure of tobacco mosaic virus, then, is based on a helix, or, in other words, it has a screw axis—in this case[8] a non-integer screw axis. This symmetry axis implies that all the protein sub-units in the body of the virus have the same environment. The same contact points between neighbouring sub-units are used over and over again as we move along the helix. This feature is the clue to the general principle which we can apply whenever, on the molecular level, a structure of a definite size and shape has to be built up from smaller units; namely, that the packing arrangements are likely to be repeated again and again—and hence that the sub-units are likely to be related by symmetry elements.

So far we have been mainly concerned with the protein, and have neglected the ribonucleic acid component of the virus. Is that, too, made up of sub-units? The ribonucleic acid content of tobacco mosaic virus is rather low, and not more than four nucleotides can be associated with a given protein sub-unit. Now if all these groups were identical, the analytical composition of the ribonucleic acid would be based on the number 4, which it certainly is not[14]. Moreover, the ribonucleic acid is probably connected with the genetic properties of the virus, and so its fundamental unit must contain a much larger number of nucleotides.

This does not mean, however, that ribonucleic acid sub-units do not exist, since it is possible that the ribonucleic acid core contains a number of identical strands systematically interacting with the protein shell. The important consideration is that the packing arrangement should be repeated over and over again; and this can be done if the symmetry of the ribonucleic acid is the same as the symmetry of the protein and if the symmetry applies only to the sugar-phosphate backbone and not to the sequence of bases. It remains to be seen whether this type of arrangement can be established experimentally.

Spherical Plant Viruses

We have seen that the rod-shaped helical form of tobacco mosaic virus represents a natural way of constructing a large container from identical much smaller building blocks. The question we must now ask is whether the protein shell of the spherical viruses is likewise constructed by a regular aggregation of one type of small protein molecule, and, if so, how this is done. Unfortunately, there has been, to our knowledge, no systematic chemical search for the presence of sub-units in spherical viruses and so we must rely almost completely on crystallographic evidence.

It has been shown in two cases—bushy stunt virus[15] and turnip yellow mosaic virus[16]—that spherical viruses crystallize in a unit cell which has the shape of a cube; but unfortunately the X-ray photographs did not establish whether the symmetry also was cubic. This is important because, as has been pointed out by Dr. Dorothy Hodgkin[1] and Dr. Barbara Low[1], if the lattice possesses true cubic symmetry so must the virus particle, since there is only one particle in the primitive unit cell.

It has now been clearly established by Caspar (see following communication) that the unit cell of bushy stunt virus has cubic symmetry, and that, in this particular case, the virus has an even higher symmetry than the unit cell. Though this evidence applies to only one virus, we expect that further investigation will show that many small spherical viruses have cubic symmetry, for the reasons given below.

Now a virus possessing cubic symmetry must necessarily be built up by the regular aggregation of smaller asymmetrical building bricks, and this can be done only in a very limited number of ways. Since viruses are made of protein and ribonucleic acid, both of which contain asymmetric carbon atoms of one particular hand only, those symmetry elements (mirror planes and centres of symmetry) which turn a right hand into a left hand are *impossible*. Thus we can only have rotation axes, and for cubic symmetry this limits us to only three different combinations of symmetry elements.

Table 1. THE THREE POSSIBLE CUBIC POINT GROUPS FOR A SPHERICAL VIRUS

Crystallographic description	No. and type of rotation axes present	No. of asymmetric units	Platonic solid with these symmetry elements
23	3 2-fold 4 3-fold	12	Tetrahedron
432	6 2-fold 4 3-fold 3 4-fold	24	Cube Octahedron
532	15 2-fold 10 3-fold 6 5-fold	60	Dodecahedron Icosahedron

The number of sub-units will be the same as, or a multiple of, the number of asymmetric units

Each of these three classes must contain at least four three-fold axes and three two-fold axes, arranged as for a tetrahedron. The first class contains no additional type of axis, while the second and third have four- and five-fold axes, respectively. Such an arrangement of symmetry elements is known as a 'point group', in contrast to a space group which applies to a regular arrangement extending to infinity. In Table 1 are listed the three cubic point groups possible for virus particles and also the regular polyhedra which have these symmetry elements (among others). Notice that in all these point groups the minimum number of asymmetric units must be a multiple of 12.

Three further points must be made to prevent misunderstanding. First, it is possible to arrange sub-units in other ways to produce a spherical shell, but the symmetry will not be cubic, and as they are less likely we shall not discuss them further here. Second, the asymmetric unit, upon which the symmetry elements act to build up the spherical shell, may consist of several identical sub-units joined together in some unsymmetrical fashion. This occurs quite often in protein crystals and would not be unexpected. Nor need the sub-unit be a single protein molecule in the chemist's sense of a unit joined together by chemical bonds. Several different protein molecules may aggregate to form the asymmetric unit. Third, our predictions concern the symmetry elements present in a virus particle, not its exact shape. However, this is likely to be approximately spherical, and may, under high resolution, appear polyhedral or perhaps with bumps on, like a rather symmetrical mulberry. Both these forms have been seen in electron micrographs.

It is not easy to explain in a short space why there are so few ways of building a spherical shell, but the reader can soon convince himself that it is difficult by trying to draw identical shapes which completely cover the surface of a tennis ball. It is impossible, for example, to do this entirely with hexagons, even if their shape is irregular. The point is very well stated in D'Arcy Thompson's "On Growth and Form"[17], in which we find "the broad, general principle that we cannot group as we please any number and sort of polygons into a polyhedron, but that the number and kind of facets in the latter is strictly limited to a narrow range of possibilities". The reason is essentially a topological one.

From the present X-ray evidence we are unable to distinguish the respective contributions of the protein and the ribonucleic acid, so we cannot be sure whether the cubic symmetry is perfect and applies strictly to both of them. We cannot tell whether the protein sub-units contain identical sequences of amino-acids, or whether the ribonucleic acid sub-units (if they exist) have identical sequences of nucleotides. It should not be very difficult, by end-group analysis, to decide whether the protein components are all approximately equal. By analogy with tobacco mosaic virus we would guess that this will be found to be the case. With the ribonucleic acid component, however, the problem is more difficult than it was in the case of tobacco mosaic virus, as the number of nucleotides per sub-unit is certainly much larger. (This follows from the higher percentage of ribonucleic acid[7] and the much smaller number of protein sub-units.) Only with a more detailed understanding of the ribonucleic acid core is the problem likely to be settled.

Animal and Other Viruses

For animal viruses we are handicapped because there is no X-ray evidence available so far. However, it is now becoming clear[2] that many of the smaller animal viruses, such as poliomyelitis and the various encephalitic viruses, are morphologically very similar to the spherical plant viruses. Not only are they of similar size (approximately 300 A. diameter); but it has recently been shown[18] that poliomyelitis virus also contains ribonucleic acid and can form crystals which appear as regular as those produced by the plant viruses. We thus think it very probable that cubic symmetry also extends to these animal viruses, and that the soluble antigens[19] (of about 120 A. diameter) frequently observed in infected cells are related to the sub-units normally used in the assembly of the final infective virus.

We also see no reason why our hypothesis should not be valid for viruses containing deoxyribonucleic acid rather than ribonucleic acid. Although the structure of bacteriophages is usually more complex than the smaller viruses discussed here, the fact that their heads appear polyhedral suggests that ideas of this general type may apply to them, too. On the other hand, it is less likely that they will be relevant to the structure of the larger viruses like vaccinia.

Conclusion

We can now describe our hypothesis in a more general manner. We assume that the basic structural requirement for a small virus is the provision of a shell of protein to protect its highly specific packet of ribonucleic acid. This shell is necessarily rather large, and the virus, when in the cell, finds it easier to control the production of a large number of identical small protein molecules rather than that of one or two very large molecules to act as its shell. These small protein molecules then aggregate around the ribonucleic acid in a regular manner, which they can only do in a limited number of ways if they are to use the same packing arrangement repeatedly. Hence small viruses are either rods or spheres. The number of sub-units in a rod-shaped virus is probably unrestricted, but for a spherical virus the number is likely to be a multiple of 12. Every small virus will contain symmetry elements and in favourable cases these can be discovered experimentally.

We believe that this hypothesis is likely to apply (in this form or a simple variant of it) to all small viruses which have a fixed size and shape.

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Structure of Bushy Stunt Virus

CRYSTALS of bushy stunt virus yield detailed X-ray diffraction patterns indicating a high degree of regularity in the virus structure. Bernal, Fankuchen and Riley[1] found that the unit cell is body-centred cubic with one virus particle per primitive lattice point. Previous X-ray photographs[1,2] did not show whether the symmetry as well as the shape of the lattice is cubic. This is of considerable interest, since cubic symmetry for the lattice would imply that the individual virus particles possess cubic symmetry[3]. This is discussed in the preceding article (by Crick, F. H. C., and Watson, J. D.).

Precession photographs have been obtained from single crystals of bushy stunt virus which were grown by Messrs. F. C. Bawden and N. W. Pirie and kindly supplied by Dr. C. H. Carlisle. Two of these photographs, showing the basal reciprocal lattice planes normal to the edge and body diagonal of the cubic unit cell, are illustrated in Figs. 1 and 2. These show two- and three-fold symmetry respectively about the cube edge and cube diagonal, and establish the space group as $I\,23$ ($a = 386$ A.).

Early in this study, photographs were obtained from a disordered crystal which did not give lattice reflexions but in which the relative orientation of the virus particles appears to have been maintained. In one particular orientation this crystal gave a pattern of diffuse reflexions lying in several rings, each of which contained ten symmetrically arranged spots. This suggests that the virus particle has five-fold as well as two- and three-fold symmetry.

If the virus has the point-group 532, rather than merely 23, it will have additional symmetry axes. There will be one set each of two-fold, three-fold and five-fold axes lying in non-crystallographic directions, as well as the set of two-fold and the set of three-fold axes belonging to the space group. The directions of members of each of these five sets are shown in Figs. 1 and 2, except for the three-fold axes of the space group which can be seen in another photograph not reproduced here.

The intensity distribution which such symmetry is likely to produce on an X-ray photograph is best considered by reference to the Fourier transform of an individual virus particle. It can be shown that this transform is likely to exhibit spikes of high intensity extending from the origin along the direction of the symmetry axes. The X-ray pictures actually confirm the existence of such spikes along the postulated axes. The only difficulty in the identification arises from the fact that the symmetry of the crystal lattice (23) is lower than that of the individual virus particles (532). This means that directions in the transform which are related by the symmetry of the virus particle have to be sampled on reciprocal lattice points which have no symmetry relation, and the arrangement of which tends to obscure or confuse the underlying symmetry of the transform. However, allowing for this sampling difficulty, it is found that the radial variation of intensity near one type of diad of the point groups 532 is very similar to that near the other type; this is exemplified especially by regions of zero intensity occurring at the same distance from the origin along both types of dyads. A similar correspondence is also found for the two types of triads. Moreover, the intensity variations along the dyads and triads are different.

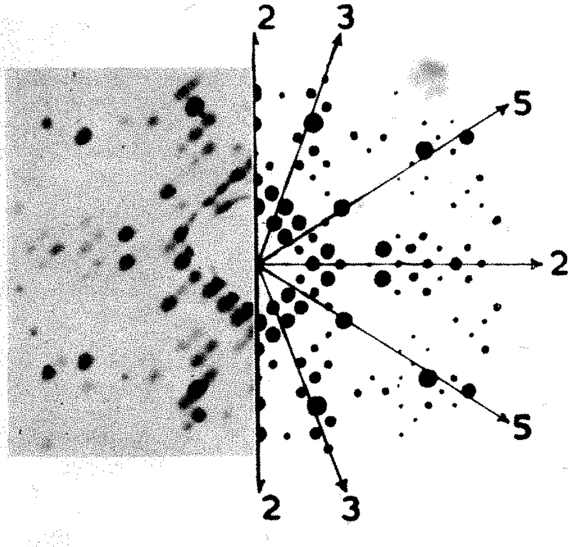

Fig. 1. Precession photograph of basal reciprocal lattice plane normal to the cube edge of bushy stunt virus crystal (left). Weighted reciprocal lattice net showing the orientation of the two-, three- and five-fold axes of the point group 532 which lie in this plane (right). The two-fold axes in this plane lie along the [100] directions of the lattice

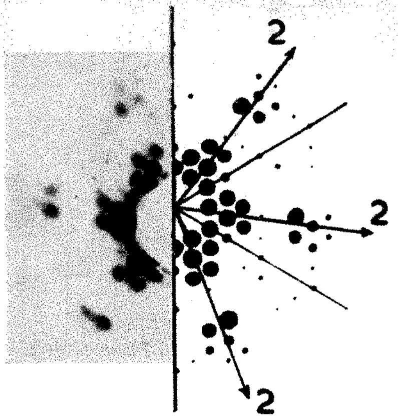

Fig. 2. Basal reciprocal lattice plane normal to cube diagonal showing the orientation of the two-fold axes of the point group 532 which lie in this plane. The unlabelled lines lie along the [110] directions of the lattice

All the evidence indicates that the virus has the point-group symmetry 532, which implies that it is built up of sixty structurally identical asymmetric units. The molecular weight of bushy stunt virus is about 9 million[4], of which about 17 per cent is ribonucleic acid[5]; therefore, the molecular weight of the protein part of the asymmetric unit is about 125,000. The point group symmetry does not preclude the possibility of each crystallographic unit being subdivided further into a number of chemically identical protein molecules. Thus 125,000 is a maximum value for the size of the protein sub-unit.

Chemical evidence, in fact, does suggest that the protein sub-unit may perhaps be smaller than this. There have been no end-group analyses reported for bushy stunt virus, but its amino-acid analysis obtained by de Fremery and Knight[5] can be used to calculate the minimum size of the sub-unit. Tryptophan, cysteine, methionine and histidine are present in very small amounts and approximately in the molar ratio 1 : 2 : 2 : 3. Assuming that all the protein molecules in the virus are identical (which may not be true) these analyses give a minimum molecular weight of 25,000–28,000, suggesting perhaps three hundred protein sub-units.

Thus the X-ray evidence shows that bushy stunt virus possesses sub-units. The number of sub-units is certainly a multiple of twelve and very probably a multiple of sixty. The chemical data suggest that the actual number may be as high as three hundred.

I gratefully acknowledge the advice and assistance of Drs. J. D. Watson and F. H. C. Crick.

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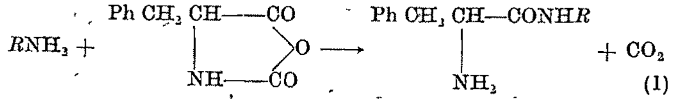
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The 'Chain Effect': a Possible Analogue of Enzyme Action

We wish to report a novel type of reaction in which the polymerization of DL-phenylalanine N-carbonic anhydride is initiated by polysarcosine (as dimethylamide). This reaction, which has brought to light some features that are potentially of general importance in reactions involving polymers, shows marked analogies with processes in which enzymes function as catalysts.

The normal propagation reaction in the polymerization of DL-phenylalanine N-carbonic anhydride initiated by primary or secondary bases is:



$$RNH_2 + \underset{NH\text{——}CO}{\overset{Ph\,CH_2\,CH\text{——}CO}{|\qquad\quad >O}} \longrightarrow \underset{NH_2}{\overset{Ph\,CH_2\,CH\text{—}CONHR}{|}} + CO_2 \qquad (1)$$

and when carried out in nitrobenzene solution at 15°, it has[1] a bimolecular rate constant of 0·6 mole^{-1} l. min.$^{-1}$. However, if polysarcosine with a degree of polymerization (n) of about 20 is used as initiator, the ensuing reaction may be several hundred times as fast as would be expected on the basis of this rate constant. The initial rate of reaction, measured for a given polysarcosine concentration, is a function of n as shown in Fig. 1. The rate of the normal propagation reaction obtained with non-polymeric initiation for the same concentrations of anhydride and base is only 3×10^{-4} mole l.$^{-1}$ min.$^{-1}$ and is indistinguishable from zero in the graph. It is evident that the polysarcosine chain is capable of exercising a remarkable catalysis upon the reaction, and we designate this the 'chain effect'.

When low concentrations of polysarcosine are employed, the rate of reaction, initially high, may fall to the value corresponding to the normal propagation reaction after a comparatively small degree of conversion, and unchanged anhydride remains in solution. Titration of the reaction mixture shows that the base groups are still free at this stage, no acid formation being detectable in the system. It seemed likely that the reaction product—poly-DL-phenylalanine—was an inhibitor, and this has been confirmed by experiments in which this polymer was added initially. Under these conditions no rapid reaction was observed.

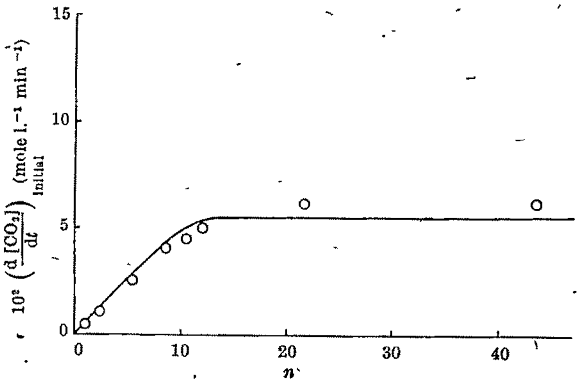


Fig. 1. Dependence of initial rate on length of polysarcosine chain. Reaction in nitrobenzene at 15° C. $[M]_0 = 0{\cdot}1$ mole l.$^{-1}$, concentration of polysarcosine dimethylamide $= 0{\cdot}54 \times 10^{-2}$ mole l.$^{-1}$. ○, Experimental points; full curve calculated on the basis of equations 2(a), (b)

In order to observe the chain effect in the system described, it is necessary for the polysarcosine chain to carry a terminal base group. If this is acetylated, no reaction occurs. Addition of a primary or secondary base (for example, piperidine) to the solution containing anhydride and acetylated polymer leads to a reaction which has only about a tenth of the rate of that due to the chain effect, indicating that the base is much more effective when attached to the polysarcosine chain.

We believe that the chain effect arises as a result of attachment of the anhydride molecules to the polysarcosine chain, probably by hydrogen bonding between the >NH groups of the former and the >CO groups of the polymer. Polysarcosine would be expected to be particularly effective in this respect, since it contains no >NH groups, and is therefore unable to form inter-peptide hydrogen bonds. On the other hand, poly-DL-phenylalanine, which contains >NH groups, does not give rise to the chain effect. As a result of the 'adsorption' of the anhydride by the polysarcosine, the concentration of anhydride in the proximity of the base is greatly increased, and since the polysarcosine chain is fairly flexible, the collision frequency between the base and the anhydride is much higher than that calculated on the basis of the overall concentrations of the reactants. Calculations of the order of magnitude suggest that this mechanism is sufficient to account for the high rate observed, even if it is assumed that the reactivity of the anhydride is not increased by adsorption. The chemical changes occurring are probably essentially similar to those in (1), and the final product is a block copolymer of sarcosine and poly-DL-phenylalanine. The process described would not operate when unattached base and acetylated polysarcosine are used, but hydrogen bonding between base and polymer may be sufficient to give a small degree of attachment.

The inhibition of the reaction by poly-DL-phenylalanine is readily understandable on this mechanism, since this polymer would form interchain hydrogen bonds with the polysarcosine, leading to aggregates of chains in which the accessibility of the adsorbed anhydride to the base is low, for steric reasons. Further, it would be expected that the nature of the solvent would be an important factor. This is so in practice; the chain effect in NN-dimethylformamide solution is only small. This liquid is capable of hydrogen bonding to the anhydride and the polymer, and this will reduce the adsorption of the anhydride by the polymer. N-substituted carbonic anhydrides should not show the chain effect unless the substituent carries a strong hydrogen-bonding group.

The observed dependence of the initial rates of reaction upon the experimental variables (n, anhydride concentration $[M]$ and sarcosine residue concentration $[S]$) is accounted for by the following simple kinetic scheme:

$$\begin{array}{lll} S + M \rightleftharpoons E & (a) & \\ E \rightarrow \text{products} & (b) & \end{array} \qquad (2)$$

where E represents an adsorbed DL-phenylalanine N-carbonic anhydride molecule. The equilibrium in

2(*a*) is supposed to be maintained throughout the reaction; the rate-determining step 2(*b*) requires the intervention of the base group at the end of the chain upon which *E* is situated, but this does not, of course, appear in the kinetic equations. The products in 2(*b*) are carbon dioxide and a phenylalanine residue which becomes joined to the terminal base group. The kinetic behaviour is quite different from that observed with the normal propagation reaction.

The process giving rise to the chain effect may therefore be visualized as the growth of one polymer on the surface of another in solution. It has analogies with heterogeneous reactions at interfaces. Of greater interest is the possible analogy with enzymic reactions. The dependence of the rate of the polymerization reaction upon the experimental variables, which is usually of the form shown in Fig. 1, resembles that found with enzymic reactions, and indeed the scheme (2) is similar to the simple Michaelis–Menten mechanism. The importance of the resemblances between the two types of system should become clearer with further work with other polymers and reactants.

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Carbohydrases in Blow-fly Larvæ

Hobson[1] showed that glycerol and/or dried preparations of the gut and salivary glands of *Lucilia sericata* Meig. showed strong proteinase activity but very little carbohydrase activity, only starch being hydrolysed, whereas maltose, sucrose and lactose were not hydrolysed at all. Since that report, these results have been quoted[2] to support the plausible example of adaptation, wherein larval and adult blow-flies are assumed to possess digestive ability corresponding to their diet. Thus larvæ feeding on a protein-rich diet are adequately provided for because the gut shows strong proteolytic activity and the lack of carbohydrases is of no consequence. The reverse picture is presented in adult blow-flies which feed principally on carbohydrates; very active carbohydrases are present but only relatively weak proteinases.

However, Evans[3] has recently established that gut tissues from the larvæ of *Calliphora erythrocephala* Meig. are able to hydrolyse a wide range of carbohydrates, there being little difference in this respect between larvæ and adults. Using the same techniques, it has now been demonstrated that *Lucilia sericata* larvæ are also capable of hydrolysing a wide range of carbohydrates. The salivary glands or gut tissues were incubated on a welled microscope slide in buffered substrate (*p*H 6·8) which had previously been saturated with toluene. Hydrolysis of non-reducing substrates was readily detected by placing the slides on a hot plate after the addition of Benedict's sugar reagent and noting the appearance of red cuprous oxide. Any change in sugar content of reaction mixtures with reducing substrates was determined by paper chromatographic analyses of samples of the reaction mixture before and after incubation. In all experiments suitable controls using denatured tissues were always employed.

The following substrates were hydrolysed by salivary gland and mid-gut tissue from *Lucilia* larvæ: maltose, sucrose, trehalose, α-methyl galactoside, raffinose, melezitose, starch; whereas the following were not hydrolysed: α-methyl glucoside, lactose, melibiose, cellobiose, cellulose.

These results, which are similar to those obtained for *Calliphora*, are of interest in relation to the problems of carbohydrase specificity. Fraenkel[4] explained the ability of adult *Calliphora* to digest a range of carbohydrates by assuming the bond-specificity concept of Weidenhagen[5]. So far as the disaccharides and trisaccharides were concerned, only enzymes capable of splitting α-glucoside and α-galactoside linkages were required to be present. However, the carbohydrase activity of larval blow-fly tissues cannot be accounted for so easily because: (1) α-methyl glucoside is not hydrolysed, unlike all the other sugars containing an α-glucoside bond, namely, maltose, sucrose, trehalose and melezitose; (2) α-methyl galactoside is hydrolysed, but melibiose, another α-galactoside, is not. It is clear that the properties of larval blow-fly carbohydrases do not completely exemplify Weidenhagen's hypothesis of bond specificity, the over-generalized nature of which has been criticized more recently[6]. Much more information about the properties of animal carbohydrases is necessary to give a satisfactory explanation of the ability to digest certain carbohydrates and not others in terms of bond specificity or otherwise.

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Comparative Antiœstrogenic Potencies of Progesterone and 17α-Hydroxyprogesterone

Progesterone is known to be not only a progestational compound but also to exert various antiœstrogenic actions: it prevents œstrogen-induced abdominal fibroids, œstrogen-induced growth of the myometrium, and œstrogen-induced excessive luteinization[1]. The antiœstrogenic potency of progesterone is diminished by oxidation at C_{21}, C_{11} and C_{17} [2,3]. The validity of this rule has been demonstrated by comparing progesterone with C_{11}-derivatives such as 11β-hydroxyprogesterone and 11-keto-progesterone, and with a C_{21}-derivative such as deoxycorticosterone. As to oxidation at C_{17}, comparison was made between deoxycorticosterone and Reichstein's compound *S* or 17α-OH-11-deoxycorticosterone[2]. Thus the conclusion as to loss of antiœstrogenic potencies due to oxidation at C_{17} in the α-position has been so far an indirect one; a comparison of progesterone with 17α-hydroxyprogesterone was still lacking. Results with the latter are given in the present communication.

Table 1. TWENTY-TWO CASTRATED FEMALE GUINEA PIGS RECEIVING ŒSTRADIOL AND 17α-HYDROXYPROGESTERONE OVER A PERIOD OF THREE MONTHS

No of animals	Œstradiol per day (μgm.)	17α-hydroxy-progesterone per day (μgm.)	Fibrous tumoral effect (ref 2)	Coeff. Q_{2-3} (ref. 2)	Uterine weight (gm.)	No. of pellets and concentration of 17α-hydroxyprogesterone
6	51	9 (8–10)	5·9 ± 1·1 (2–9·5)	1·5	4·[illegible] (2·3–6·5)	½; 40%
10	43	16 (13–19)	8·5 ± 0·4 (7–11)	2·9	5·7 (2·7–11·8)	½–1; 40%
6	44	136 (123–145)	7·5 ± 1·5 (2·5–12)	2·2	6·3 (5·2–13·0)	1; 100%

Pellets of 17α-hydroxyprogesterone were implanted beneath the skin of castrated guinea pigs; pellets of œstradiol also were implanted. Absorption was of 2·1 μgm. per sq.mm. of 17α-hydroxyprogesterone, against 3·3 μgm. of progesterone. Results for twenty-two animals receiving œstradiol and 17α-hydroxyprogesterone are given in Table 1; comparison between fifty-two animals receiving œstradiol and progesterone[4] is made in Fig. 1.

As seen from the table, neither œstrogen-induced abdominal fibroids nor uterine growth was prevented with as much as 136 μgm. of 17α-hydroxyprogesterone a day. On the other hand, as seen in Fig. 1, the fibrous tumoral reaction with 15 μgm. of progesterone per day was only 1·5 against 7·5 with amounts of 17α-hydroxyprogesterone eight or nine times greater than that. The coefficient Q_{2-3}, which refers to incidence of larger tumours only, was no less than 2 with 16 μgm. and even with as much as 136 μgm. of 17α-hydroxyprogesterone (Table 1); on the other hand, Q_{2-3} was zero with 15 μgm. of progesterone[4]. In Fig. 2 the maximal œstrogen-induced fibrous reaction in the presence of 13–24 μgm. of progesterone per day is compared with the non-maximal reaction in the presence of 123–145 μgm. of 17α-hydroxyprogesterone per day.

Uterine weight was 2·8 gm. and 5·7 gm. with 15 μgm. of progesterone and 17α-hydroxyprogesterone respectively (Fig. 1).

It is also of interest to compare results obtained with 17α-hydroxyprogesterone with those obtained with C_{11} and C_{21} derivatives of progesterone: as to antifibromatogenic and antihysterotrophic potencies, it is inferior to 11β-hydroxyprogesterone, to 11-ketoprogesterone and to deoxycorticosterone[2].

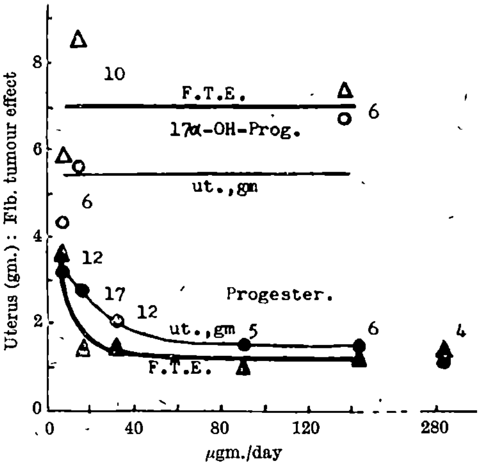

Fig. 1 Fibrous tumoral effect (△) and uterine weight (○) of twenty-two castrated females receiving œstradiol and 17α-hydroxyprogesterone, compared with 52 castrated female guinea pigs receiving œstradiol and progesterone (▲ and ●). Figures indicate number of animals in the group (Variations of fibrous reaction and uterine weight with 17α-hydroxyprogesterone are considerable; see also Table 1 But these differences between the 17α-hydroxyprogesterone groups are not significant and thus of no interest. The average in animals receiving only œstradiol may vary, according to the groups, between 4 and 7 or more)

Thus, there is full evidence that with oxidation at C_{17} the antiœstrogenic potencies of progesterone are diminished and in a manner seemingly more pronounced than with oxidations at C_{11} or C_{21}.

Comparative results as to antiœstrogenic potencies of progesterone and the oxy-derivatives mentioned are of considerable interest because the latter occur also in the body of mammals[5]. But results with 17α-hydroxyprogesterone deserve special attention in view also of recent findings with its caproate ester: whereas the free compound administered to women by intramuscular injection is without progestational action, the caproate ester is progestational[6]—apparently 're-acquired' through esterification. We have not yet examined whether antiœstrogenic potencies are also re-acquired by the caproate ester of 17α-hydroxyprogesterone.

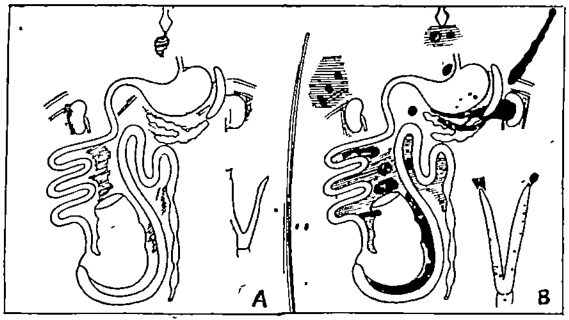

Fig. 2. Fibrous tumoral effect. Solid black surface, massive fibrous tumours; shaded areas, fibrous strands (A) Maximal fibrous reaction in a group of seventeen animals receiving during three months œstradiol and 13–24 μgm of progesterone per day Fibrous tumoral effect, 1·5. (B) Non-maximal fibrous reaction in a group of six animals receiving œstradiol and 123–136 μgm. of 17α-hydroxyprogesterone per day. Fibrous tumoral effect, 10

Thanks are due to Prof. Carl Djerassi, of Wayne University, for the sample of 17α-hydroxyprogesterone, and to Syntex, S.A., Mexico, for a generous supply of œstradiol.

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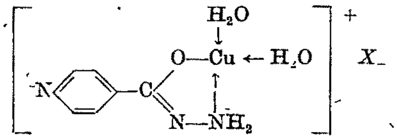
Mode of Action of *Iso*nicotinic Hydrazide

In our earlier report we directed attention to the importance of chelation as an essential step in the anti-tuberculous activity of *iso*nicotinic hydrazide (isoniazid)[1]. It was impossible to decide whether the chelating action with a metal or metals took place before (in the medium) or after adsorption on the bacterial cell.

Since then we have had the opportunity of examining the activity *in vitro* and *in vivo* of the relatively insoluble cupric complex of isoniazid :



X_- = a univalent anion

The results now reported (see Table 1) indicate that this complex is highly active. Thus, it might now be postulated that isoniazid is probably inactive in the absence of a chelating metal, and that its anti-tuberculous activity is, in fact, due to its metal complex, in this instance the cupric derivative. These findings are strongly reminiscent of those obtained in earlier studies of the mode of action of 8-hydroxyquinoline (oxine)[2].

Table 1. ACTIVITY OF *iso*NICOTINIC HYDRAZIDE AND ITS CUPRIC CHELATE COMPLEX

Compound	Anti-tuberculous activity		
	In vitro (ref. 5) Tuberculostatic end-point. Medium : synthetic serum-synthetic		*In vivo* (ref. 3) Healing ulcer response
*Iso*nicotinic hydrazide (isoniazid)	2,048,000 (0·07 μgm /ml.)	2,048,000 (0 07 μgm /ml.)	20 mgm /kgm. weekly I.M. *HR* 100 in 28 days.
Cupric complex of isoniazid	4,096,000 (0·08 μgm./ml.)	512,000 (0 6 μgm./ml)	20 mgm./kgm. weekly I.M *HR* 99 in 28 days.

It will be noted that the activity *in vivo*, examined by the healing-ulcer technique previously reported[3]; is extremely high, two injections effecting 85 per cent cure (*HR* value 85) in three weeks and 99 per cent cure in 28 days after three injections.

This copper derivative appears to be as active as isoniazid, verazide[4] or any drug we have tested so far. However, it exhibits a profound local and general toxicity in mice and guinea pigs. During treatment of guinea pigs by intramuscular injection, a severe gangrenous necrosis and ulceration developed at the site of injection, and in mice the acute toxicity (*LD*50) was as low as 36 mgm./kgm. body-weight compared with 200 mgm./kgm. for isoniazid itself.

The interest in these findings centres on the demonstration that the copper-isoniazid chelate complex is active *in vitro* and *in vivo* under conditions in which it is unlikely to break down to isoniazid. This observation, taken in conjunction with our earlier findings[1], has led us to conclude that the anti-tuberculous activity of isoniazid is expressed after it has formed a chelate metal complex in the medium or the animal body in which it is acting. The identity of the complexing metal *in vitro* or *in vivo* is still unknown, and the activity of other metal complexes is being investigated.

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Reduction to Normal Levels of the High Erythrocyte Sedimentation-Rates in Apparently Healthy South African Bantu Men

In the tropics and semitropics, unusually high values for erythrocyte sedimentation-rates are common among apparently healthy individuals. Thus, among seventy-five medically fit young Indian medical students, the mean rate (Wintrobe's method)[1] was 11·2 ± 9·4, range 0·5–30 mm. ; high values are assumed to be pathological, although the cause was unknown[2].

Neither malnutrition nor under-nutrition (unless very severe) is believed directly to influence erythrocyte sedimentation-rate[3]. Nevertheless, we find that although very high rates are common among different regional groups of apparently healthy Bantu mine-workers, the mean high values become reduced to within normal limits after subjects, without any medical treatment, have consumed for four–fifteen months the excellent diet provided in the mine compounds.

The Bantu mine-workers were eighteen to forty years old, in good physical condition, not anæmic, and free from radiological tuberculosis. No significant enlargement of liver, spleen or lymph nodes was apparent. Subjects were variously parasitized, particularly the tropical group. The Kolmer–Wassermann test for syphilis was positive in 4 per cent of cases. The majority showed liver dysfunction as revealed by the common biochemical tests on serum.

Workers came from areas where the diet is usually adequate in calories and gross protein, but is low in animal protein, fat and certain mineral salts and vitamins. The mine compound diet, which may be eaten to satiety, is nutritionally adequate.

The erythrocyte sedimentation-rate was determined on oxalated blood using Wintrobe's method[1], two technicians working in parallel, and determinations being completed within 3 hr.

In Table 1, only in the mixed group do data refer to the same individuals examined at the beginning and end of periods of service.

Our results revealed an equal degree of abnormality of erythrocyte sedimentation-rate among recruits with and without previous periods of service in the mines : this finding suggests that the normal values found on leaving the mines rise again on returning for some months to conditions of tribal life.

The dramatic and unexpected changes in erythrocyte sedimentation-rate found in these outwardly healthy subjects are not due to any medical treat-

Table 1. SEDIMENTATION-RATES IN BANTU MINE-WORKERS AT THE BEGINNING AND END OF PERIODS OF SERVICE

Subjects	Mean erythrocyte sedimentation-rate, standard deviations, ranges, and (in brackets) number of subjects	
	Values at beginning of service	Values after 4–15 months period
Eastern Transvaal and Moçambique (Shangaans)	11·5 ± 11 (75) 1–35	3·5 ± 2·5 (25) 0·5–10
Transkei (Pondos and Xosas)	12 ± 9 (47) 2–38	3·0 ± 2·5 (31) 0·5–11
Nyasaland, Angola, Northern Rhodesia (Tropical group)	29 ± 10 (75) 1–49	3·5 ± 4·0 (30) 1–11
Mixed group	16 ± 11 (15) 1–43	3·0 ± 2·5 (15) 1–9

ment, and we are driven to ascribe the changes directly, or indirectly, to the consumption of an excellent diet for several months. The precise explanation and significance of our observations remain to be established; nevertheless, it is suggested that in future studies on the nutritional status of non-white populations, determinations of erythrocyte sedimentation-rate may contribute valuable information.

We are grateful to Dr. R. C. Pearson and the late Dr. R. M. Yeo, of the Witwatersrand Native Labour Association Hospital, who facilitated the collection of blood from some of the groups of Bantu mine-workers, and to Miss G. McNab, of this Institute, for carrying out the Kolmer–Wassermann tests. This communication is published with the permission of the South African Council for Scientific and Industrial Research.

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Effect of a Coliform Organism (*Escherichia*) on the Second Ecdysis of Nematode Larvæ parasitic in the Horse

IT was recently shown that third-stage infective larvæ of the family Strongylidae commonly parasitic in the horse would readily shed their protective sheaths in equine duodenal contents[1]. Similar results have also been obtained by Sommerville[2] using ovine material.

The effect of artificial duodenal contents prepared according to the formula given by Silverman[3] has recently been observed using infective equine nematode larvæ. Results using the fresh solution proved disappointing. In three separate experiments the average percentage ecdysis only reached 13·6 after five hours.

It was noted that artificial duodenal contents, kept in a laboratory where horses' fæces are regularly examined and where no special precautions were taken to preclude entry of bacteria, developed after five days an offensive odour reminiscent of equine duodenal contents. Larvæ of the same age as those used above were therefore placed in the contaminated solution and the degree of ecdysis observed. This reached 80 per cent after three hours and increased to 89 per cent after five hours. It seemed, therefore, that the contamination of the artificial duodenal contents had enhanced its power to induce ecdysis.

A coliform organism was afterwards isolated from the contaminated solution, and it was therefore thought that it might be profitable to assess the effect of bacteria of this type on the rate of ecdysis.

Accordingly, artificial duodenal contents were freshly prepared. The solution was passed through a Seitz filter, after which it was divided into two equal portions, one of which was inoculated with a known coliform organism (*Escherichia*) of equine origin. This was incubated at 37° C. overnight. Larvæ of the same age were placed in both solutions and the rates of ecdysis compared. Fig. 1 illustrates the results obtained. There can be no doubt that the presence of the coliform organism has accelerated the rate of ecdysis. At present, four coliform organisms

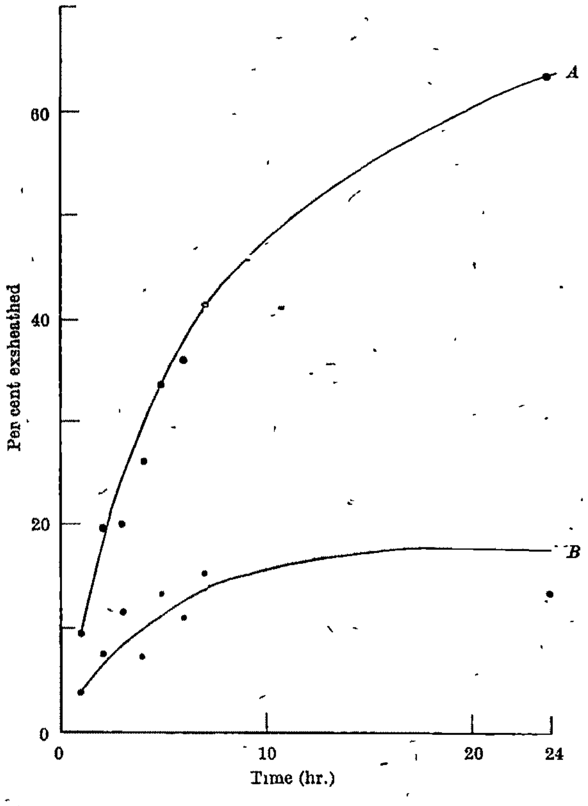

Fig. 1. The percentage of larvæ undergoing ecdysis plotted against the time in hours. Curve *A* shows the results in Seitz-filtered artificial duodenal contents plus coliform organisms (*Escherichia*). Curve *B* shows the results in Seitz-filtered artificial duodenal contents alone

(*Escherichia*) of different equine origin have been used and all have accelerated the rate of ecdysis.

Experiments have also been conducted using Seitz-filtered natural equine duodenal contents. Larvæ placed in this have never undergone great degrees of ecdysis, 9 per cent after twenty-four hours being the greatest yet recorded. In unfiltered duodenal contents, ecdysis regularly reaches 90–100 per cent before this time.

In all these experiments, mixed larvæ of the family Strongylidae were used. These were obtained from charcoal cultures of equine fæces, and it is likely that small amounts of bacteria were present on them, despite the fact that they were washed in sterile distilled water before use.

It is concluded that the presence of coliform organisms is necessary for the normal occurrence of the second ecdysis of nematode larvæ of the family Strongylidae commonly parasitizing the horse.

I wish to thank L. W. Mahaffey for advice on coliforms and supplies of pure cultures.

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Adrenergic Sweating in Cattle

Cattle skin is abundantly supplied with sweat glands[1], and these glands have been suggested to be functional[2,3]; but very little is known about the secretory control. Muto[4] recorded that adrenaline produces marked sweating in horses and sheep but has no effect on the calf. Ferguson and Dowling[3], on the other hand, observed the formation of sweat droplets in the calf in response to intradermal injections of adrenaline. Precise information, however, on whether the control of sweat glands of cattle is adrenergic and/or cholinergic is still lacking. We have therefore extended our experimental work on the cutaneous evaporation in cattle, in order to test the response of sweat glands to some of the drugs affecting the sympathetic nervous system.

An American Brahman calf, between the ages of three and seven months, was exposed at intervals to an air temperature of 108° F. dry-bulb and 80° F. wet-bulb. Cutaneous evaporation was measured from the shoulder area using a semicircular capsule made of 'Perspex', with an area of 19·6 sq. cm. Hot-room air was circulated through this capsule at the rate of 2·5 lit./min. At frequent intervals, the hot air was passed, after it had circulated over the skin under the capsule, through an absorber (concentrated sulphuric acid), and at the same time the same quantity of air at the same rate of flow was passed through another identical absorber. The difference of gain in weight between the two absorbers represents the amount of water evaporated from the skin.

Results presented in Fig. 1 indicate that N-(2-chloroethyl) dibenzylamine hydrochloride (dibenamine) given intravenously at the rate of 7 mgm./kgm. body-weight gradually reduced sweating. Sweating was completely blocked three hours after the injection. During the course of adrenergic blockade intradermal injections of adrenaline and nor adrenaline (0·2 mgm.) given near the site of th capsule failed to stimulate sweating. On the followin day, the blockade of adrenaline action graduall diminished until the sweating-rate returned to it initial level; at this stage, injection of adrenalin increased the sweating whereas noradrenaline re mained ineffective. The action of dibenamine o cattle sweat glands is therefore similar to that o human sweat glands[5].

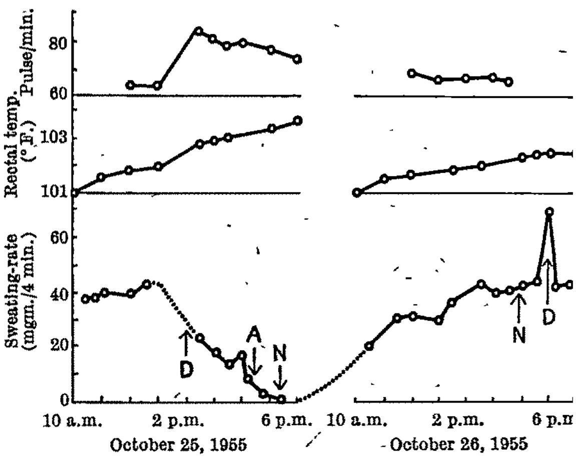

Fig. 1. Effect of dibenamine, adrenaline and noradrenaline on sweating-rate, rectal temperature and pulse-rate of a calf. Dotted lines indicate unmeasured intervals. Dibenamine (*D*), adrenaline (*A*) and noradrenaline (*N*) administered at points marked by arrows. Room temperature 108° F. dry bulb and 80° F. wet bulb

The inhibition of sweating induced by dibenamin was accompanied by increase in rectal temperature an pulse-rate with a room temperature of 108° F. As th sweating gradually increased on the following da the pulse-rate and the rectal temperature were foun to be below the levels recorded during administratio of dibenamine. Intramuscular injections of diben amine caused inhibition of sweating; but loca subcutaneous administration of 2 mgm. of 2-benzy 2-imidazoline (priscol), another adrenergic blockin agent, did not reduce sweating. A higher dosage c priscol (10 mgm.), on the other hand, caused profus sweating similar to that in man[6].

There was no response of sweat glands to sub cutaneous injections of atropine (60 mgm.) an acetylcholine (0·2 mgm.), but the injections c adrenaline given at the shoulder region increased th sweating-rate on the average from 32·1 to 45· mgm./cm.²/hr. Cattle sweat glands appear, therefor to be adrenergic, in this way differing from those c man, which are both adrenergic and cholinergic.

Thanks are due to Prof. W. V. Macfarlane for h assistance, advice and encouragement.

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Transfer of Hydrogen from Alcohols to Quinones

WHEREAS an extensive study of hydrogen abstraction by methyl radicals in the gas phase has been reviewed[1], hydrogen transfer in solution has only recently been discussed and the various types classified[2] as an introduction to a general study of this phenomenon: in particular, some hydrogen transfers to quinones in solution have been studied[3]. It is therefore pertinent to indicate briefly the conclusions drawn from the determination of the reactivity of some simple alcohols to photo-oxidation sensitized by quinones.

Bolland and Cooper[4] have concluded from a variation of the quantum yields of reaction products with experimental conditions that alcohols are attacked by photo-excited anthraquinones A^* with the production of semiquinones $\cdot A$H as follows:

$$A^* + R\text{CH}_2\text{OH} \rightarrow \cdot A\text{H} + R\underset{\cdot}{\text{C}}\text{HOH} \qquad (a)$$

$$R\underset{\cdot}{\text{C}}\text{HOH} + \text{O}_2 \rightarrow R\text{CHOH} \atop {\quad\; | \atop \quad\; \underset{\cdot}{\text{O}_2}} \qquad (b)$$

the subsequent reactions of the hydroxyperoxy radicals leading to the formation of stable products.

It has been found from a kinetic study of the reaction using sodium anthraquinone-2-sulphonate in aqueous solutions that the reactivity of the alcohols to hydrogen transfer can be determined from measurements of the rate of oxygen uptake of the system under varying conditions. The following are reactivities determined for some simple alcohols:

Substrate	Reactivity per $>$COH group relative to ethanol
Methanol	~ 0·12
Ethanol	1·00
n-Propanol	1·53
n-Butanol	2·07
*Iso*propanol	2·14
tert. Butanol	~ 0·01
Ethylene glycol	0·289
1,2-Propylene glycol	0·625
2,3-Butylene glycol	1·49
Glycerol	0·280

Thus: (i) in the primary alcohols reactivity increases with increasing chain-length; (ii) in the glycols, reactivity increases with increasing methylation of the carbon atoms in the α-position to the hydroxyl groups; (iii) reactivity increases in the monohydric alcohols with increasing alkylation on the α-carbon atom until all hydrogen atoms are replaced, when a great reduction in reactivity results, that is, reactivity increases along the series t-BuOH $\ll$ MeOH $<$ EtOH $<$ *iso*PrOH; (iv) increasing hydroxylation of propanol produces a decreasing reactivity, that is, reactivity decreases along the series *n*-PrOH $>$ propylene glycol $>$ glycerol.

The increase in reactivity with increase in alkylation is in accord with trends of reactivity observed in cases of hydrogen transfer from the α-carbon atom of primary and secondary alcohols to other acceptors both in the vapour and liquid phases[1,5]. Observation (iv) would suggest that hydration has a hindering effect on the hydrogen transfer process. The above results were determined in neutral solution. However, using *iso*propanol, the reactivity to photo-excited sensitizer has been found to decrease with increasing acidity; this has been adequately interpreted in terms of formation of an oxonium ion $R_2\text{CH}\,\overset{+}{\text{O}}\text{H}_2$, which is unreactive compared with the alcohol itself. On this assumption a detailed analysis of the kinetics gives the value of

$$K_b = \frac{[(\text{CH}_3)_2\,\text{CH}\,\overset{+}{\text{O}}\,\text{H}_2]}{[(\text{CH}_3)_2\,\text{CHOH}]\,[\text{H}^+]}$$

for

$$(\text{CH}_3)_2\,\text{CHOH} + \text{H}^+ \overset{K_b}{\rightleftharpoons} (\text{CH}_3)_2\,\text{CH}\,\overset{+}{\text{O}}\text{H}_2$$

as 2·5 litres mole^{-1} at 0° C.

For the thermal hydrogen transfers between hydroaromatic compounds and quinones, which are accelerated by acid conditions, Braude *et al.*[3] have suggested a slow transfer of a hydrogen anion to the quinone followed by a rapid transfer of a proton. The heterolytic fission of the α C—H bond in the alcohols is unlikely to occur in these photochemical transfers as it would produce the ion $R_2\overset{+}{\text{C}}\text{OH}$, which could not yield by interaction with oxygen the $R\text{O}_2\cdot$ radical, a necessary intermediate in the formation of the stable products. Straightforward hydrogen atom transfer[6], and electron transfer[7] (in this case from the oxygen of the alcohol; Kenner, private communication) followed by proton expulsion, have been proposed as mechanisms for photo-oxidations sensitized by dyestuffs. For the alcohols:

hydrogen atom transfer:

$$A^* + R\text{CH}_2\text{OH} \longrightarrow \cdot A\text{H} + R\underset{\cdot}{\text{C}}\text{HOH} \qquad (a)$$

electron transfer:

$$A^* + R\text{CH}_2\text{OH} \xrightarrow{\text{slow}} \cdot A^- + R\text{CH}_2\overset{+}{\text{O}}\text{H} \qquad (c)$$

$$R\text{CH}_2\overset{+}{\text{O}}\text{H} \xrightarrow{\text{fast}} R\underset{\cdot}{\text{C}}\text{HOH} + \text{H}^+ \qquad (d)$$

The increase in reactivity with increase in alkylation on the α-carbon atom of the alcohols discussed above could be consistent with either hydrogen atom transfer or electron transfer, with the increasing inductive effect assisting the removal of the hydrogen atom or the electron. However, on the electron-transfer mechanism the rate-determining process (*c*) would be expected to be more facile with *tert.* butanol than with *iso*propanol. A detailed consideration of the mechanism shows that any difference in the subsequent behaviour of the radical of *tert.* butanol from those of the primary and secondary alcohols would change the rate of oxygen uptake, and hence the reactivity, by a factor of only two or three, since the rapid reversion of semi-quinone to quinone:

$$\cdot A\text{H}(\cdot A^-) + \text{O}_2 \rightarrow A + \text{HO}_2\cdot\,(\cdot\text{O}^-_2)$$

must still operate. Therefore, the very low relative reactivity of *tert.* butanol indicates that the reaction proceeds by simple hydrogen-atom transfer from the alcohol to the quinone, as in (*a*).

A detailed account of the kinetics and rate constants will be given elsewhere. This work forms part of the fundamental research programme of the Council of the British Rayon Research Association.

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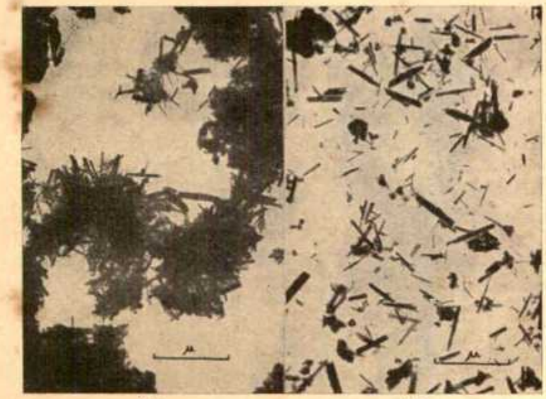
Petroleum Ether (80°-100° C.) used as a Dispersing Agent for the Examination of Particulate Matter by Electron Microscopy and Electron Diffraction

IN these laboratories, many powders of electrochemical interest have been produced and their structural properties examined by electron microscopy and electron diffraction, using a Metropolitan-Vickers *E.M.*3 instrument.

Deposits obtained from aqueous suspension methods utilized initially for specimen grid preparation frequently resulted in the aggregation of the fine particles present so that it was found necessary to employ a dispersion technique. Specimens made for transmission electron diffraction have always been degreased by spraying with a fine jet of petroleum ether. It was the use of petroleum ether in this connexion which led to the idea of determining its efficiency as a dispersing agent. For most of the substances which have so far been studied here, satisfactory dispersions of fine particles have been obtained by employing the following simple method.

A small quantity of the powder is placed on to a clean glass microscope slide. From a wash bottle constructed using 'Quickfit' ground-glass joints and having a fine jet, a few drops of petroleum ether are directed on to the powder. This is then crushed to a very fine paste by means of a lancet-pointed dissecting needle.

More dispersing agent is applied and the flat blade of the needle is moved across the slide, thus removing the larger particles and leaving a 'smear' of extremely fine particles. The 'smear' is moistened with a further small quantity of petroleum ether and the collodion film on a copper grid is drawn lightly over the dispersed material on the slide using a pair of forceps. After a few seconds (allowed for evaporation of any remaining liquid), the specimen grid is ready for insertion into the electron microscope.



(1) (2)

Fig. 1. Aqueous suspension deposit
Fig. 2. Petroleum ether dispersion

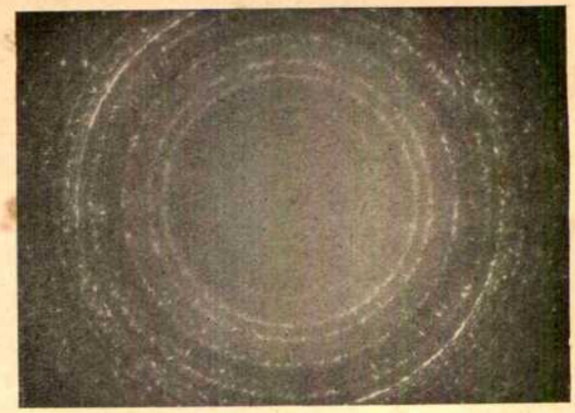


Fig. 3. Electron diffraction pattern from crystals similar to those shown in Fig. 2

The method has the following advantages: (*a*) It is suitable for the majority of inorganic and many organic materials which are insoluble in petroleum ether; (*b*) it is quick, as only one medium is used which rapidly evaporates; (*c*) the dispersed material is deposited on the membrane in such a way that it can be shadowed; (*d*) the dispersion is free from grease and is therefore suitable for electron diffraction.

Synthetic manganese oxides[1], oxides of lead, silver, nickel and vanadium, clay minerals, diatomaceous earth, pyranthrone and flavanthrone are some of the materials which have been investigated in this department by electron microscopy and electron diffraction after successful dispersion using the method described.

Figs. 1 and 2 show the rod-shaped crystals obtained from a sample of α-manganese dioxide (with potassium in the lattice) which had been heated at 400° C. in oxygen for 24 hr. The highly resolved transmission electron diffraction pattern of Fig. 3 was taken from crystals like those in Fig. 2.

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Determination of Arc Temperatures using Shock Waves

SOME years ago, Suits[1] suggested and developed a method for the determination of the gas temperature of an arc discharge by the measurement of the velocity of a sound wave passing through the arc channel. The sound wave was obtained from the initiation of a spark discharge, and its propagation was observed by the increased brightness it produced in the channel. In his investigation, Suits observed that the original pressure disturbance created by the spark possessed abnormally high velocities which were rapidly attenuated with the propagation of the disturbance. However, since his experiments showed that for different spark-strengths, and hence for

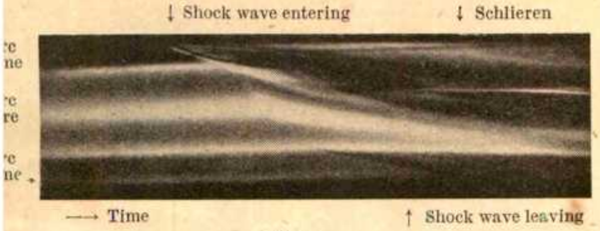

Fig. 1

different abnormal velocities, the same velocity was always obtained when the disturbance had reached the arc, he assumed that the disturbance had become attenuated to one possessing the normal sound velocity.

It is now well known[2] that these abnormal velocities are characteristic of a shock wave which is produced by spark initiation. It would appear, however, that the attenuation allowed by Suits was insufficient to produce a sound wave since (*a*) with a sound wave no arc brightening is to be expected, and (*b*) the records given by Suits show a bodily movement of the arc channel which is most likely due to the mass flow associated with the tail of a shock wave. We suggest, therefore, that Suits observed the passage of a shock wave; and calculations applied to his records indicate that his temperature values are about 5 per cent high due to the application of sound-wave calculation to the relatively weak shocks actually used. The use of strong shock waves would increase the error appreciably. It is also of interest to note that in allowing the shock wave to become attenuated, the sharpness of the pressure front is also reduced, thus producing a brightness change which is difficult to measure accurately. This may explain the relatively few measurable records obtained by Suits.

In the technique which we have developed, the shock wave produced by the spark is not allowed to become attenuated but is, on the contrary, maintained at maximum strength by enclosing the spark in a shock tube. In this way we obtain records showing a large brightness change and which are therefore accurately measurable. It is clear, however, that in these circumstances shock wave theory must be used if large errors are to be avoided. It was found that the application of the Rankine–Hugoniot equations to the arc, considered as a gas of uniform temperature bounded by two simple contact discontinuities, was insufficiently accurate owing to the appreciable radial temperature gradients which exist in the arc. We have therefore developed a theory which gives the variation of velocity of a plane shock wave with a continuously varying temperature distribution. It is then possible to determine the gas temperature at a point *A* if the shock velocity is known at *A* and if the velocity and temperature are known at some other point *B*. In order to obtain these data a schlieren system has been combined with a rotating mirror camera so that the shock propagation can be recorded in the regions outside the arc as well as in the arc channel. The local temperatures outside the arc are easily measured. A typical record is shown in Fig. 1. With this technique we have determined the following arc gas temperatures to an estimated accuracy of ± 150° K., after allowing for shock attenuation. (1) 40-amp. arc in air at 1 atm., cored carbon electrodes with 8-mm. gap, anode above, temperature in middle of gap 6,800° K. (2) 10-amp. arc in nitrogen at 2 atm., tungsten electrodes with 6-mm. gap, cathode above, temperature in middle of gap 6,650° K.

The method is complicated by the shock wave attenuation which occurs in the arc regions; but experiments have now shown that this difficulty may be minimized by using a pulsed arc inside the shock tube. The technique is being further developed in order to determine the decay of gas temperature subsequent upon arc interruption. It will be appreciated that by using a schlieren system the method is applicable to other determinations of non-luminous high gas temperatures.

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Crystallite Orientation in the Tooth Dentine of *Macropus*

Mammalian dentine consists mainly of hydroxyapatite crystallites with an average size of about 0·03μ [1], and collagen fibres. If the latter are removed from a dentine section and the preparation embedded in a medium with a refractive index high enough to eliminate 'form' birefringence, the optical properties of the mineral are then seen, and it has been shown that the crystallites are orientated in definite patterns[2]. They may lie with their optic axes parallel with the original direction of the collagen fibres, parallel with the dentine tubules, or they may be 'spheritically' orientated.

In longitudinal sections of *Macropus* dentine, crystallites tend to lie parallel with the original collagen direction. However, in the root near the pulp cavity an unusual effect has been noticed, for when viewed between the crossed nicols of a polarizing microscope, such areas show well-defined black lines running across the dentine tubules (Fig. 1). The birefringent crystallites are arranged approximately at right angles to these lines, which are not artefacts produced by the embedding medium and which were initially thought to be zones either containing a different, isotropic mineral, or else possessing a low degree of calcification. It was later found that these lines may still be seen when a section is examined in plane-polarized light, but they are extremely faint and only visible when at right angles to the polarizer; rotating the section causes them to appear and disappear alternately.

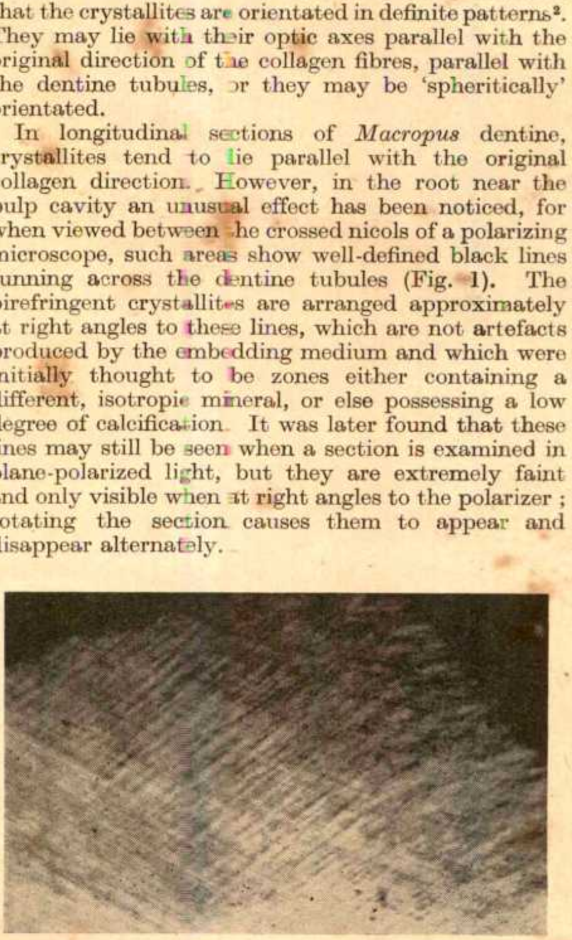

Fig. 1. Appearance of extracted *Macropus* dentine between crossed nicols

The explanation of this phenomenon now appears to be that all the mineral in the dentine is the same, but a somewhat regular, double orientation of crystallites exists. The majority of the crystallites lie in the plane of the section and therefore exhibit two refractive indices (n_e and n_0). These are broken up into groups by lines of similar crystallites the optic axes of which are perpendicular to the plane of the section and, therefore, show only one refractive index (n_0) and have no activity between crossed nicols. If the optic axes of the crystallites in the plane of the section are parallel with the vibration direction of the polarizer, the plane-polarized light is subject to the extraordinary refractive index (n_e), and the lines, which are at right angles to this vibration direction, will appear since the index of their mineral is somewhat different (n_0). On rotating the section through 90° all the crystallites will be showing the same index (n_0) and the lines become invisible.

Thanks are due to the Zoological Society of London for the material. It is hoped that a complete account of the structure of marsupial teeth will soon be available.

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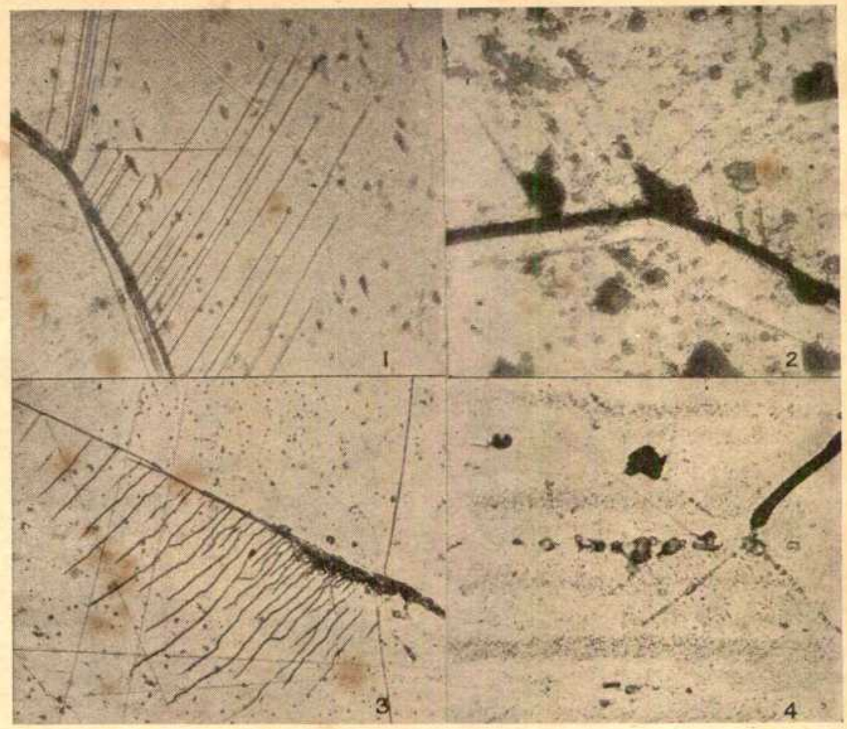

(1) Slip bands near a fatigue crack. × 570. Etch: 15% hydrofluoric acid, 35% hydrochloric acid, 50% water

(2) As Fig. 1 but specimen heat-treated and etched to produce etch pits

(3) Wavy slip bands. × 570

(4) Crystallographic crack and markings in a commercial alloy. × 1,500. Etch: 10% sodium hydroxide

Slip during Fatigue of an Age-hardened Alloy

IT has long been suspected that the room-temperature fatigue properties of age-hardened aluminium alloys are dependent upon any over-ageing that may occur during a fatigue test[1]. This has recently been directly verified by comparison of fatigue behaviour at room and liquid-air temperatures[2]. It is supposed that alternating stresses cause dislocation movements which in turn generate vacant lattice sites. At room temperature these are mobile and can give rise to over-ageing by reason of the increase in the local diffusion-rate. At liquid-air temperatures this cannot occur, and the fatigue properties are much superior.

However, practically nothing is known about slip processes in age-hardened alloys. No slip bands are seen when single crystals are extended, and the stress-strain curves show little dependence upon orientation[3]. Nevertheless, examination of an aluminium alloy containing 6·6 per cent zinc, 3·0 per cent magnesium and 1·4 per cent copper and aged to peak ultimate tensile stress of 38·2 tons/sq. in., has revealed slip bands in specimens fractured in fatigue at room-temperature. Those shown in Fig. 1 were produced by etching a polished longitudinal section of a specimen which had broken after 10^5 cycles of ± 19·1 tons/sq. in. The crack is parallel to one set of bands and changes direction at a grain boundary (revealed by a different etch). It proved impossible to develop etch pits for the determination of crystal orientation in the fully hardened alloy; but after over-ageing specimens at 200° C. for a short time, satisfactory pits could be produced. At the same time, however, the bands disappeared and could not be re-etched. This suggests that the original etching effect was due to solute atoms which had segregated to dislocations stuck in the slip band, and that at 200° C. some redistribution occurred. The development by alternating strains of a yield point in this type of alloy has been noted[4] and supports this suggestion.

The structure shown in Fig. 2 was produced by re-etching the surface of the specimen shown in Fig. 1 after over-ageing but without intermediate repolishing. It is apparent that while two sets of traces may possibly be ascribed to intersections of (111) planes with the surface, the third may not. In aluminium, slip on (111) planes is commonly found, but very occasionally slip on (100) and (110) planes occurs in polycrystalline specimens deformed in tension[5]. The third trace is consistent with either (100) or (110) planes. This has been found for numerous bands: in addition wavy slip is also seen, as shown in Fig. 3.

No bands were found in a specimen fatigued at iquid-air temperatures.

The existence of many potential slip bands in age-hardened alloys undergoing fatigue provides an additional explanation of the poor fatigue properties of some age-hardening alloys relative to their static strength properties. Besides the possibility of over-ageing, slip can more readily occur in any one crystal and be transmitted to its neighbours. The alloy described is simply a super-pure version of a common commercial alloy, and it is of interest that crystallographic cracking can be found in such an alloy, although its analysis is complicated by the presence of gross inhomogeneities and intermetallics (Fig. 4).

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Apparent Velocity of Alpha-Particles in Cloud Chambers

Visual demonstration of α-tracks in cloud chambers, especially of the diffusion type, sometimes gives the impression that the tracks actually shoot out from the radioactive source in a fraction of a second (not unlike the smoke trail of a train moving in a distant landscape, though the time-scale is different). It is curious not to find this effect mentioned in the literature, though it must baffle those teachers that have to correct their pupils when they think it is the actual velocity of the particles they are observing.

We suggest the phenomenon is due to the finite diffusion-rate of vapour molecules to the droplets that are forming, their growth being slower at the end of the track because of the stronger competition due to the larger density of ionization. Assuming the known values of this density and assuming the track to be a cylindrical sink in the diffusion field, we find the right order of magnitude for the retardation at the end, the track being fully developed in somewhat less than a second near the end, and in about half that time in the central part.

On a similar basis rests the explanation of a related condensation phenomenon that may be observed with yet simpler means. When one looks at a small light source through a flask with moist air in which an adiabatic expansion is produced (for example, by sucking through a rubber tube) a coloured diffraction halo around the light source is seen. It is, however, not stationary, but at first moves inward during a fraction of a second. This must be attributed to an increase in the size of the fog droplets, due to the same finite diffusion-rate of the water vapour (and of the heat dissipation). Here the sink to be used in the calculation is the spherical droplet itself.

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An Unusually Radioactive Fossil Fish from Thurso, Scotland

During recent investigations on the distribution of radioactive elements in phosphates[1], it was noted that many of the Old Red Sandstone fish remains from north-east Scotland have an abnormally high radioactivity; in particular an unidentified *Homostius* plate (GSM 89090) was shown by rough radiometric assay to have an activity equivalent to 0·5 per cent U_3O_8.

More detailed radiometric assays we have carried out indicated that this material is either in a state of secular disequilibrium, or contains appreciable amounts of thorium. As the latter alternative seemed the more likely, part of the specimen was assayed chemically (Radiochemical Group, Chemical Research Laboratory, Teddington) and found to contain 0·32 per cent U_3O_8 and 0·51 per cent ThO_2, a result which is in excellent agreement with the equivalent U_3O_8 value of 0·48 per cent obtained on the same sample. On obtaining chemical confirmation that appreciable thorium is associated with this particular fish plate, additional investigations were undertaken in an endeavour to obtain more information on the distribution of the radioactive elements within the plate.

In thin section the plate is opaque except where small amounts of interstitial calcite occur; but in polished section the bone structure can be seen clearly (Fig. 1). The bone cavities are filled with hydrocarbon or hydrocarbon partly replaced by calcite. Accessory minerals recognized in the polished sections are pyrite and chalcopyrite.

The mineral constituting the bone tissue was identified by normal optical methods and by X-ray powder photographs of an untreated sample, and of a similar sample ignited to destroy the associated hydrocarbon. Powder photographs of fluorapatite and of carbonate-fluorapatite were also taken for comparison purposes. The X-ray data on which the identification is based are given in Table 1.

It is apparent from the above observations that the apatite of the bone matrix has an *a* cell dimension between carbonate-fluorapatite and fluorapatite, but a *c* dimension somewhat greater than the other carbonate-fluorapatites examined. The refractive indices of the ashed material, ω = 1·628 and ε = 1·616, however, are in good agreement with carbonate-fluorapatite, and since fluorine and only a trace of chlorine were detected chemically (C. O. Harvey, Geological Survey and Museum), it seems reasonably certain that the Thurso material is in fact a carbonate-fluorapatite.

Table 1. Cell Dimensions of Some Varieties of Apatite

		a (in A.)	*c* (in A.)
1. Hydroxylapatite, Holly Springs, Ga., U.S.A.		9·413	6·875
2. Fluorapatite, Bob Lake, Canada		9·396 ± 0·005	6·879 ± 0·005
3. Fluorapatite, Durango, Mexico		9·386	6·878
4. Apatite from *Homostius* bone tissue, Thurso, Scotland	(Untreated)	9·356 ± 0·01	6·910 ± 0·01
	(Ashed)	9·366 ± 0·005	6·894 ± 0·005
5. Carbonate-fluorapatite, Staffel, Germany		9·344	6·881
6. Carbonate-fluorapatite, Florida, U.S.A.	(Untreated)	9·339 ± 0·005	6·894 ± 0·005
	(Ashed)	9·351 ± 0·005	6·885 ± 0·005

Determinations 1, 3 and 5 are by Z. S. Altschuler, E. A. Cisney and I. H. Barlow using an X-ray diffractometer. Abstract in *C.R. XIX Int. Geol. Congr. Algiers*, **11**, 9 (1952).

In determinations 2, 4 and 6 a 114·6-mm. diameter camera was used with copper *Kα* radiation and an internal standard of potassium chloride; *a* was determined from the reflexion $41\bar{5}0$ and *c* from 0004.

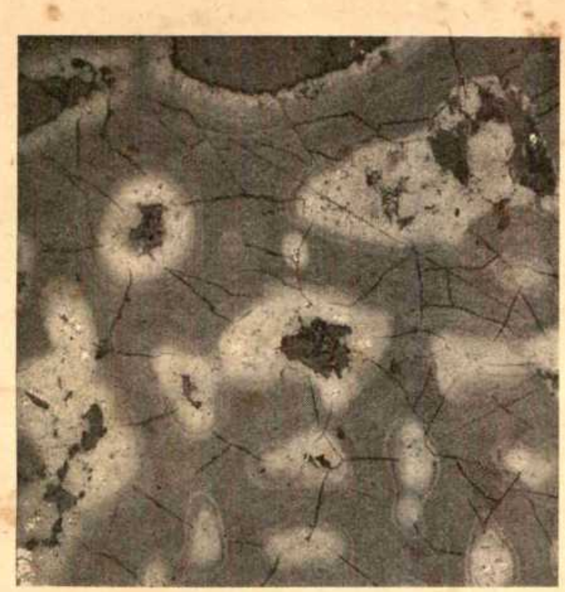

Fig. 1. Polished section of *Homostius* plate showing bone matrix (medium grey), hydrocarbon (light grey) and calcite (dark grey). The white specks are pyrite. × 45

Autoradiographs prepared from polished sections show that whereas both the bone matrix and the hydrocarbon are radioactive (Fig. 2), the alpha-track density of areas corresponding to the hydrocarbon is approximately 1·5 times that of areas corresponding to bone matrix. Measurements of the lengths of alpha-tracks clearly indicate that those of sufficient energy to be attributed to polonium-212 are present only in emulsion that had been in contact with the hydrocarbon, and it is therefore concluded that the thorium is concentrated in the hydrocarbon and does not occur in the bone phosphate. It was further shown from a comparison of the alpha-track population and the U_3O_8 and ThO_2 values obtained chemically that some uranium occurs with the thorium in the hydrocarbon.

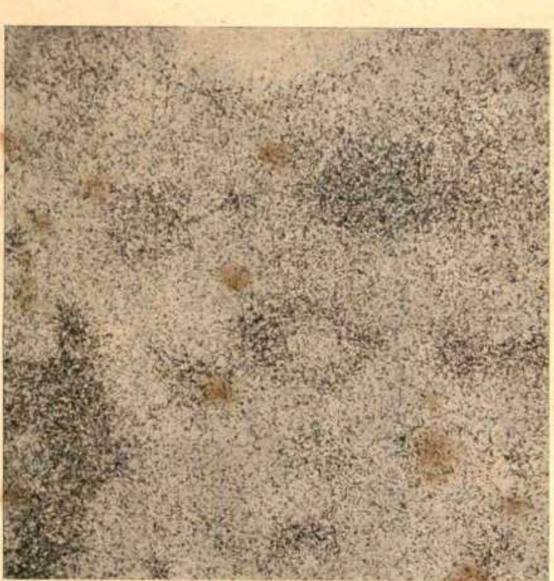

Fig. 2. Autoradiograph of same field as Fig. 1 showing concentrations of alpha-tracks corresponding with areas of hydrocarbon. The calcite is inactive. × 45

These observations indicate that whereas both uranium and thorium form organic complexes or compounds with hydrocarbon, only uranium is fixed by bone apatite under the conditions appertaining in this instance. Had the uranium and thorium been taken up under reducing conditions, it would have been expected that thorium (ionic radius 1·02 A. would have replaced calcium (radius 0·99 A.) in the carbonate-fluorapatite lattice in the same way as the tetravalent uranium ion (radius 0·97 A.) could have done; but since thorium is not present in the bone apatite, it is assumed that uranium is fixed by some other mechanism. The most likely method of fixation would seem to be that suggested by Neuman and his co-workers[2], in which the uranyl ion (UO_2^{++} combines with two adjacent phosphate groups at the surface of the bone apatite crystals and displaces a calcium ion. This type of exchange adsorption could explain such observed phenomena as the marginal concentration of uranium on apatite crystals, or fossil teeth, and on some phosphorite nodules. It also explains why uranium in ground-water is not substituted for calcium in other common calcium minerals.

We are indebted to Mr. J. E. T. Horne for his assistance in deriving the X-ray data. The communication is published by permission of the Director of the Geological Survey and Museum.

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Differences in Proportion of Fawns to Hinds in Red Deer (*Cervus elaphus*) from Several New Zealand Environments

From more than a hundred liberations, between 1851 and 1923, red deer have spread into the majority of forested areas in New Zealand. In the present communication autumn fawn/hind ratios in New Zealand are compared between five different areas and within each area on two successive years, 1952 and 1953.

The relative proportions of fawns to hinds are shown in Table 1, where hinds are given an arbitrary value of 100. Samples of deer were taken in autumn for comparison with ratios available on deer in the northern hemisphere.

New Zealand fawn/hind ratios show highly significant differences in the five environments tested. Fawn/hind ratios range from 28(±10)/100, in the Central North Island, to 70(±14)/100 in the Nelson–Marlborough area, South Island (Table 1). Such differences perhaps could be expected in New Zealand, as red deer range over a wide variety of contrasting environments. Similarly, for adult stags in autumn, differences in fat reserves have recently been demonstrated for several different New Zealand environments[2].

Fawn/hind ratios varied more between different areas than similar ratios taken from the same area

Table 1. FAWN/100 HIND RATIOS FOR RED DEER (*Cervus elaphus*) FROM FIVE NEW ZEALAND AREAS

Area	Total animals	Fawns/ 100 Hinds	Approx. 90 per cent confidence limits
Central North Island	134	28	± 9 8
Nelson–Marlborough	284	70	± 13·9
Canterbury	224	39	± 9·6
Southern Lakes	272	47	± 10·1
South Westland	96	35	± 13 5
All areas	1,010	47	

Corrected χ^2 (ref. 1) to test differences between the areas was 20·62, with a probability of a greater value 0 0004. Approximate 90 per cent confidence limits were calculated using the formula

$$\frac{100F}{H} \pm \left(100\sqrt{\frac{(F+H)F}{H^3}}\right) 1\ 6449.$$

for two consecutive years. Three of the five areas showed no significant difference between fawn/hind ratios taken in 1952 and 1953. Values for the three areas were: Central North Island, 27/100–31/100 ($\chi^2 = 0{\cdot}023$); Nelson–Marlborough, 67/100–75/100 ($\chi^2 = 0{\cdot}228$); and Southern Lakes, 48/100–47/100 ($\chi^2 = 0{\cdot}00015$).

Southern Lakes, South Westland, Canterbury and Central North Island habitats include most of the deer population in New Zealand. Fawn/hind ratios from these four areas combined (41($\pm$4)/100) correspond closely to those recorded by Alex-Hansen[3] from Jutland (38·5/100), near the northern limit of the range of the European red deer, and are significantly less ($\chi^2 = 6{\cdot}84$) than those ratios of 60/100 recorded from Scotland and Germany by Darling[4] and Müller-Using[5] respectively.

Grateful acknowledgment is made to those Government shooters who co-operated in recording results of unselective shooting to make these data available. This work was done while I was employed by the Department of Internal Affairs. The formula for approximate 90 per cent confidence limits was supplied by the Applied Mathematics Laboratory, Department of Scientific and Industrial Research, New Zealand.

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The Reniform Nematode in the Gold Coast

THE reniform nematode (*Rotylenchulus reniformis*) was first described as an obligate parasite on the roots of many plants in Hawaii[1], and a list of sixty-five hosts was given by Linford and Yap[2]. Subsequent records[3-5] have added a further five hosts from the United States.

The occurrence of the reniform nematode has now been noted on a number of hosts at three sites in the Gold Coast, West Africa.

Plants on which this nematode has been found capable of egg production in the Gold Coast are: *Amaranthus spinosus* L.*, *Citrus limon* Burm. f.*, *Crotalaria juncea* L., *Crotalaria striata* D.C., *Daucus carota* L. var. *sativa* D.C., *Glycine max* Merr.*, *Hibiscus esculentus* L., *Ipomoea batatus* L.*, *Lycopersicon esculentum* Mill., *Manihot esculenta* Grantz.*, *Nicotiana tabacum* L., *Persea americana* Mill.*, *Poinciana pulcherrima* L.*, *Solanum melongena* L. var. *esculentum*, *Sorghum vulgare* Pers., *Synedrella nodiflora* Gaertn.*, *Vigna sinensis* Endl., and *Zea mays* L. Those marked with an asterisk are new host records for the reniform nematode.

Life-history studies suggest that the West African forms have a shorter life-cycle than those described by Linford and Oliveira[1]. Soya grown from seed in soil infested with *Rotylenchulus* contained swollen forms after four days, mature females with gelatinous matrix after seven days; egg-laying commenced at ten days, and, fifteen days after sowing, second-generation larvæ were hatching within the egg-masses.

All three sites were old centres of European cultivation within fifteen miles of the capital, Accra, so it is not possible to say whether the reniform nematode is indigenous to the Gold Coast. A more detailed account will be given elsewhere at a later date.

I wish to thank Dr. J. B. Goodey, Nematology Department, Rothamsted, and Dr. S. A. Sher, Division of Plant Nematology, Riverside, California, for help and advice.

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Regulation of Outbreeding in Field Beans (*Vicia faba*)

IT has been reported that field beans show about 30 per cent of cross-fertilization in eastern England[1], and rather more in eastern France and Germany[2]. In the course of some pollination experiments at the Plant Breeding Institute, evidence has been obtained of a natural regulating mechanism which stabilizes this breeding structure.

The plants studied came from commercial seed, inbred lines, and F_1 hybrids, and were grown in an insect-proof glasshouse. Several self- and cross-fertilization treatments were applied, and the results of three of these are set out in Table 1, expressed as the mean number of seeds obtained per flower treated.

It can be seen that, on inbreeding, the ability to set seed without some manipulation of the flower was progressively lost. In most cases it was immaterial whether self- or cross-pollen was applied, except in the more advanced inbreds, where cross-pollen was more effective, possibly indicating some degree of self-incompatibility in this group. On hybridization,

Table 1

Group	Treatment		
	a	*b*	*c*
Commercial sample	0·56	2·97	2 89 ± 0·266
Second-generation inbreds	0·27	2·13	1·87 ± 0·158
Fourth-generation inbreds	0·04	1·42	2·14 ± 0·123
F_1 hybrids between third-generation inbreds	1·36	1·98	2·09 ± 0·133

(*a*) *Control*: flowers left untreated. (*b*) *Artificial self-pollination*: keel of mature flower depressed to push self-pollen on to the stigma. (*c*) *Mixed pollination*: as (*b*), but foreign pollen placed on stigma in addition to self-pollen already there.

spontaneous self-fertility was restored; in fact, in this respect the hybrids surpassed the commercial sample.

In the field, flowers may be pollinated by bees (similar to treatment *c*) or pods may be formed from unvisited flowers (as in treatment *a*). The results above suggest that although all types will be equally fertile after bee pollination, those plants arising from cross-fertilization in the previous year will set more seed from unvisited flowers than others in the population. As seed set in the absence of bee visitation must be entirely self-fertilized, this will mean that cross-bred plants will bear a higher proportion of selfed seed than plants derived from one or more generations of self-fertilization.

This unusual breeding behaviour has several important consequences :

(1) The ability of some plants to set seed on unvisited flowers ensures maintenance of the population even in years of low bee activity.

(2) The distribution of this self-set seed mainly on the more heterozygous members of the population restricts the rate of fixation of genetic variability under these conditions.

(3) The undiminished fertility of the inbred plants when pollinated by bees promotes rapid remixing of genetic material under favourable conditions.

The overall effect will be to maintain the population in a stable state of intermediate heterozygosity, in spite of disturbing factors such as seasonal variation in the level of bee activity, and the selective elimination of inbred plants under adverse environmental conditions.

The regulating mechanism described is of interest as it represents a means of maintaining a moderate degree of heterozygosity without complete dependence on insect pollinators.

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Cytogenetics of South American Orthoptera

THIS is a preliminary report of an investigation in progress dealing with cytogenetics of orthopteran insects of the southern hemisphere belonging to the family Acrididae and new to cytology. In this report the number of chromosomes is established, taking specially into account the existence of metacentric chromosomes. We have studied thirty-two species of four subfamilies, as shown in Table 1.

In *Aleuas brachypterus*, *Diponthus maculiferus*, *Ommaexecha servillei* and *Dichroplus pratensis*, the reduction of chromosome numbers has taken place by centric fusion of two acrocentric (rod-shaped) autosomes, whereas in *Tropinotus laevipes*, *Atrachalacris unicolor*, *Dichroplus bergi* and some forms of *D. pratensis* this evolutionary change took place between autosomes and sex chromosomes, producing in this case an XY–XX sex-determining mechanism by formation of a neo-Y, neo-X system in the male[1].

Table 1

Species	Diploid number $2n$ (♂)	No. of metacentrics	X-chromosome	No. of chromosome arms
Subfam. Acridinae				
Dichroatettix bohlsi (Giglio-Tos) Rehn	23	—	free	23
Hyalopterix rufipennis Charpentier	23	—	free	23
Staurorhectus longicornis G. Tos	23	—	free	23
Scyllinops bruneri (Rehn)	23	—	free	23
Scyllinops pallida (Bruner)	23	—	free	23
Rhammatocerus pictus (Bruner)	23	—	free	23
Amblytropidia australis Bruner	23	—	free	23
Parorphula graminea Bruner	23	—	free	23
Orphulella punctata (De Geer)	23	—	free	23
Dichromorpha australis Bruner	23	—	free	23
Sinipta dalmani (Stal)	23	—	free	23
Laplatacris dispar Rehn	23	—	free	23
Metaleptea brevicornis adspersa (Blanch.)	23	—	free	23
Allotruxalis strigata (Bruner)	23	—	free	23
Subfam. Cyrtacanthacridinae				
Neopedies brunneri (Giglio-Tos) Heb.	23	—	free	23
Scotussa lemniscata (Stal) Lieb.	23	—	free	23
Aleuas brachypterus Bruner	19	4	free	23
Dichroplus punctulatus (Thumb)	23	—	free	23
Dichroplus conspersus Bruner	23	—	free	23
Dichroplus elongatus Giglio-Tos	23	—	free	23
Dichroplus bergi (Stal)	22	1	fused	23
Dichroplus pratensis (Bruner)	18	1	free	19
Dichroplus pratensis ?	18	5	fused	23
Dichroplus sp. (brachypteran form)	8	4	X–Y	12
Subfam. Romaleinae				
Xyleus fuscipennis (Bruner) Gistel.	23	—	free	23
Elaeochlora viridicata (Serville) Stal	23	—	free	23
Chromacris speciosa (Thunberg)	23	—	free	23
Zoniopoda tarsata cruentata (Blanch) Rehn	23	—	free	23
Tropinotus laevipes (Stal) Gistel	22	1	fused	23
Diponthus maculiferus (Walker) Stal	21	2	free	23
Atrachalacris unicolor	22	1	fused	23
Subfam. Ommexechinae				
Ommaexecha servillei Blanchard	21	2	free	23

Particularly interesting is the genus *Dichroplus*, which shows interspecific variation in the number of chromosomes. As Table 1 shows, there is a numerical series ranging from the ancestral karyotype $2n$ (♂) = 23 to the surprising number of $2n$ (♂) = 8. Some forms of *D. pratensis* give 18 diploid chromosomes, while the number of major chromosome arms is not reduced, remaining 23. Other forms of this genus, on the contrary, have also 18, but the number of arms is reduced to 19, which means that four chromosomes have probably been lost.

The rather striking extreme case is the brachypteran form of *Dichroplus* that shows eight diploid elements, meaning that eleven chromosomes had been lost of the original complex. In these individuals the sex chromosome does not behave as an odd element, since it is associated with a small chromosome so as to form a heterozygous acrocentric bivalent, segregating in the first meiotic division as an X–Y complex.

FRANCISCO A. SAEZ

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Montevideo, Uruguay.
Nov. 1.

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[1] White, M. J. D., "Advan. Genet", **4**, 267 (1951); "Animal Cytology and Evolution" (Camb. Univ. Press, 1954).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 12

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. J. M Zarek · "Behaviour of Materials in the Human Body".*

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p m —Dr W. Idris Jones: "Britain's Fuel and Power Prospects". (Clayton Memorial Lecture.)

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6.15 p m.—Dr J. F. Allan: "Effect of Roughness in Ship Resistance".

Tuesday, March 13

University College Hospital Medical School (at University Street, London, W.C.1), at 4.30 p.m.—Prof. C. Rimington, F.R.S.: "The Biosynthesis of Hæmoglobin" (Sydney Ringer Memorial Lecture).

Physical Society (in the Lecture Theatre, The Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Francis Simon, F.R.S.. "The Third Law of Thermodynamics—an Historical Survey". (40th (1956) Guthrie Lecture)*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Imperial College (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), at 5.30 p m.—Prof. Arthur Porter · "The Control of Processes". (Inaugural Lecture.)

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. de Dani: "The Use of Reinforced Plastics in the Chemical Industry and Some Chemical Problems Connected Therewith".

Wednesday, March 14

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p.m.—Mr. Michael Wyatt: "The Monadhliath Adamellite, Inverness-shire" (to be read by Dr. S. O Agrell); Mr. Scott Simpson: "On the Trace-fossil *Chondrites*".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5 15 p.m.—Dr. C L. Mallows. "Generalizations of Tchebycheff's Inequalities".

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. A. Shaw. "Refinery Utility Installations".

Malacological Society of London (at the Linnean Society, Burlington House, Piccadilly, London, W 1), at 6 p m.—Meeting on "Pelagic Mollusca—Swimmers and Drifters".

Society of Chemical Industry, Food and Microbiology Groups (at the Chemical Society, Burlington House, Piccadilly, London, W.1) at 6.30 p.m.—Dr. M Ingram, Mr. F J. H. Ottaway and Dr. J. B M. Coppock. "The Preservative Action of Acidic Substances in Foods".

Thursday, March 15

Physical Society, Optical Group (at Imperial College, London, S W.7), at 2 30 p m.—Annual General Meeting, followed by Scientific Papers.

Physical Society, Low Temperature Group (at the Royal School of Mines, London, S.W.7), at 4 p.m.—Dr. E. H. Putley and Mr Vernon Roberts. "The Properties of Semiconductors at Low Temperatures".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Meeting for Election of Fellows. 4 30 p.m.—Mr. R. G. West · "The Quaternary Deposits at Hoxne, Suffolk"; Mr. G. M. Brown: "The Layered Ultrabasic Rocks of Rhum, Inner Hebrides"

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr W. H Wilson: "An Account of the Exploration of the Avoca Mines, County Wicklow, Ireland"; Mr. D. G Armstrong: "The Design, Construction and Operation of a Laboratory Classifier".

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p.m —Scientific Papers.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. K Kuratowski "On the Topology of Continuous Complex-Valued Functions".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W.C 2), at 5.30 p.m.—Dr. C. D. J. Statham · "Underground Lighting in Coal Mines".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, W.1), at 6 p m —Mr. D. G. Ainley: "The High Temperature Turbo-Jet Engine"

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall, Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S W.1), at 6 p.m.—Mr. A. H. Thorneloe: "The Assessment of the Properties of Mortar and Plastering Mixes"; Dr. J. W. Skeen. "Mortar Plasticisers".

Royal Society of Tropical Medicine and Hygiene (at the Royal Army Medical College, Millbank, London, S.W.1), at 7.30 p.m.—Laboratory Meeting. Chairman: Prof. R. M Gordon, O.B E.

Friday, March 16

Society for Water Treatment and Examination (at Caxton Hall, Caxton Street, London, S.W.1), at 9 30 a.m.—Annual General Meeting and Scientific Papers.

British Association of Chemists (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6 p.m.—Mr. T. McLachlan: "The Analyst—Chemist, Technician or Magician?"

Institution of Mechanical Engineers, Industrial Administration and Engineering Production Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p m.—Discussion on "The Development of Automatic Control in Industry".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C 2), at 7 p m.—Annual General Meeting. 7.30 p.m.—Dr. J. D. Johnson: "Continuous Counter-Current Distribution of Batches of Material".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. W. Grey Walter: "The Imitation of Mentality".

Saturday, March 17

British Mycological Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10 30 a.m.—Meeting on "Yeasts".

British Psychological Society (in the Gustave Tuck Theatre, University College, Gower Street, London, W C 1), at 2 30 p.m —Dr. L Weiskrantz · "Some Effects of Temporal Lobe Lesions on Behaviour in Monkeys"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (preferably with a degree in one of the natural sciences) in Charge of the Natural Sciences Library—The Registrar, University College, Singleton Park, Swansea (March 17).

Senior Scientific Officer (with a degree of high standard, with chemistry as a major subject, and several years research experience, and preferably with a knowledge of paint technology) in the Defence Standards Laboratories, Department of Supply, Maribyrnong, Victoria, Australia, for research and developmental work in connexion with paints, such as the study of methods of measuring the properties of paint films and changes in properties during ageing and weathering, the study of the protection of metals by primers, underwater protection of ships and anti-fouling paints—The Senior Representative (AP.45), Department of Supply, Australia House, Strand, London, W.C.2 (March 19).

Forestry Assistant (with a recognized degree or certificate in forestry) for duties which will include the preparation of Tree Preservation Orders and planting schemes, management of woodlands, consideration of felling licence applications and general liaison with the Forestry Commission—The Planning Officer, Peak Park Planning Board, Aldern House, Bakewell, Derbyshire (March 21).

Research Worker (with an honours degree in biochemistry or equivalent qualification) in the Department of Biological Chemistry, to assist in work on the metabolism of the autotrophic nitrifying bacteria—Prof. W. O. Kermack, Department of Biological Chemistry, Marischal College, Aberdeen (March 24).

Scientific Officer (with a good honours degree in science) in the Cereals Section, to engage in genetical, physiological and breeding research, and an Assistant Experimental Officer (with a degree in agriculture or horticulture) for duties as Glasshouse and Plot Manager—The Secretary, Plant Breeding Institute, Trumpington, Cambridge (March 26).

Lecturer in the Department of Fluid Mechanics—The Registrar, The University, Liverpool (March 29).

Lecturer (with an honours degree and practical experience in public works engineering) in Civil Engineering—The Registrar, The University, Leeds 2 (March 31).

Lecturer or Assistant Lecturer in Agricultural Zoology, and a Lecturer or Assistant Lecturer in Crop Husbandry at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 2).

Senior Lecturer (with a good academic qualification, and wide teaching and/or research experience, in tropical agriculture) in Tropical Agriculture at Kumasi College of Technology—The Appointments Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 1 Woburn Square, London, W.C.1 (April 7).

Chair of Medicine at St Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 19)

Chair of Physical Chemistry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 20).

Imperial Chemical Industries Research Fellows in Chemistry, Physics and allied subjects, for example, pharmacology, engineering and metallurgy—The Registrar, The University, Manchester 13 (April 30).

Keeper of the Department of Archæology—The Director, National Museum of Wales, Cardiff (April 30).

Lecturer (entomologist, preferably with research interest in insect pests of stored products in the tropics) in Zoology at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (April 30)

Professor of Mechanical Engineering at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 30).

Senior Lecturer in Inorganic Chemistry at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

Lecturer (with practical experience of forestry in Great Britain) in the Department of Forestry—The Secretary, The University, Edinburgh (May 31)

Professor of Agriculture, and a Professor of Botany, at the Imperial College of Tropical Agriculture, Trinidad, British West Indies—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 1).

Aerodynamicists and Mathematicians (with a first- or second-class honours degree or equivalent, and preferaby with some research or development experience) with the Ministry of Supply at various Experimental Establishments and London Headquarters, for research and development work on aircraft projects, performance analysis of aircraft and weapons, statistics and operational research, guided weapons, gas turbines—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.69/6A/AA.

Demonstrator in Chemistry (inorganic, organic and physical)—The Secretary of University Court, The University, Glasgow.

Engineers and Physicists (particularly with electronics), Senior Scientific and Scientific Officer grades (with a first- or second-class honours degree or equivalent high professional attainments) at Royal Naval Scientific Service Experimental Establishments chiefly in the Weymouth and Portsmouth areas, and the Home Counties—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.344/5A.

Lecturer in Physical Testing of Rubber-like Polymers, and a Senior Lecturer in Plastics Technology—National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

Master to teach Mathematics up to university scholarship standard—The Headmaster, Trent College, Long Eaton, Nottingham.

Principal Scientific Officer (with a first- or second-class honours degree in physics or electrical engineering, and considerable experience of servo systems and other electrical mechanical devices) at the Royal Aircraft Establishment, Farnborough, to lead a section engaged in research and development of automatic flight controls—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.76/6A/AA.

Research Assistant (with a special interest in plant physiology) in Botany—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

Scientific Officer (Chemist), Assistant Experimental Officer (Chemist), and an Assistant (Scientific), in the Metropolitan Police Laboratory—The Secretary, Room 165, New Scotland Yard, London, S.W.1.

Technician (preferably with some experience in geology) for research in micropalæontology—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Geology/B.P.'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Broadcasting Corporation: Engineering Division. Monograph No. 4: The Design of a Ribbon Type Pressure-Gradient Microphone for Broadcast Transmission. By D. E. L. Shorter and H. D. Harwood. Pp. 22. (London: British Broadcasting Corporation, 1955.) 5*s*. [21

Bulletin of the British Museum (Natural History). Botany. Vol. 1, No. 8: The Heterophyllous *Selaginellae* of Continental North America. By A. H. G. Alston. Pp. 219–274+plates 5 and 6. (London: British Museum (Natural History), 1955.) 16*s*. [21

General Register Office. Census 1951—England and Wales. Index of Place Names. Vol. 1: A–K. Pp. iv+1–654. Vol. 2: L–Z. Pp. 655–1377. (London: H.M. Stationery Office, 1955.) 63*s*. net the two volumes. [21

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 663, Vol. 239 (22 December 1955): The Decomposition of Some Organophosphorus Insecticides and Related Compounds in Plants. By D. F. Heath, D. W. J. Lane and P. O. Park. Pp. 191–214. 7*s*. 6*d*. No. 664, Vol. 239 (22 December 1955): The Ammonite Succession in the Lower Oxford Clay and Kellaways Beds at Kidlington, Oxfordshire, and the Zones of the Callovian Stage. By J. H. Callomon. Pp. 215–264+plates 2 and 3. 19*s*. (London: Royal Society, 1955.) [21

Discovery Reports. Vol. 28, Pp. 1–190: Mysidacea. By Dr. Olive S. Tattersall. (Cambridge: At the University Press, 1955. Issued by the National Institute of Oceanography.) 65*s*. net. [21

National Parks and Access to the Countryside Act, 1949. Sixth Report of the National Parks Commission for the year ending 30th September, 1955. Pp. iv+60+8 plates. (London: H.M. Stationery Office, 1955.) 4*s*. net. [41

The Nature Conservancy. Report of the Nature Conservancy for the year ended 30th September 1955. Pp. iv+56+12 plates. (London: H.M. Stationery Office, 1955.) 4*s*. net. [41

Home Office; Scottish Home Department. Manual of Civil Defence. Vol. 1, Pamphlet No. 1: Nuclear Weapons. Pp. iv+55 (24 plates). (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [161

N. A. Bulganin and N. S. Khrushchov—Full Texts of Speeches and Statements in India, Burma and Afghánistan. Pp. 47. (London: Soviet News, 1955.) [181

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute (University of London). Report of the 30th meeting of the Ross Institute Industrial Advisory Committee, 17th November, 1955. Pp. 28. (London: Ross Institute Industrial Advisory Committee, 1955.) [181

National Union of Teachers. The School Meals Service. Pp. 36. (London: National Union of Teachers, 1955.) [181

Building Research Station Digest No. 83: Index to Building Research Station Digests Nos. 1 to 82. Pp. 6. (London: H.M. Stationery Office, 1955.) 3*d*. [181

Linen Industry Research Association. Report of the Council, 1955. Pp. 20. (Lambeg, Belfast: Linen Industry Research Association, 1955.) [181

West African Cocoa Research Institute. Technical Bulletin No. 3: The Propagation of Cacao by Cuttings. By J. F. Archibald. Pp. 6+6 plates. (London: Crown Agents for Oversea Governments and Administrations, 1955.) 1*s*. 6*d*. [181

University of Cambridge School of Agriculture Memoirs: Memoir No. 27: A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organizations during the period Oct. 1st, 1954–Sept. 30th, 1955. Review Series No. 10: Crop Husbandry Experiments in Cambridge. By F. Hanley. Pp. 30. (Cambridge: School of Agriculture, 1956.) 3*s*. [181

British Hat and Allied Feltmakers Research Association. Eighth Annual Report of the Director of Research for year ending August, 1955. Pp. 23. (Manchester: British Hat and Allied Feltmakers Research Association, 1955.) [181

Other Countries

Report of the King Institute of Preventive Medicine, Guindy, for the period from 1st April 1952 to 31st March 1953. By Dr Y. S. Narayana Rao. Report of the Government Analyst, Madras. By Sri S. Narayana Ayyar. Pp. 142+2. (Madras: Government Press, 1955.) [161

American Association for the Advancement of Science and participating affiliated and associated societies. General Program—Directory, Atlanta Meeting, December 26–31, 1955 (122nd meeting of the Association). Pp. 352. (Washington, D.C.: American Association for the Advancement of Science, 1955.) [161

Annalen van de Sterrewacht te Leiden. Deel 20, Zestiende Stuk, Uitgegeven door de Directeur der Sterrewacht, Prof. Dr. J. H. Oort. Thirty New Short-Period Variable Stars in a Region Around CPD–31° 5547. By J. Ponsen. Discussion of Fifty Long-Period Variable Stars in a Region Around CPD–31° 5547. By J. Ponsen. Pp. 383–418. (Leiden: Staatsdrukkerij- en Uitgeverijbedrijf, 1955.) [161

Bulletin of the Astronomical Institutes of the Netherlands. Vol. 12, No. 461 (December 3, 1955): 400 Mc./s Partial Eclipse Observations on 30 June 1954. By C. L. Seeger. Pp. 273–284. (Communication from the Netherlands Foundation for Radio Astronomy and the Observatory at Leiden.) (Leiden: The Observatory, 1955.) [161

Proceedings of the American Academy of Arts and Sciences. Vol. 83, No. 6: Thermodynamic Relations in *n*-Variable Systems in Jacobian Form. Part 2: Polyphase Polycomponent Chemical Systems. By F. H. Crawford. Pp. 191–222. (Cambridge, Mass.: American Academy of Arts and Sciences, 1955.) [161

Segundo Catalogo General de Colecciones Micologicas Latino Americanas. Pp. 111. (Montevideo: Centro de Co-operación Cientifica de la Unesco para América Latina, 1955.) [161

Food and Agriculture Organization of the United Nations. Problems of Food and Agricultural Expansion in the Far East. Pp. viii+78. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1955.) 3*s*. 9*d*. [181

Annuaire pour l'An 1956, publié par le Bureau des Longitudes, avec un Supplement pour l'An 1957. Pp. viii+729. (Paris: Gauthier-Villars, 1956.) [181

British Caribbean Meteorological Service. Annual Report, 1954. Pp. 11. (Trinidad: British Caribbean Meteorological Service, 1955.) [181

Council of Scientific and Industrial Research, New Delhi. Rain-Making: Its Present Position and Future Possibilities. By A. K. Roy. Pp. iii+31. (New Delhi: Council of Scientific and Industrial Research, 1955.) [181

Proceedings of the United States National Museum. Vol. 103, No. 3335: On the Anatomy and Relationships of Glossy Cuckoos of the Genera Chrysococcyx, Lampromorpha, and Chalcites. By Andrew J. Berger. Pp. 585–597. Vol. 104, No. 3347: Fishes of the Family Percophididae from the Coasts of Eastern United States and the West Indies, with Descriptions of Four New Species. By Isaac Ginsburg. Pp. 623–639. Vol. 105, No. 3351: An Anatomical Study of the Peregrine Megascolecid Earthworm *Pheretima Hupeiensis* in the Eastern United States. By William C. Grant, Jr. Pp. 49–63. Vol. 105, No. 3356: Populations of the Berycoid Fish Family Polymixiidae. By Ernest A. Lechner. Pp. 189–206. (Washington, D.C.: Smithsonian Institution, U.S. National Museum, 1955.) [181

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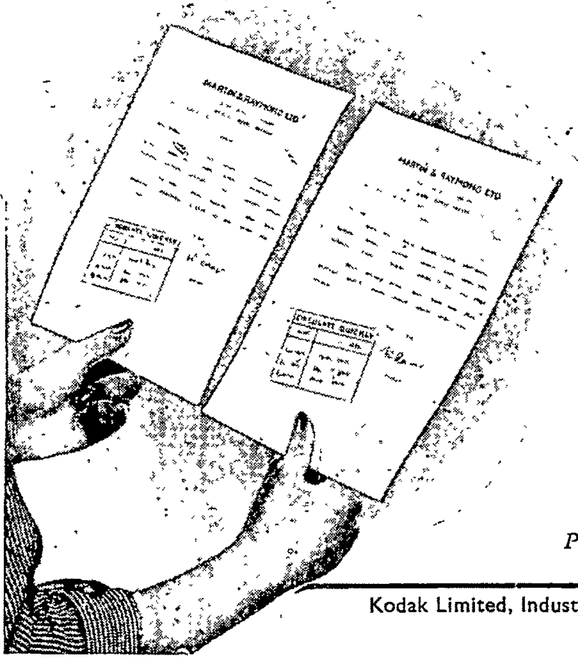

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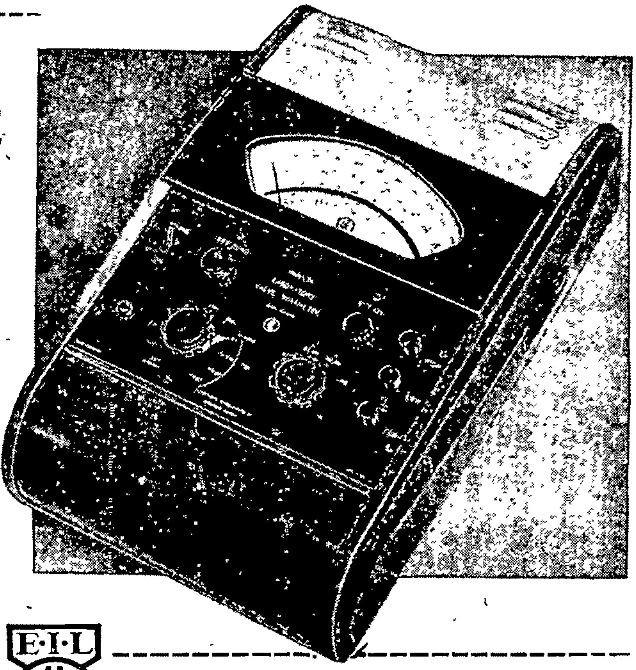

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SAFETY AND HEALTH IN INDUSTRY

THE annual reports of the Chief Inspector of Factories are primarily of interest to those directly concerned with health and safety in industry in Britain, and in so far as both health and safety depend increasingly on the knowledge and co-operation of the scientist, these reports are invariably of scientific interest. They often, however, are of a wider scientific or technical interest, as is well illustrated by the latest of these reports, that for the year 1954*. While particular and general trends in safety in health, welfare and hours of employment are reviewed in sections of the report devoted to these subjects, they are preceded by an introduction which gives a most useful survey of industrial developments during the year, bringing out a number of features of special interest to the scientist as well as to the technologist.

It is not surprising to find that the report notes that the factory population was the highest yet recorded in times of peace; but the number of power factories registered at the end of the year was 212,909, as against 214,020 at the end of the previous year, and the number of non-power factories also decreased from 21,032 to 18,955. The increase in the total number of persons employed is due to increases in the number of medium- and larger-sized factories, and for the second time since the War there was an appreciable increase in the total number of accidents —in factories from 158,597 to 161,458—but the accident-rate was slightly less. Doubt is expressed as to whether the same attention is being given to the training of women and girls as is given to that of men and boys, and while the importance of the human factor in accident prevention is far more widely realized than formerly, this report brings out well the supreme importance of management in effective organization for preventing accidents.

This is a point where the scientist or the technologist is directly concerned. It is not so much that his knowledge is required in devising appropriate measures, as that his interest is a vital factor in obtaining the necessary enthusiasm on the part of the works manager, the shed superintendent, the foremen and supervisors. Unless that is secured, it is almost impossible to make the worker himself aware of the part he can and should play in preventing accidents. In the present man-power situation, the elimination of loss of man-power due to accidents or sickness is of fundamental importance to Britain's economic effort, quite apart from those humanitarian considerations which will normally prompt every scientist or technologist to play his full part in preventing avoidable human suffering. The growing shortage of skilled and technically qualified workers during the past four years has enhanced the importance of training schemes for apprentices and others, and such training for production should never be divorced from training for safety. From the same economic consideration, the evidence presented in this report that the accident-rates for those aged sixty or more are less than for those in the prime of life is of general interest; but it should also be noted that quite small adjustments may make the lot of the elderly worker more comfortable and even safer. Apart from the slight contribution thus made to improving the man-power situation, such adjustments often have the further advantage that the older workers can retain their usual jobs with efficiency.

The importance of minor improvements in Britain's man-power resources is the more apparent in the light of the trends in industrial development stressed in this report. For example, trends in the design of factory premises are in the direction of single-story buildings with wide-span roofs; the particular example cited of retort houses in the gas industry, in which the gas producers are now built separate from, instead of integral with, the retorts, gives, with welded portals, a clear and unobstructed working space, and much improved lighting and ventilation, so providing conditions which are particularly helpful for the older worker. Again, the modern tendency to house chemical plant in a light weather-proof structure, besides being economical, greatly reduces the risk of explosion due to accumulation of inflammable dust or gases, while since much of this plant is remotely controlled and there are no men working full-time on it, no hardship is caused to operators. The report also emphasizes that mechanization of production continues to increase, particularly in industries in which raw or finished materials are handled in bulk, and sometimes the whole pattern of the manufacturing process is altered in consequence, while in a wide range of industry continuous methods are replacing batch processes.

Some of these last provide examples of one of the two particular trends to which the report directs attention. Methods of automatic production in one form or another have been a growing feature of industrial development for many years, and the real novelty of the present phase known as 'automation' lies in developments in the field of electronics during and since the Second World War. These, in turn, have led to entirely new conceptions of the master control of machinery and processes by means of a device called a computer, one type of which will issue predetermined 'orders' fed into it by means of punched-paper tape or magnetic tape. In this way, the operation of a machine or a series of machines may be controlled, quite independent of human intervention, to ensure that the final product comes up to specification.

The uses of automation, however, are not confined to the machine shop. It is beginning to appear, for example, in the manufacture of petroleum chemicals, where the levels of liquids in large tanks or other containers can be accurately controlled, variations caused by fluctuating input or output being compensated. Further, it is possible in some cases by electronic means to draw off samples at various stages of the process, analyse them automatically and record the analyses by graphical means, the whole process being conducted on an instrument plant which may be several hundred yards away from the plant.

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* Annual Report of the Chief Inspector of Factories for the year 1954. Pp. 265. (Cmd. 9505.) (London: H.M. Stationery Office, 1955.) 8s. net.

We are only at the beginning of such developments, but the report does not encourage excessive claims for the speed with which the automatic factory will be introduced. It is stated that automation has a considerable future in Britain for mass-production work, where long lines of the same type of product can be assured by public demand ; but even in these fields no drastic overnight change is envisaged, and the automatic factory, full of complicated machinery controlled by only a few people, will take a long time to develop. None the less the importance of these trends has been noted by thoughtful people, and the whole subject is receiving serious consideration by those responsible for the future pattern of industry. The Factory Department believes that automation will eventually enhance the cleanliness as well as the safety of the factory. Automatic handling, too, is bound to increase and should eliminate many accidents in handling goods and materials.

While the report points out that, without an increase in shift working, automation would be uneconomic, it does not otherwise touch on the two most important implications of such developments. The first is one that is emphasized elsewhere in the report in discussing accident prevention. Just as the latter demands the full co-operation and understanding of the workers themselves, so the introduction of automation demands the co-operation and understanding of all those affected. It is not simply a matter of gaining their consent to shift-working. It means equally that the implications of redundancy and the transfer of labour, and not least the educational issues, must be fairly faced and frankly discussed with all concerned.

There is evidence enough in this report to show that not all managements have appreciated the importance of such co-operation and understanding even in relation to accident prevention. If Britain is to benefit to the full from the possibilities of automation, and to hold her position in competition with other nations who are adopting such methods, we must make full use of the breathing-space that the slow rate of introduction predicted in this report affords us to prepare the way for the changes and adjustments that will be required. The remarks on this subject should be weighed alike by trade unions and managements.

The implications of automation for technical education require particularly careful consideration ; no plans for the expansion and development of the technical colleges are adequate for Britain's economic future if, in concentrating on the supply of technologists or even technicians, they ignore the needs of some measure of technical education for an increasing proportion of the operatives in industry. Here again is a matter demanding urgent attention, and much keener thinking than it appears to have received as yet. Its importance, moreover, is also emphasized by some of the comments in this report on the second of the particular trends in industrial developments which are noted, as well as in the remarks on the extension of electric supply and the use of electricity.

This second trend is the development of radiology in industry. This section of the report demonstrates more clearly than any other both the dependence of safety on the vigilance and co-operation of the scientist and technologist and the importance of technical education for those called upon to handle the apparatus and processes involved. The increasing use of gamma-ray radiographic sources seems to have supplemented rather than supplanted the use of X-rays for the radiography of castings and welds, and it is satisfactory to note that in recent years very few gamma-radiographic rooms newly built or specially adapted for the purpose have failed to meet the standards of the Factory Department. The rapid development of the electronics industry has increased the need for equipment incorporating piezo-electric quartz crystals serving as oscillators, resonators and frequency standards, and the cutting of these quartz crystals in the correct orientation depends largely on the use of X-ray crystallographic test equipment ; the precautions to be taken in using this equipment were reviewed during the year in collaboration with the X-ray Analysis Group (Equipment Sub-Committee) of the Institute of Physics. As a result, the appropriate section in the Department's pamphlet, "Precautions in the Use of Ionizing Radiations in Industry", was revised when the pamphlet was reprinted in August 1954.

Iridium-192 continues to be the source most commonly used in industry for gamma-radiography. Use of tantalum-182 has practically disappeared, and thulium-170 has only gained slightly in popularity. Cobalt-60 provided the strongest gamma-ray sources used during 1954 in Britain for the radiography of castings and welds. The increasingly powerful sources of gamma-radiation being used by industry require corresponding advances in the design of their protective and operating containers, and during the year two manufacturers marketed new models of containers suitable for use with cobalt-60 sources up to about 10 curies in strength. Some incidents occurred during the year in connexion with radiographic sources and other radioactive materials, fortunately without serious consequences, though affording valuable lessons, of which due notice is being taken in considering statutory regulation. In view of the unique way in which radioisotopes can be used industrially to follow the mechanism of chemical, physical, engineering and biological processes, it is surprising how few uses are made of these materials as tracers in premises coming strictly under the Factories Acts. In this field the research laboratories attached to factories and the research stations of the Department of Scientific and Industrial Research have been far more active, and in various studies, including the location of gas leaks, the travel of coal in retorts, paint sedimentation, metal extrusion and electroplating and mould metabolism, some eighteen radioisotopes are listed as having been used.

The scientific interest of the Factory Department's work is particularly apparent in such recent developments, though it is equally to be seen in the Department's research work designed to limit the dangers of explosions of dust, carried out in collaboration with the Department of Scientific and Industrial Research at the Safety in Mines Research Station, Buxton. Here attention is being turned, at the request of the Central Electricity Authority, to the problem of protecting the pulverized fuel plant used in power stations. Schemes of research with the object of limiting the explosions of gas and vapour have also been prepared, and it is hoped that they will be put into operation shortly, with the co-operation of the Department of Scientific and Industrial Research and the Ministry of Fuel and Power.

One encouraging feature of the report in regard to health in industry is that the general improvement in working conditions—such as cleaner premises, lighter and more cheerful surroundings, better washing and cloakroom facilities—is gradually changing the attitude of the operatives. They are tidier in themselves and more appreciative of the amenities provided. Most firms go well beyond legal requirements in regard to working conditions, though much could still be done to provide more comfortable conditions if thought were given to the use of modern equipment, to the provision of thermal insulation for the building and to the prevention of draughts. Substantial progress has also been made in the provision of natural and artificial lighting, and here again, while the scientific and technical expert has his part to play and perhaps is especially responsible for the initiative, the really encouraging feature is the evidence that the operatives respond when management takes the lead and seeks to stimulate their interest.

The report of the Chief Inspector of Factories makes it abundantly clear that the scientist and technologist have a decisive contribution to make to safety and health in industry, and that contribution is not made solely or even mainly through the 361 inspectors employed by the Factory Department, to the quality of whose work, efficiency and tact the report bears impressive witness. Industrial safety and health, like industrial efficiency, depend even more on the unceasing vigilance of the chemist, the physicist and the engineer, employed in industry at whatever level from works manager to process control, research, testing or construction. Much depends on their insight and initiative, their ability to co-operate with foremen and supervisors and operatives, and, though it is true that the Factory Department is finding difficulty in recruiting staff to fill its existing vacancies, it is not only as factory inspectors that those with scientific and technical qualifications can find expression for their concern for human welfare in industry. It is from within industry, by and large, that the attitude of management must be changed where necessary, not simply to fulfil existing requirements or to conform to the best practice rather than the legal minimum, but still more to undertake the constructive thinking that the adoption of new methods such as the change-over from batch to continuous processing, the introduction of new materials and new techniques like radioactive tracing, and, even further, the use of electronic and fully automatic methods demand.

The report gives no reason for doubting that it is possible to secure the necessary co-operation of the workers and their unions; but it will not be done without frankness, clear thinking and openmindedness on the part of unions as well as management. The Chief Inspector of Factories suggests that we still have time for such thinking, and for making adequate preparations for the changes required. This report for 1954 is valuable for the glimpse it gives of some of the problems which Britain must face if she is to adapt her economy to an age in which automation, nuclear power and radiology play an increasing part in industrial development. It is above all to be valued for its challenge both to unions and managements to face those implications as a matter of urgency, and to work out in co-operation and as expeditiously as possible the changes in industrial practices and in technical education which are required to enable Britain to enjoy the full benefits of technological advance with the minimum disturbance to industry or society.

FREUD'S "INTERPRETATION OF DREAMS"

The Interpretation of Dreams
By Sigmund Freud. (Translated from the German and edited by James Strachey.) Pp. xxxii + 692. (London: Allen and Unwin, Ltd., 1954.) 21s. net.

FREUD always looked on "The Interpretation of Dreams" as his most important work. This and the "Essays on the Theory of Sexuality" were the two publications that he regularly strove to keep up to date as fresh editions were required. Substantial additions and omissions, sometimes even entirely new sections, progressively appear in the seven German revisions, and Mr. James Strachey's version is in effect a *variorum* edition: every important departure from the original text is clearly indicated and dated, so that the inquiring reader is enabled to trace the gradual evolution of Freud's views.

The editor has furnished a long and valuable introduction, with illuminating quotations from Freud's own letters written both before and after the book appeared. As early as 1895, five years before it was published, Freud relates how, "not long ago, I was obliged to exchange my usual bed for a harder one; and, having as a result more numerous and more vivid dreams, I took the trouble to write them out and tried to solve them". A few months later he set down on paper a "Project for a Scientific Psychology" (recently published as an appendix to his correspondence with Fliess); and in the concluding part of the manuscript he sketches his first attempt at a coherent theory of dreams. Here he put forward the novel and epoch-making suggestion that permeates the book itself, and so many of his later writings, namely, the close analogy between the mental mechanisms underlying dreams and those underlying neurotic symptoms.

One of the chief difficulties felt by the academic psychologist in assessing Freud's theory springs, as Mr. Strachey points out, from the fact that many of its basic concepts—"mental energy", "sum of excitation", "cathexis", and the like—are left undefined. In the "Project", however, we learn that "scientific psychology", as Freud originally conceived it, was to be formulated in terms of the anatomical doctrine of the neurone, which had recently been developed by German neurologists. This he proposed to combine with Helmholtz's doctrine that neural activity, like other physiological processes, must be interpreted in accordance with the principles of the conservation and transformation of energy. An inevitable corollary was the postulate of strict determinism which underlies his whole theory of dreams.

The working model elaborated on this twofold basis was curiously like that independently suggested by William McDougall in Britain a few years later. But, like McDougall, Freud quickly discovered that, when dealing with the mental processes of the individual, the only intelligible description would be one that is expressed in psychical rather than physiological terms. This radical change, as both writers recognized, involved the assumption that some of the most important processes in the mind must be regarded as wholly unconscious—a doctrine which eventually became the keystone of all Freud's theories. Accordingly, in "The Interpretation of Dreams" we no longer hear of "nervous excitation" flowing across the "contact-barriers" that separate one system of neurones from another, but of unconscious "wishes" tending automatically to fulfil themselves in the face of unconscious "resistance". But, despite this drastic change in vocabulary, the structural pattern attributed to the mind remains much the same as in the scheme originally outlined for the earlier interpretation in anatomical terms. Mr. Strachey, both in his introduction and in his explanatory footnotes, works out the parallel in some detail; and his explanations do much to elucidate the obscurer and more paradoxical features of Freud's own exposition.

Freud's style, as he himself realized, is tortuous and abstruse, with "involved and trailing sentences, bolstered up with sidelong glances and indirect phrases" (his own self-criticism). Mr. Strachey's translation, which is entirely new, skilfully surmounts the difficulties thus presented to the English-speaking student. At times the puns, the associations, the colloquial *double entendres*, on which many of the interpretations turn, are so peculiar to the German tongue that previous translators in despair have omitted many of the most typical dreams and even substituted examples of their own, either genuine or invented *ad hoc*. Mr. Strachey, quite rightly, has decided to keep scrupulously to Freud's own narrative, quoting and annotating the German where occasion demands. The index, bibliographies and supplementary notes are invaluable. As a result, both the psychological specialist and the general reader now have available a richly documented edition of what is after all one of the most original contributions to science published during the present century.

Cyril Burt

ANTIBIOTICS

Antibiotics Annual, 1954–1955

Proceedings of the Second Annual Symposium on Antibiotics. Edited by Dr. Henry Welch and Dr. Felix Marti-Ibañez. Pp. ix+1154. (New York: Medical Encyclopedia, Inc.; London: Interscience Publishers, Ltd., 1955.) 10 dollars.

Assay Methods of Antibiotics

A Laboratory Manual. By Dr. Donald C. Grove and Dr. William A. Randall. (Antibiotics Monographs, No. 2.) Pp. xxvi+238. (New York: Medical Encyclopedia, Inc.; London: Interscience Publishers, Ltd., 1955.) 5 dollars.

FOR anyone with an unsated appetite for new literature on antibiotics, the first of these volumes will indeed come as a bumper annual. This formidable mental meal constitutes the proceedings of the Second Annual Symposium on Antibiotics held in Washington, D.C., in October 1954. In format and content it is virtually indistinguishable from *Antibiotics and Chemotherapy* and *Antibiotic Medicine* and is, in fact, produced under the same auspices as these two journals. With more than 1150 pages and 172 papers, it almost equals in size their combined output for the year 1955 and clearly comprises a sizable part of the current literature on antibiotics. It is a pity, therefore, that those not attending the symposium had to wait some eight months—at any rate in Britain—for these admittedly well-produced proceedings.

The subject of antibiotics seems still to be in the exponential stage of development—no doubt because growth is plentifully nourished by dollars—and this volume gives an interesting cross-section of the subject towards the end of 1954. Thus, antibiotics are reported to be active *in vitro* or effective *in vivo* not only against a widening range of bacteria but also against viruses, yeasts, fungi, protozoa, and even tumour cells. Fourteen new antibiotics are reported. Many clinical papers deal with the use of established or newer antibiotics or of combinations of them with each other or with hormones or drugs, in a variety of maladies. Nearly fifty papers deal with some aspect of the tetracyclines. There is a timely summary of the untoward effects of the indiscriminate use of antibiotics, and a plea for the better training of physicians and medical students in their rational use. Greatly enhanced requirements are foreshadowed by the papers dealing with their place in veterinary medicine, animal husbandry and horticulture. All but seven of the papers are by Americans, though representatives of thirty-five nations were said to have attended the symposium.

The second of the volumes under review, instead of offering yet more new facts and theories about antibiotics, presents a neatly digested résumé of reliable methods for their assay, detection and testing. The names of the authors, and the fact that they write from the Antibiotics Division of the United States Food and Drug Administration, inspire confidence in the methods even when they are not the official Administration methods, and this confidence is enhanced the more one studies the book. The attitude is, not unnaturally, uncompromisingly American, and of the thirty-five references cited only two originate outside the United States. It follows that one will look in vain for certain methods much used in Britain, such as microbiological assays on large plates.

Successive chapters are devoted to penicillin, streptomycin, the tetracyclines, chloramphenicol, bacitracin, tyrothricin, polymixin, neomycin, erythromycin, carbomycin, viomycin, fumagillin, nystatin and anisomycin. Each chapter (with some exceptions) has four sections, dealing in turn with microbiological methods of assay, physical and chemical methods, assay of salts and pharmaceutical preparations, and determination in body fluids, tissues and animal feeds. Next follow chapters on the assay of mixtures of antibiotics—sixty-three mixtures are listed, mostly containing two active components—and on the identification of antibiotics by qualitative tests, by infra-red and ultra-violet absorption spectra (thirty-seven such spectra are given) and by optical and crystallographic properties. The procedure and specified amounts of various preparations to be used in toxicity, pyrogenicity and sterility tests; the determination of bacterial sensitivity to antibiotics; a chapter of miscellaneous tests and methods; and a list of media, buffers, reagents and apparatus conclude this unique book.

Discussion, where it occurs, is informative and brief; practical instructions are admirably clear and concise. Although, as mentioned, this book is selective and American in outlook, it contains a very large amount of useful information which it would be almost impossible to track down in the literature. One suspects that a good deal of it is being published here for the first time and is drawn from a critically accumulated store of experience. Anyone concerned with antibiotic assay or the other aspects covered here—whether through active interest or reluctant compulsion—will turn to this book with gratitude, tempered perhaps with momentary irritation that a method he values may not even be mentioned.

N. G. HEATLEY

MEASUREMENT AND APPLICATION OF NUCLEAR MOMENTS

Nuclear Moments

By Prof. Norman F. Ramsey. (Reprinted in part from Segrè (Editor), Experimental Nuclear Physics, Vol. 1.) Pp. x+170. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 40*s*. net.

PROF. N. F. RAMSEY'S book on nuclear moments gives for the first time a comprehensive account of a series of experimental methods, the rapid development of which since 1945 has contributed so much to our knowledge of nuclear physics, of the solid state and of chemistry. Starting with two short chapters dealing with the elementary theoretical aspects of the interactions between nuclear moments and the electromagnetic field, he soon launches into an admirably lucid account of the various methods now available for the measurement of these interactions. Through a happy use of example and diagram, the author manages to translate his reader into the laboratory where he can see for himself, and compare, these various methods.

The final two chapters deal with the results of measurements of nuclear moments. The first of these includes a table of all nuclear moments determined up to 1952 and a brief discussion of shielding corrections. The second was added at a later date to the original version of the book, which was published as part of Vol. 1 of "Experimental Nuclear Physics", edited by E. Segrè. This deals exclusively with the many exciting applications of these techniques to chemistry and the physics of the solid and liquid states. It would be hard to find a more brilliant refutation of those who bewail the imagined fragmentation of science than this final chapter.

One thing only tends to mar an otherwise delightful presentation, namely, the hesitant way in which concepts are introduced in the early part of the book, sometimes very fully defined and sometimes completely undefined. Thus, for example, the vector J is introduced on p. 4, but is nowhere defined as being the resultant angular momentum of the extra-nuclear electrons. Similarly, on p. 29 a selection rule for the emission and absorption of radiation is introduced without a word of explanation, although many less difficult concepts are explained with great elaboration.

Notwithstanding this criticism, Prof. Ramsey's book will remain for many years as a standard reference work for those who wish to refresh their minds on some aspect or other of the measurement of nuclear moments and their applications, and in this respect the long list of references will be invaluable. The printers and binders have done an excellent job.

B. H. FLOWERS

COLOUR TELEVISION

An Introduction to Colour Television

By G. G. Gouriet. Pp. 72. (London: Norman Price (Publishers), Ltd., 1955. Published for the Television Society.) 8*s*. 6*d*. net.

THIS book is based on two lectures delivered to the Television Society in 1954 by G. G. Gouriet, who is on the research staff of the British Broadcasting Corporation. The first part gives an elementary introduction to tricolour analysis and synthesis, leading up to the proposition that, since three variables are needed to specify a colour sensation, the basic problem is the relatively simple one of conveying three pieces of information simultaneously. While the principle was demonstrated as long ago as 1928 by J. L. Baird, and made into a workable field-sequential system in the United States, the practical difficulties of fitting it into the existing framework of broadcasting are considerable.

The second part of the book explains the system devised by the National Television System Committee, which is 'compatible' (that is, able to give an ordinary picture with receivers not adapted for colour), and can operate within the necessarily restricted bandwidth limits. This requires two signals on two carrier waves, one of which, the luminance signal, provides the compatible picture. The other carries two colour-difference signals corresponding to co-ordinates on the chromaticity diagram, the double task being effected by making the two independent modulations 90° out of phase with one another. For this purpose the axes of the chromaticity diagram are shifted, so that instead of working in terms of primaries one signal operates along the orange–cyan line of the diagram and the other along the green–magenta line.

After explaining the principles adopted by the National Television System Committee, Mr. Gouriet describes briefly the technical details of colour analysis in the tricolour camera by means of dichroic mirrors, and various means of colour synthesis at the receiving end. These include the three-tube method using dichroic mirrors, the shadow-mask system with a tricolour phosphor mosaic, and the Lawrence tube which is effectively a linear shadow-mask device. Finally, mention is made of the Valensi system, in which colour discrimination comparable with that of the eye is achieved (possibly more simply for transmission purposes) by treating the chromaticity diagram as a finite number of colour patches instead of a continuum.

The book is admirably illustrated in colour, and is very reasonably priced. It leaves one wishing one could have heard the original lectures.

G. R. Noakes

DYESTUFFS CHEMISTRY

The Chemistry of Synthetic Dyes and Pigments

Edited by H. A. Lubs. (American Chemical Society Monograph Series—No. 127.) Pp. xiv+734. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 148*s*. net.

ACCORDING to the publisher's notice on the dust cover, "Here is without question the most authoritative work ever published on the subject of synthetic dyes". It should be authoritative in that it has been compiled by a formidable band of experts in the Du Pont Co., but whether it is the most authoritative is open to question. This is not an easy book to review; in fact, on a first cursory examination, the British reader is liable to form the opinion that something important is missing. It is an American book written primarily from an American point of view, which is not always quite identical with the British or European. There is no internationally agreed nomenclature for dyestuffs and intermediates; that used in America is not precisely the same as that used in Britain or in Germany, and the non-American reader must keep this point clearly in mind. The book has its shortcomings, particularly as a text-book suitable for students. For example, the historical development of the subject, as displayed in the various chapters, each dealing with a specific class of dyestuffs, is of necessity very scanty and may be misleading.

It is not always easy to follow the reasons for the development of a particular line of invention or to get a clear picture of how the chemistry of the subject developed. So much detailed information is given in such a concise form that some chapters tend to become not much more than a catalogue of the dyestuffs under discussion, with the briefest descriptions of how each is made. The literature citations, which are plentiful, may also give a false impression. Recent patent specifications with a tendency sometimes, but not always, to refer to the United States specifications rather than the original, and references to BIOS and FIAT reports predominate; thus the reader is referred mainly to very objectively written recipes for manufacturing particular dyestuffs and intermediates, and the uninitiated reader might conclude that reading dyestuffs chemistry is rather like reading Mrs. Beaton's cookery book.

It is, however, unfair to emphasize these shortcomings because Dr. H. A. Lubs and his collaborators have aimed at presenting a really up-to-date survey of dyestuffs chemistry, as it is at the present tim within the scope of a single volume. This they hav achieved; they have produced a good book, an they are to be congratulated on their performanc As in all the monographs of the American Chemic Society, the printing of the text and the innumerabl formulæ is excellent. Why, however, do publishe of such eminence persist in making difficulties f themselves and for their readers by using irregul hexagons in the formulæ of complex polycycli compounds?

S. Coffey

A NEW SCHEME OF QUALITATIV INORGANIC ANALYSIS

Qualitative Inorganic Analysis

A New Physico-Chemical Approach. By Prof. Charlot. (Translated from the Fourth French editio by Dr. R. C. Murray.) Pp. xi+354. (London Methuen and Co., Ltd.; New York: John Wile and Sons, Inc., 1954.) 42*s*. net.

MANY teachers feel that the classical method qualitative analysis is uninteresting. It ce tainly familiarizes the student with the appearan and chemical properties of a large number of i portant substances which he might otherwise nev see, and if properly taught it can be used to illu trate many aspects of physical chemistry. The u of newer organic reagents in colour reactions suffe from the objection that the student at that stage h no idea of the structure of the reagent or what happening in the process, and the procedure empirical in the extreme. Teachers may think th analytical chemistry as taught is too little related what is done in works laboratories; but each wor has its own techniques, and the object of a course qualitative analysis should be to teach chemistry.

From time to time modified schemes of analys have appeared, and this book gives one in whic group separations are abandoned and detections a by specific reagents in solution. The first part co tains a long description of various branches of i organic and physical chemistry which are at least well described in separate treatises on those subject The methods used depend largely on *p*H and red potential control and the formation of complex co pounds. Solvent extraction is also used. The pra tical part of the book goes through a number groups of elements arranged according to the ba of the scheme. Some less common elements a included. Extensive tables of equilibrium consta and diagrams of solubility products as functions *p*H as well as redox potentials are given, and ev in the second part of the book the text is interrupt by long digressions on theory.

As an alternative to the usual method, the pr cedure described in the book is certainly worth trial. I think, however, that the average stude would be bewildered by the book. If given a su stance for identification, he would not know whe to begin. A book on qualitative analysis shou serve as a guide to such an identification and not text-book of physical or inorganic chemistry. T book should be examined by teachers of qualitati analysis; even if they do not feel disposed to ado its methods, they will find much in it which will helpful in other parts of their work.

J. R. Partington

An Introduction to the Principles of Chemistry

By Prof. L. H. Cragg and Prof. R. P. Graham. Pp. ix+740. (London: George G. Harrap and Co., Ltd., 1954.) 35*s*. net.

THIS book, by two Canadian teachers, deals with what used to be called 'theoretical chemistry' and is not a text-book of inorganic chemistry. In the preface it is truly said that students from school beginning a course in a university are disheartened if their hardly won knowledge, rudimentary and sometimes incorrect as it may be, is ignored and they are compelled to go through books containing much that they already know. The authors assume that the reader has such a knowledge, and they attempt to extend and correct it.

Among the topics dealt with are the discovery and classification of the elements, atomic and molecular structure, the kinetic theory, solutions, reaction velocity and equilibrium, electrolytes, energy changes, nuclear phenomena and trans-uranic elements, applications of nuclear science, and the use of less common elements in industry. The literary style is excellent, and the book is well illustrated. Care is taken to explain all difficult points (the section on the kinetic theory of gases is notably good in this respect), and there are good exercises and hints for further reading at the ends of the chapters.

In many places the authors attempt to inspire the young reader with a real love of science and make it clear that much remains to be done in known fields, not to mention much that may yet be quite unknown. What may be called the research spirit enlivens the whole text. This is a notably good book which every teacher of chemistry ought to see. Although very modern in content and inspiration, it frequently uses the historical approach and something is said of the personalities whose work has built up the science of chemistry. Most young students are attracted by such a treatment, as the authors well know. It can win new workers in the field, and the book openly encourages its readers to join the ranks of the discoverers. The book is very attractively produced, and its price is moderate.

Experimental Inorganic Chemistry

By Dr. W. G. Palmer. Pp. xx+578. (Cambridge: At the University Press, 1954.) 50*s*. net.

COURSES in practical inorganic chemistry have always been a problem for the teacher. Most students have done parts at school, and the severe discipline called for in quantitative inorganic analysis is apt to be irksome as compared with the rather untidy progress through a course of organic preparations.

Dr. W. G. Palmer has had the ingenious idea of combining the analysis with the preparative work, and of introducing the preparation of substances not too familiar to the students but of undoubted interest and importance. The first hundred or so pages give a concise survey of modern theory in inorganic chemistry, and the book then goes through the preparations and analyses in the order of the elements in the periodic table. A compound is first prepared and then quantitatively analysed. It is certain that this plan will enliven the subject, make it more intelligible and interesting, and give the student a better appreciation of inorganic chemistry as a whole.

At the end of each section there is a short list of literature references, which are intended to be read. The theory is extended in the introduction to each group, so that the book provides a concise text-book of inorganic chemistry as well as a practical course. Many of the exercises could be done at school, and all are suitable for university courses. Dr. Palmer's book can be strongly recommended to all concerned with teaching practical inorganic chemistry, and every teacher of the subject in school or university should have a copy.

Sunspot and Geomagnetic-Storm Data derived from Greenwich Observations 1874–1954

Compiled under the direction of Sir Harold Spencer Jones. Pp. viii+106. (London: H.M.S.O., 1955.) 25*s*. net.

FOR the past eighty years the annual volumes of the "Greenwich Magnetic and Meteorological Observations" and "Greenwich Photoheliographic Results" have served to tabulate data on geomagnetic storms and measures of sunspot areas and positions. This wealth of material has now been collected in a single volume which includes catalogues of the larger sunspots and of great and small geomagnetic storms, and tables of areas of sunspots and faculæ with detailed information on the latitude distribution of the sunspots.

A feature which will be welcomed by many workers is the adoption of the calendar month for the mean areas of sunspots and faculæ; this will go far to justify the hope of Sir Harold Spencer Jones that "this compilation . . . will be useful to those investigating solar-terrestrial relationships". Each section contains explanatory notes and references to published papers; some diagrams have also been included, among which it is interesting to find Maunder's 'butterfly' diagram, which has been brought up to date and now contains more than seven complete cycles.

Thermionic Valves 1904–1954

The First Fifty Years. Pp. iii+70. (London: Institution of Electrical Engineers, 1955.) 9*s*.; or 4*s*. to members.

A DETAILED account of the celebrations, held in November 1954, of the jubilee of the thermionic valve has already been published in *Nature* (**174**, 1076; 1954). As a record of the proceedings which took place on that occasion, the Institution of Electrical Engineers has published a most attractive book entitled "Thermionic Valves 1904–1954: The First Fifty Years". The frontispiece is a photograph of the original Fleming diode; and this is followed by an appreciation of Sir Ambrose Fleming and Dr. Lee de Forest by Captain C. F. Booth, together with a copy of both the provisional and complete specifications of British Patent No. 24850: 1904, applied for by Fleming on November 16, 1904.

The next thirty pages of the book comprise the full texts of the opening address of the Marquess of Salisbury, and the three lectures given by Prof. G. W. O. Howe, Sir Edward Appleton and Dr. J. Thomson, on the occasion of the meeting at the Institution last November. The last two lectures are well illustrated by some excellent diagrams and photographs of typical valves and circuit arrangements. The book is completed by a catalogue of 242 types of thermionic valve, with nearly fifty photographs, representative of experiment and production over the past fifty years.

All those interested in the history of the thermionic valve, and the part it has played in the development of telecommunications and electronics, will welcome this publication. R. L. S.-R.

NEW X-RAY DATA ON COALS

By L. CARTZ, R. DIAMOND and P. B. HIRSCH
Crystallographic Laboratory, Cavendish Laboratory, Cambridge

FOLLOWING a recently published investigation on vitrains[1], further work has been concentrated on three topics : (1) examination of other coal types ; (2) examination of coal extracts ; (3) study of the carbonization of coals. While the results to date are in most cases only preliminary, certain qualitative conclusions may already be drawn from them. Full details will be given later.

Examination of Other Coal Types

Coal petrologists have long recognized different petrographic constituents of coals[2] ; among these vitrinite, exinite, micrinite and fusinite are the most important. These petrographic components differ both in optical properties and chemical composition. Generally, the exinite component of a given coal has a relatively high hydrogen content and the micrinite a relatively low hydrogen content compared with that of the vitrinite. A preliminary examination has been made of a series of black durains, rich in exinite, and a series of grey durains, rich in micrinite. The work on untreated durains is difficult owing to high ash content ; however, preliminary tests carried out at the Coal Survey Laboratory, Sheffield, indicate that, at least in the case of the grey durains, the mineral matter can be removed by treatment with hydrochloric and hydrofluoric acids without appreciably altering the structure.

(*a*) *Black durains*. Fig. 1 (*a* and *b*) shows low-angle X-ray patterns from two durains of different rank. The patterns can be divided into two parts : the first consists of diffuse scattering or a band at about 20 A. at low angles, together with the 002 band (due to the stacking of the layers) at higher angles ; this part of the pattern is somewhat similar to that of vitrains of similar rank, except that the 002 band is considerably sharper, and for the low-rank durain the diffuse low-angle scattering is not as prominent as for the corresponding vitrains. This part of the pattern bears a very strong resemblance to that obtained from micrinite (see below). The second part of the pattern, and the dominant feature at low angles, is the very broad band at about 4–5 A., which does not occur for vitrains. This band occurs at the same spacing as the 'γ' band found by Blayden, Gibson and Riley[3], and it is likely that the 'γ' band was indeed due to the presence of exinite in the specimen examined by these workers. Nelson[4] has also reported the occurrence of the 'γ' band in durains but not in vitrains.

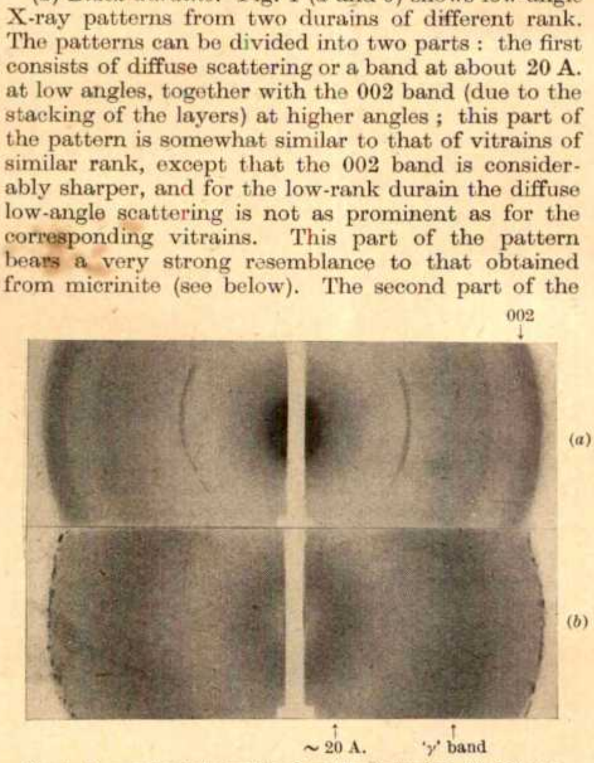

Fig. 1. Low-angle photographs of two black durains, (*a*) 82·4 per cent carbon, (*b*) 87·9 per cent carbon, showing the 002 and 'γ' bands. In the case of the higher-rank durain, there is a band at about 20 A., whereas for the lower rank, only diffuse scatter at very low angles is observed. The faint, spotty lines are due to traces of mineral impurities

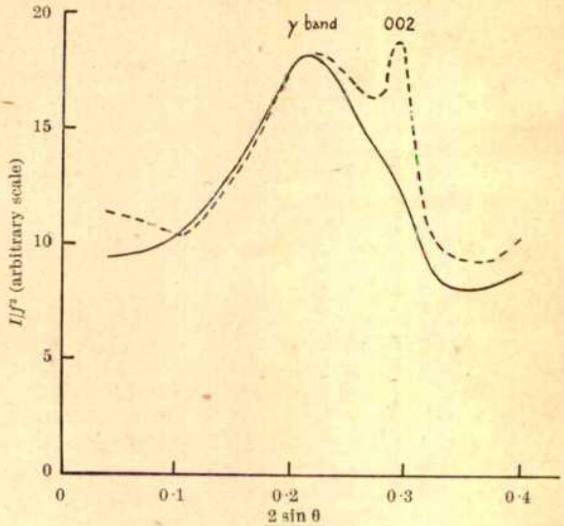

Fig. 2. Low-angle scattering from a black durain (dashes) and an exinite-rich concentrate (full-line). (f is atomic scattering factor, 2θ is angle of scatter, λ(A.) is the X-ray wave-length)

In order to decide whether the two parts of the patterns arise from different phases in the coal, an exinite-rich concentrate was prepared from one of the durains. Fig. 2 shows intensity curves as a function of $2 \sin \theta/\lambda$ (2θ is scattering angle, λ is wave-length) from the original durain and from the concentrate. It appears that in the exinite-rich concentrate both the band at about 20 A. and the 002 band are considerably reduced in intensity relative to that of the 'γ' band ; this indicates very strongly that the 'γ' band is associated with the spore material (exinite) whereas the rest of the pattern is due to another phase. Examination of slabs has shown that while the layers of the vitrain-like phase have a preferred orientation parallel to the bedding plane, this is not the case for the structure giving rise to the 'γ' band.

At high angles, only the two-dimensional diffraction bands (due to the structure within the layers) occur, and these are very similar to those obtained from vitrains.

These observations indicate in the first place that exinite, like vitrinite, consists mainly of condensed aromatic layers, although there may be small but important differences in the diameter and distortion of the layers. The 'γ' band is thought to arise from irregular packing of these layers, and the greater spacing of this band compared with that of the 002 band may perhaps be due to buckling of the layers or to the presence of more aliphatic material around

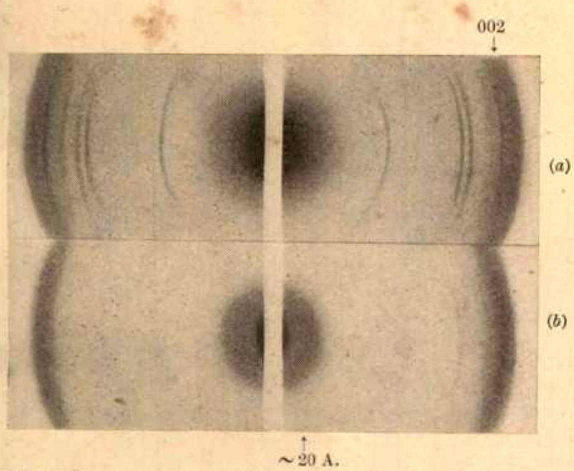

Fig. 3. Low-angle photographs of two grey durains (a) 82·3 per cent carbon, (b) 91·4 per cent carbon, showing the 002 band. In the case of the higher-rank durain, a band at about 20 A. is observed, there being only diffuse scattering for the lower-rank coal. The faint lines are due to traces of mineral impurities

he edges of the aromatic systems, which may prevent he layers from packing at a distance closer than hat possible for aliphatic chains (also about 4–5 A.). [This suggestion is in agreement with the fact that he spore material is relatively rich in aliphatic naterial (Brown, J. K., private communication).

(b) *Grey durains*. Fig. 3 shows low-angle patterns rom two grey durains of different rank. The patterns re similar to those of the black durains, except that he 'γ' band is relatively unimportant compared to he 'vitrain-type' pattern. As already mentioned for he black durains, their pattern differs mainly from hat of the vitrains in the greater sharpness of the 02 band, and in the decreased intensity of the iffuse scattering at very low angles for the low-rank oals. At high angles the pattern again consists of he usual two-dimensional bands, from which it ppears that the layers are probably of somewhat arger diameter, or more perfect, than those of the itrains. The consequent improved packing of the ayers would also account for the enhanced sharpness f the 002 band. Apart from these differences, the eries of patterns from grey durains of different rank ppear to change in a manner similar to that seen in itrains, that is, with increasing rank the diffuse ow-angle scattering decreases, and a band appears t about 20 A.

These experiments indicate that exinite and nicrinite really do represent structurally distinct hases; while the basic aromatic structure is similar, he packing of the layers in the micrinite of a grey urain is better, and in the exinite of a black durain vorse, than for the vitrains. This may be a function f the perfection of the layers or particularly of the on-aromatic edge groups. It appears that the reater the content of hydrogen and of aliphatic naterial, the more difficult it becomes for the layers o pack together.

Extracts and Residues

A series of ethylene diamine extracts from different oals has been examined. While the patterns at high angles are very similar to those of the vitrains, mportant differences occur at low angles. In the ase of the lowest-rank coal (Fig. 4a (80 per cent arbon)), a new band appears in the extract at about 12 A. (that is, $2 \sin \theta/\lambda \simeq 0\cdot08$), which is not present in the parent coal, and the low-angle scattering decreases. The same is observed with a parent coal of 78 per cent carbon. For a coal of 84 per cent carbon, a band appears in the extract at about 16 A., whereas for a coking coal of 89 per cent carbon (see Fig. 4b), which shows a strong band at about 20 A. in the original vitrain, the band moves to about 30 A. in the extract. The tentative interpretation of these results is that the extracted material is to some extent disentangled and can 'crystallize' to form the

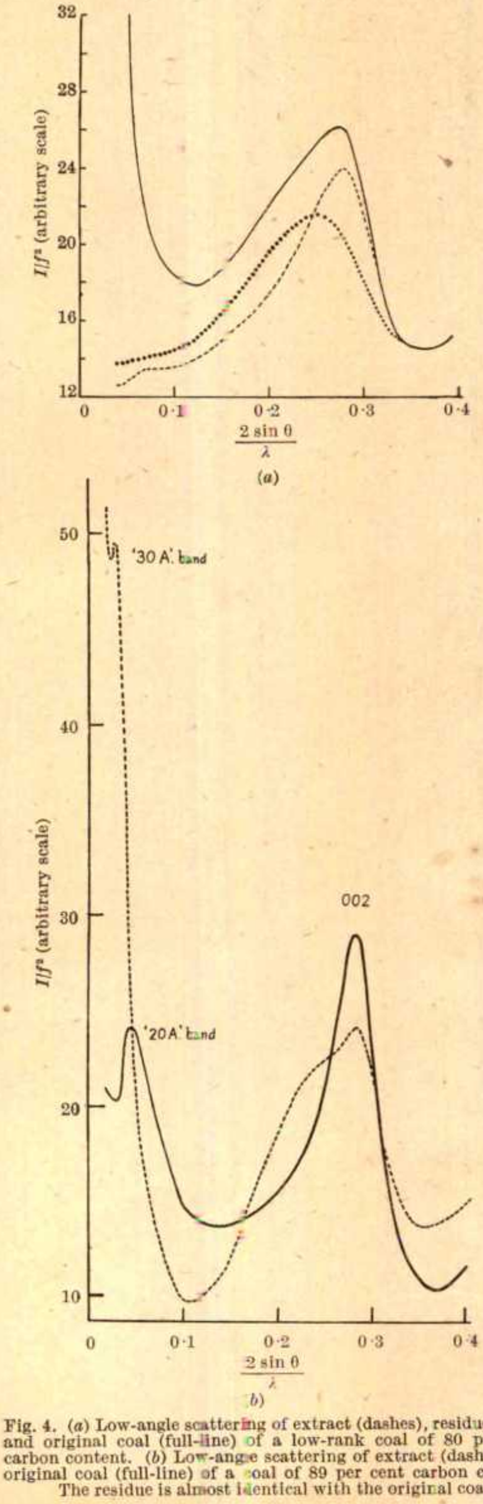

Fig. 4. (a) Low-angle scattering of extract (dashes), residue (dots) and original coal (full-line) of a low-rank coal of 80 per cent carbon content. (b) Low-angle scattering of extract (dashes) and original coal (full-line) of a coal of 89 per cent carbon content. The residue is almost identical with the original coal

same type of 'micro-pore' structure as occurs in the coking coals.

The residues left after extraction show, in the case of the low-rank coals, a marked increase in the broadening and a movement to lower angles of the 002 band and a decrease in the low-angle scattering (see Fig. 4*a*). These results indicate that, after extraction, the material left behind expands locally in the direction normal to the layers, at the same time closing some of the larger pores.

Carbonization of Coals

A caking and a coking coal have been carbonized at intervals of 100° C. from room temperature to 1,000° C. Fig. 5 shows a series of low-angle patterns obtained from the caking coal.

In the case of the caking coal, up to 400° C. the low-angle scattering decreases and the band at about 20 A. becomes more intense. Above 500° C. the 20-A. band again becomes more diffuse, until at about 700° C. it is almost completely replaced by diffuse low-angle scattering. The two-dimensional bands at high angles show that no growth of the layers occurs before about 500° C.; growth begins to be appreciable from about that temperature and probably accelerates at about 700° C. It appears, then, that up to about 500° C. the only directly observable changes are the closing of the larger pores and an improvement of the micro-pore structure; the latter, however, is at no stage as pronounced as in the coking coal. From about 300° C. these changes are accompanied by an evolution of volatile matter which proceeds at a maximum rate at about 450° C. The growth of the layers above about 500° C. is accompanied by increased diffuse low-angle scattering, suggesting a 'clustering' process leading to a wide distribution of layer diameters and a wide distribution of larger pores.

In the case of the coking coal, which shows a strong 20-A. band in the unheated state, very little change occurs up to about 500° C.; above that temperature the patterns are similar to those of the caking coal. The onset of growth also occurs at about 500° C., and detailed numerical analysis indicates that the true mean layer diameter is linear with temperature from 500° to 1,000° C., varying from 7 A. up to 14 A., with the high-temperature specimens showing some very small molecules and some larger than 20 A.

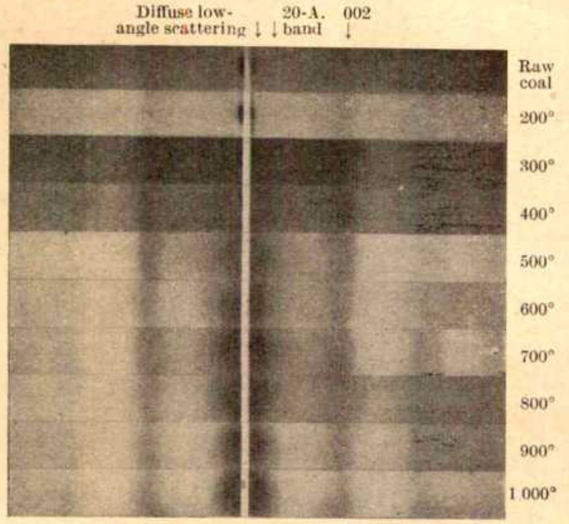

Fig. 5. Low-angle scattering from a carbonized caking coal initially of 84 per cent carbon content. Temperatures in degrees centigrade

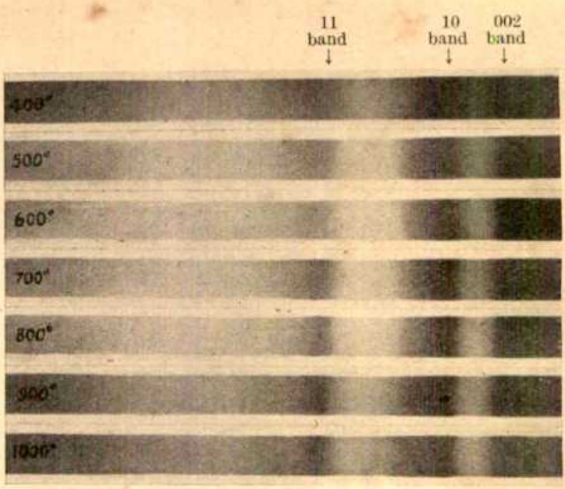

Fig. 6. High-angle photographs from a carbonized coking coal initially of 89 per cent carbon content. Temperatures in degrees centigrade

Fig. 6 shows the high-angle photographs from the coking coal, demonstrating the increase in sharpness of the 10 and 11 bands as the temperature rises beyond 500° C.

It would be premature at this stage to attempt to draw definite conclusions about the carbonization process. It is interesting to note, however, that the temperature at which growth becomes appreciable (500° C.) is in the same range as that in which a secondary reaction takes place; this reaction, on the evidence of infra-red spectroscopy[5], has been interpreted in terms of cross-linking, and is accompanied by the removal of aromatic hydrogen and hydroxyl groups. At this temperature also the concentration of 'free radicals' is a maximum[6]. The increase in layer size at higher temperatures is accompanied by a decrease of electrical resistance.

The diffraction pattern of the caking coal at 500° C. differs from that of the coking coal at 500° C. in that the band at 20 A. is not so pronounced in the former as it is in the latter. This may be correlated with the fact that the carbonized coking coal contains fewer hydroxyl groups than the caking coal[5]. The same correlation is found in the coalification series[7], where the band at 20 A. increases in intensity as the proportion of hydroxyl groups decreases.

One other feature of the low-angle photographs for the caking coal, which can be detected by eye and confirmed by photometry, is the reduction in intensity at high temperatures in the region midway between the 002 band and the direct beam. This can be interpreted as a reduction of the fraction of layers which occur singly.

A more detailed account of this work is to be published later, in which quantitative data and interpretations will be given and in which proper acknowledgment will be made of our indebtedness to a number of colleagues.

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CHROMOSOMES, GENES AND MACROMOLECULAR SYSTEMS*

By Prof. FRANCIS O. SCHMITT
Biology Department, Massachusetts Institute of Technology, Cambridge, Mass.

Structure of Living Systems

It has long been supposed that organization is one of the most characteristic properties of living systems. This applies at all levels of complexity from the small metabolite molecules through the larger protein molecules, macromolecules and subcellular organelles to cells, organisms and groups of organisms. The temporally and spatially ordered coupling of energy upon the macromolecular lattices of protoplasm is at the core of most processes of cellular biology. Therefore it is most important that investigations be made of the structure and properties of this molecular machinery. Fortunately, such investigations are being actively pursued in many laboratories both from the more to the less complex (that is, studies of cellular ultra-structure by the electron microscope) and in the reverse direction (that is, crystallographic studies of the detailed structure of protein and nucleic acid macromolecules by X-ray diffraction, based upon detailed studies of the simpler single amino-acids and lower peptides).

From such studies and from physical-chemical investigations of extracted and purified materials it has been found in a number of cases (myosin, tropomyosin, paramyosin, collagen, fibrinogen, keratin) that the characteristic particle is a long thin macromolecule 15–20 A. in diameter and some hundreds or thousands of angstrom units in length. These macromolecules may be built up by adlineation of smaller units or precursors; but the full biological and chemical properties are manifested only by the larger macromolecular units. It is in these particles that the complementarity and specificity reside in so far as processes of building up and chemical interaction are concerned.

In few cases has it been possible thus far to observe the individual macromolecules directly with the electron microscope. However, under appropriate conditions, the macromolecules interact with each other to form fibrous aggregates which manifest in the electron microscope a very regular periodic cross-striated appearance. The axial period and the detailed intraperiod fine structure are characteristic of each protein. In a few cases the structure and modes of aggregation of the macromolecules have been deduced from the structure observed in the electron microscope. Collagen is one of these systems[1,2] and it will serve to illustrate what might prove to be typical of other fibrous proteins.

The macromolecular unit of collagen is a particle of dimensions about 14 × 2900 A.[3]. It is thought to be composed of three polypeptide chains in helical configuration[4-7]. The sequence of amino-acid residues in the macromolecular chains is presumably constant and specific. Therefore, the types of side-chains and their distribution along the chains are also specific. The individual tropocollagen macromolecules are themselves not banded; but when they aggregate with each other laterally to form a fibril the side-chain interaction produces regions of relative disorder or order (in the crystallographic sense) and this leads to the production of bands and interbands, respectively, in the resulting fibril, according to the suggestion of Bear[8]. Depending upon the pattern of side-chain interaction and the stability of the resulting aggregate a variety of geometrical forms might be possible. In the case of collagen at least five band patterns and several intermediate forms have been observed, and these are thought to arise by different aggregation forms of the tropocollagen macromolecules. Thus if the chains are polarized all in the same direction, 'segmental long-spacing' structures may be formed if the chain-ends are in register; if the chain-ends are staggered by a specific fraction of the macromolecular length the 640-A. type structure, characteristic of native collagen, is formed. If the macromolecular chains are running in opposite directions (antiparallel array) and chain-ends are approximately in register, the axially symmetrical 'fibrous long-spacing' structures are formed[1,2].

The very significant fact which emerges from the collagen experiments is that, although the types of aggregation possible depend upon the specific composition and molecular architecture of the tropocollagen particle, that which will occur under any particular conditions depends very sensitively upon the chemical environment (pH, ionic strength, presence of certain types of substances, etc.). The transitions from one structure to the other are freely reversible, and relatively subtle changes in the chemical environment may change the structural pattern formed on reconstitution.

Somewhat similar macromolecular interactions probably occur in the case of paramyosin reconstituted from acid[9] or near-neutral salt solutions[10].

Constitution and Properties of Chromosomes

From this background of experience regarding interaction properties of protein macromolecules certain possibilities concerning the constitution and properties of chromosomes and genes suggest themselves which, so far as I am aware, have not thus far been pointed out and which may have very far-reaching importance for genetics and for the study of differentiation and morphogenesis.

Although knowledge about the proteins and nucleic acids of chromosomes is still very limited[11,12]; it seems clear that the deoxyribonucleic acid (DNA) and possibly certain of the proteins exist as long thin macromolecules in the normal chromosome. When chromosomes (as in sperm heads) are extracted under the mildest conditions, the extracted macromolecules may be very long (30,000–40,000 A.) and thin (about 20–25 A.)[13,14]. How many species of deoxyribonucleic acid and protein macromolecules exist in the chromosome is unknown, and fractionated preparations obviously contain numerous constituents.

The giant salivary gland chromosomes of certain insects are characteristically banded when viewed in ultra-violet light or after appropriate staining. In contrast with the band patterns of fibrous proteins, those of the giant chromosomes are aperiodic rather than periodic; there is no true repeat over the extent of the chromosome (about 100μ). The positions of the various genes have been localized in the genetic (linkage) maps, with respect to these microscopically visible bands. The bands and interbands, which have highly characteristic positions, dimensions, density and staining characteristics, represent regions of relatively high or low deoxyribonucleic acid-to-protein ratios, respectively, and must be explicable in terms of a specific packing of the elongate macromolecules which compose the chromosomes.

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* Based on a paper read before the American Philosophical Society on November 10, 1955 The detailed paper will be published in the *Proceedings of the American Philosophical Society*.

Aggregation of Macromolecules

As in the case of the submicroscopic band patterns of the fibrous proteins, the microscopically visible bands of the giant chromosomes may, for present purposes, be thought of as resulting from various types of aggregation of the constituent macromolecules, chiefly those of deoxyribonucleic acid and protein. At least five different band patterns (as well as various intermediate forms), representing as many different types of aggregation of the tropocollagen macromolecules, have been observed in systems containing only a single species of protein macromolecule, collagen. In chromosomes let it be supposed that a limited number of *species* of deoxyribonucleic acid and of protein macromolecules exist, together with histones and protamines. Various types of aggregation of the several species of deoxyribonucleic acid and protein macromolecules may occur. These include aggregation of individual species of deoxyribonucleic acid or of protein with themselves, with other species of deoxyribonucleic acid or protein (as well as with histones and protamines).

Each group of interacting macromolecules may aggregate in parallel or antiparallel array, with ends in register, out of register, or staggered according to some particular pattern of the reacting groups. In this way it would be possible, even with a relatively limited number of species of deoxyribonucleic acid and protein macromolecules, to produce specific aperiodic patterns of considerable length and having many bands, such as occur in the giant chromosomes.

Continuing the analogy, it may be suggested that, given a certain concentration of the various types of native deoxyribonucleic acid and protein macromolecules, the banded chromosomes may spontaneously form (be reconstituted) if all the factors of the chemical environment are appropriately adjusted. It would thus be unnecessary that the chromosome be reduplicated *as a whole*. Instead the constituent native macromolecules of deoxyribonucleic acid and of protein may be synthesized (presumably in the nucleus) and, assuming that their concentration has reached a certain minimal level, they will spontaneously aggregate in a manner characteristic of the native chromosome. This hypothesis would require that the cell be capable of maintaining a highly characteristic chemical environment, because only under such conditions would the various macromolecules spontaneously form the same characteristic, stable macromolecular pattern required by the cytological and genetic data.

Theory of the Gene

Still another, highly significant, possibility follows from the above view. This has to do with the gene itself. The now largely abandoned 'point determiner' theory of the gene considers that the genes occur as molecules or particles, arranged *seriatim* along the chromosome, like beads on a string. Quite possibly the inclination on the part of those examining chromosome structure in the electron microscope to pay especial attention to any particulate or bead-like structures which may be observed is another indication of the point determiner theory in modern guise. Recent experiments on the transforming factor and on bacterial viruses focus attention on the deoxyribonucleic acid macromolecule as such, and it is not incompatible with genetic data to regard highly localized regions of the deoxyribonucleic acid macromolecules, possibly even single turns of the double helix, as representing individual genes.

However, it is also possible that the chemical groupings which constitute the genes are not macromolecules or even small regions of *individual* macromolecules. Rather, the chemical groupings corresponding to genes may occur in juxtaposition on two or more adjacent macromolecules which may be the same or different species of deoxyribonucleic acid or of protein (a nucleoprotein may, in fact, be considered to be just such a lateral union between deoxyribonucleic acid and protein macromolecules linked by electrostatic or hydrogen bonds).

If this be the case, then with the same population of macromolecules of deoxyribonucleic acid and proteins, it may be possible to achieve or 'activate' a wide variety of biocatalysers depending on which species of macromolecules are in contact and on the way in which the constituent macromolecules are arrayed with respect to each other laterally, that is, in parallel or antiparallel array, with ends in register or in some kind of staggered array. Which arrays are stable under particular conditions will depend importantly on factors in the chemical environment. 'Activation' or 'inactivation' of genes might then occur merely by change in the relationship between particular macromolecules laterally without essential alteration of the constituent macromolecules themselves. Such changes might well result from changes in the chemical environment such as probably occur in processes of differentiation and morphogenesis. The resulting change in macromolecular relationship might bring into juxtaposition new chemical groupings which constitute different catalytic groups (genes); these in turn influence reactions which contribute to further steps in differentiation and development, thus constituting the feedback type of mechanism which must almost certainly be involved in the highly regulatory processes of development.

Phenomena such as position effect and pseudoalleles make the classical corpuscular picture of the gene obsolete in modern genetics. As suggested recently by Goldschmidt[15], the field of macromolecular chemistry must support and contribute to our revised notions of the gene. It is hoped that the suggestions put forward in this article will constitute a step toward bringing together biological observations and recent advances in macromolecular chemistry.

At the present time these suggestions must be regarded as purely speculative, based on properties observed experimentally in certain macromolecular systems. However, in collaboration with Dr. Herman W. Lewis, I have initiated attempts to obtain experimental evidence for at least one aspect, namely, the possibility of taking banded giant chromosomes apart into their constituent macromolecules in appropriate solutions and afterwards, by alteration of the chemical environment, to reconstitute banded structures (hopefully, though not necessarily, with a band pattern like that found in normal chromosomes). Progress in these experiments will be reported in due course.

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OBITUARIES

Prof. Émile Borel

THE rapid progress of mathematical analysis in the early years of the present century was due in considerable measure to the influence of the great French school, of which Émile Borel, whose death occurred on February 3 at the age of eighty-four, was a leading figure. To high creative ability, he added expository skill and unusual powers of organization; his name is known throughout the mathematical world not only for the doctrines to which it is attached—the Heine–Borel theorem, the Borel summation process, Borel sets—but also for the vast co-operative enterprises which he directed.

The theory of sets was more warmly welcomed in France, so Cantor thought, than in its German home; certainly the volumes of Jordan's classic "Cours d'Analyse" suggested that irksome continuity restrictions could only be removed by some method more powerful than that author's theory of content. In 1898, Borel's "Leçons sur la théorie des fonctions" provided a new theory of measure, while Baire's thesis on discontinuous functions appeared in the same year; and thus the way was open for the remarkable advances of the next decade. The booklet of 1898, based on lectures given at the École Normale, was followed by similar volumes—on divergent series, integral functions, meromorphic functions—all of great value to the students of analysis. The success of the series caused its scope to be broadened, and other writers contributed, under Borel's direction, notably Baire, Lindelöf and Lebesgue. The latter's two brilliant tracts, on integration and on trigonometrical series, showed for the first time to a wide public the full precision and power of the new theory of measure and of the new integral of Lebesgue. Borel never lost interest in the series of monographs; he constantly revised his own earlier volumes and prepared new ones, the latest appearing in 1952. This bore on the constructive definition and effective calculation of numbers, a topic on which he had always held strong views—strong enough at one time to carry him into a heated controversy with Lebesgue. To-day a mathematical library without the Borel monographs is unthinkable.

Shortly after the First World War, Borel, whose chair in the Faculty of Sciences at Paris was that of probability and mathematical physics, undertook the direction of another large co-operative enterprise, the famous "Traité du calcul des probabilités", in four volumes, each of five or six parts; and this itself was supplemented by a further series of monographs on probability, one of which was Borel's own work on the mathematical theory of bridge.

Borel's considerable powers of exposition were not confined to these two famous undertakings; his writings range from school geometry to relativity, all with a sureness of touch and an almost deceptive ease of manner. His triple claim to high rank in the hierarchy of mathematicians, as creative thinker, illuminating writer and powerful organizer, will cause his name long to be remembered.

T. A. A. BROADBENT

Dr. W. L. H. Duckworth

THE death, on February 14, of Dr. W. L. H. Duckworth, at the age of eighty-five, has removed from the Cambridge scene a scholar and a teacher of great distinction. Born in Liverpool in 1870, he was educated in Birkenhead and in France before going to Jesus College, Cambridge, in 1889. His associations with this College, of which he was elected a Fellow in 1893, were to be most intimate for the remainder of his long life, and culminated in his election to the mastership in 1940. At the age of seventy-five he retired from the mastership but continued to live in Jesus College until his final illness. He was president of the Anatomical Society during 1943–45.

Duckworth had very wide interests in anatomy, teratology, primatology, anthropology, archæology and general natural history. He commenced work in the Anatomy School under Alexander Macalister shortly after obtaining a double first in the Natural Sciences Tripos. This connexion with anatomy he maintained during his clinical studies at St. Bartholomew's Hospital, London, and in 1899 a University lectureship in Cambridge in physical anthropology was established for him. In 1919 he was elected to a readership in human anatomy—a post which he held until 1940. After his retirement he maintained his interest in the collections in the Anatomy School and, in spite of physical disability, did some College and University teaching well into his ninth decade. In his maturity Duckworth's formal teaching was most impressive; complete command of the facts, great blackboard artistry, an almost pedantic accuracy in description ("it is not so much a whorl as a convolution") and an eighteenth-century aristocratic manner combined to give a character to his lectures which was much appreciated by students of all levels of ability and assiduity.

During the early years of the century, Duckworth travelled widely on archæological and anthropological expeditions, and on visits to departments of anatomy on the Continent. At the same time he pursued the study of human skulls and of recent primates with a complete devotion. Some of his many studies were summarized in his book "Morphology and Anthropology", published in 1904. This volume is still a mine of recorded facts on man and his closer relations, and it is a great pity that only the first volume of a second edition ever appeared. His work was highly individual in approach and presentation, and he inclined to put off publication in the hope that another specimen would turn up. As a result, much of his investigations was never published. His knowledge of the non-metrical features of the primate skull was unique, and his experience had given him a redoubtable sense of the appropriate in reconstructions. Consequently, he was always critical of the association of the Piltdown jaw with the cranium, and if he had been listened to in the earlier discussions on that material, several reputations in human palæontology might be a little less tarnished than they now are.

Duckworth was an insatiable collector with deep cultural and historical interests. A long life-time devoted to the gathering of material and the reading of all the related information in a number of languages gave him an impressive, almost an encyclopædic, knowledge. He was learned in half a dozen fields, and his long list of publications covers only a tithe of his life's work. He is already commemorated in Cambridge in the Laboratory of Physical Anthropology, which bears his name; this is most appropriate, for his prime interest was always the history of the human body. J. D. Boyd

Prof. S. F. Nadel

The Australian National University has suffered a great blow by the death in Canberra on January 14 of Prof. S. F. Nadel, professor of anthropology and dean of the Research School of Pacific Studies at the University. He leaves a widow and one daughter.

Siegfried Frederick Stephen Nadel was born in Vienna on April 24, 1903, the son of Dr. Maurice Nadel, a medical practitioner. Of Austrian nationality in his earlier years, he later became a naturalized British subject. He was educated first in Vienna, where he graduated D.Phil. in psychology. After a short period at Cambridge, he went with a Rockefeller fellowship to the University of London, where he took his Ph.D. in anthropology, studying under the late Prof. Bronislaw Malinowski at the London School of Economics. His first anthropological field-research was undertaken during the years 1934–37 in the Nupe Kingdom of Nigeria. From this work he published two books: "A Black Byzantium" (1942) and "Nupe Religion" (1954). The former has become a standard work in the West African field, and the latter is recognized as a very substantial contribution to the theory of primitive religion. As Government anthropologist in the Anglo-Egyptian Sudan during 1938–41, Nadel carried out research among the remote tribes of the Nuba Mountains. His book "The Nuba" (1947) is one of the most solid and extensive comparative studies in modern social anthropology; it examines the social institutions of ten different hill peoples.

During the Second World War, Nadel was appointed a political officer in Eritrea, and in 1945–46 he became deputy chief secretary in the British Military Administration in Tripolitania, with the rank of lieutenant-colonel. In 1946 he was awarded the Wellcome Medal for his anthropological writings based on his war-time experiences, and in 1950 he was given the Rivers Memorial Medal of the Royal Anthropological Institute for his field-research in Nigeria and the Sudan.

His rise in the academic field was rapid. He became lecturer in anthropology at the London School of Economics in 1946–47, reader in anthropology in the University of Durham 1948–50, and held the chair in anthropology at the Australian National University from 1950 until his death.

Nadel was one of the most significant figures in contemporary British social anthropology. His publications, which were numerous apart from his books, were noted for their theoretical stimulus as well as for the soundness of their ethnography. His general treatise, "The Foundations of Social Anthropology" (1951), was an attempt, on the whole successful, to explore the basic assumptions and methods of his science. It illustrated also his wide and informed interests in other social sciences and in philosophy. Only a week before his death he had completed a second general book, on the theory of social structure, based on lectures given in 1955 at the London School of Economics. This, too, is likely to become a standard work. Nadel was a fine scholar and a fine teacher. The Department of Anthropology and Sociology which he established and led at the Australian National University has already begun to make its mark through the quality of the work produced there. Raymond Firth

NEWS and VIEWS

Royal Society of Edinburgh: New Fellows

The following have been elected Fellows of the Royal Society of Edinburgh: Prof. D. H. R. Barton, regius professor of chemistry, University of Glasgow; Dr. J. Bell, senior lecturer in chemistry and assistant director of the chemical laboratories, University of Glasgow; the Hon. Lord Blades, senator of the College of Justice in Scotland and Lord of Session; Prof. J. H. F. Brotherston, professor of public health and social medicine, University of Edinburgh; Prof. G. M. Burnett, professor of chemistry, University of Aberdeen; Dr. J. G. Campbell, research officer (British Empire Cancer Campaign), Poultry Research Centre, Edinburgh; Dr. T. C. Carter, of the Institute of Animal Genetics, University of Edinburgh; Dr. C. B. Childs, senior lecturer in natural philosophy, University of Edinburgh; Prof. M. McG. Cooper, professor of agriculture, King's College, Newcastle upon Tyne, and dean of agriculture, University of Durham; Dr. H. K. Cowan, chief medical officer, Department of Health for Scotland; Prof. K. G. Denbigh, professor of chemical technology, University of Edinburgh; Dr. G. R. Evans, senior lecturer in natural philosophy, University of Edinburgh; Dr. D. T. Gibson, senior lecturer in charge of medical chemistry, University of Glasgow; Prof. W. G. Green, professor of mechanical engineering, Heriot-Watt College, Edinburgh; Prof. James Greig, professor of electrical engineering, King's College, University of London; Dr. D. C. Martin, assistant secretary, Royal Society of London; Dr. R. H. Millar, zoologist at the Marine Station, Millport, of the Scottish Marine Biological Association; Prof. R. Miller, professor of geography, University of Glasgow; H. N. Munro, senior lecturer in biochemistry, University of Glasgow; Dr. A. Oppenheim, professor of mathematics, University of Malaya, Singapore; Dr. Magnus Pyke, head of the Laboratory Section, Yeast Research Organization of the Distillers' Co., Ltd., Menstrie, Clackmannanshire; Dr. W. Reid, member of the National Coal Board; G. A. Stewart, formerly assistant secretary and librarian, Royal Society of Edinburgh; Prof. T. Symington, St. Mungo-Notman professor of pathology, University of Glasgow; Prof. J. W. Watson, professor of geography, University of Edinburgh.

Awards

THE following Prizes have been awarded by the Society: *Keith Prize* for 1953–55, to Prof. A. D. Peacock (Queen's College, Dundee), for his paper in the Society's *Proceedings* during the period of the award and for his contributions to entomology and cytology; *Neill Prize* for 1953–55, to Dr. Robert Osborne (Poultry Research Centre, Edinburgh), for his papers in the *Proceedings* during the period of the award and for his contributions to knowledge of the genetics of the domestic fowl.

Aeronautical Engineering at Belfast: Prof. A. V. Stephens

PROF. A. V. STEPHENS, who at present holds the chair of aeronautics in the University of Sydney, has been appointed to the newly established chair of aeronautical engineering in The Queen's University of Belfast. This chair was established in 1955 with the aid of a generous grant from Messrs. Short Brothers and Harland. The Department is situated in the new engineering and science building, and it will be operating in January 1957. Prof. Stephens graduated in 1930 from St. John's College, Cambridge. After experience with the Royal Aircraft Establishment and as research fellow and demonstrator at Cambridge, he was appointed in 1940 to the chair of aeronautics in Sydney, and he has been dean of the Faculty of Engineering there since 1949. He has built up a flourishing department in Sydney and has played a prominent part in aeronautical research in Australia. He brings to his new post a wealth of experience both in the supervision of research and in administration. His appointment will notably strengthen engineering studies in Belfast and will create another valuable link between the University and the industry of Northern Ireland.

Zoology at the Chicago Natural History Museum: Dr. K. P. Schmidt

AFTER completing thirty years on the staff of the Chicago Natural History Museum, Dr. Karl Patterson Schmidt has retired from the post of chief curator of the Department of Zoology which he has held since 1941, and the latest volume of *Fieldiana* (37 (1955), from the Museum, 10 dollars) is very fittingly offered as a tribute to him. Dr. Schmidt has led a most active life both in the Museum and in the field. A prolific but nevertheless sound writer, he is widely known in North America not only for a most imposing series of scientific papers and reports mainly on material in the Museum, but also for some popular books. In fact, to English-speaking people as a whole, he is well known for his contributions to the "Encyclopædia Britannica", as translator, with W. C. Allee, of Hesse's "Tiergeographie auf oekologische Grundlage" and as part author of the "Principles of Animal Ecology". The last two owe much to his own wide field experience in five continents. Primarily a systematist, he has rendered useful service as editor of sections of *Biological Abstracts* ("Reptiles" since its foundation in 1927 and "Amphibia" added since 1941). Vol. 37 of *Fieldiana*, in its 728 pages, illustrated by 31 plates and 144 text figures, contains twenty-six articles covering a wide range of subjects, from a comparison of Old and New World Permian Reptiles to three new species of fleas from rodents, one named after Dr. Schmidt; from beetles parasitic on mammals to bats of the genus *Vampyrops*; from a discussion on the origin of the land birds of Tristan da Cunha to the ecology of fish in North Borneo. A point of interest in this great variety lies in the fact that, in a special note, twenty-seven of the authors admit their debt to Dr. Schmidt. The production of the volume is of the excellence one has learned to expect from the series. Dr. Schmidt has much work still in hand, and we wish him a happy and fruitful time in his retirement.

Meldola Medal for 1955 of the Society of Maccabæans

THE Meldola Medal of the Society of Maccabæans has been awarded for 1955 to Dr. Peter Gray, until recently of the Department of Chemical Engineering of the University of Cambridge and now lecturer in physical chemistry in the University of Leeds. The Medal is awarded each year, on the recommendation of a committee of the Royal Institute of Chemistry, to the chemist who being a British subject and less than thirty years of age, is considered to have shown the greatest promise as indicated by his or her published work. After graduating in 1946 from the University of Cambridge, Dr. Gray began research in physical chemistry at Cambridge under Dr. F. P. Bowden, at first working on the growth and decay of the transient impulsive pressures developed during impact on liquids and the application of these results to the mechanical initiation of explosion. This was followed by a study of explosions in gaseous systems, in association with Dr. A. D. Yoffe, and led to the discovery in a number of simple decomposition reactions of cool flame phenomena, known previously only in combustion. In 1951 Dr. Gray joined the then recently established Department of Chemical Engineering in Cambridge, where his previous research on explosions developed into a study of flame propagation, particularly in chemically simple systems, which afforded crucial tests of theories of laminar flame propagation. Other fields investigated jointly in the Department were extensive work on the interpretation of the reactions of dinitrogen tetroxide; a study of the combustion of hydrazine; an investigation of the structure, reactivity and thermochemistry of the inorganic azides; and work on the thermochemistry and reactions of nitrites and nitrates.

Sir George Beilby Memorial Awards for 1955

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made awards from the Fund for 1955, each of one hundred and fifty guineas, to Dr. F. D. Richardson and Dr. F. Wormwell. The awards are made to British investigators for work in such fields as fuel economy, chemical engineering and metallurgy, in which Sir George Beilby's special interests lay, and in general they are given to relatively young scientists for work over a period of years.

Dr. Richardson's award is for his work on the thermodynamic properties of high-temperature systems, with special reference to iron-smelting and steelmaking. After graduating in 1933 from University College, London, he did research there and at Princeton University and then joined the Royal Navy at the beginning of the Second World War. On demobilization in 1946 with the rank of commander, he joined the British Iron and Steel Research Association and worked on the thermodynamics of iron and steelmaking, extending his interests to the pyro-metallurgy of non-ferrous metals when he joined, in 1950, the Imperial College of Science and Technology, London, as Nuffield Fellow to establish the Nuffield Research Group in Extraction Metallurgy. The work of Dr. Richardson and his colleagues has covered solutions in iron, copper and lead and molten salts and silicates, especially the chemistry of sulphur dissolved in molten silicates as sulphide and sulphate. New measurements have been made of the activities in the iron–carbon system and of the influence of chromium on the activity coefficients of carbon and silicon in molten iron. These and other studies have been particularly important in elucidating the reaction equilibria of the blast furnace, in deoxidation and during carbide formation in cooling metal.

Dr. Wormwell, whose award is for his work on surface reactions, with special reference to the mechanism of metallic corrosion, oxidation and passivation processes, graduated in 1926 from the University of Manchester and has spent his research career to date at the Chemical Research Laboratory, Teddington, where he is now senior principal scientific officer and head of the Corrosion of Metals Group. Much of his earlier published work dealt with studies of the mechanism of metallic corrosion in salt solutions and natural water, with special reference to the influence of oxygen supply, temperature, pressure and movement, by means of accurate rate-measurements over long periods in carefully controlled conditions. He worked jointly on oxide films formed on mild steel and stainless steel at ordinary and elevated temperatures, and the development of improved methods of stripping films from the metal substrate. This has involved corrosion studies of moving specimens, high-speed-rotor and electrochemical tests of painted steel, cathodic protection, corrosion inhibitors (particularly sodium benzoate) and underground corrosion and its prevention.

Meteorology and Geographical Features of the Antarctic

The discovery by the United States Antarctic Expedition of a great trough flanked by mountains 12,000–15,000 ft. high in the Antarctic ice-cap between Victoria Land and Wilkes Land, reported by Dr. Paul Siple, of the Expedition, in *The Times* of March 6, if confirmed, will arouse particular interest in meteorological circles in Great Britain. The trough was reported as lying between a range of mountains roughly along the 160° E. meridian and another high mountain wall about 200–300 miles to the west. The floor of the trough was at 7,000–9,000 ft. above sea-level. The probable existence of such a mountainous channel in the lofty ice-covered interior of Antarctica in the sector indicated was predicted last year by Mr. H. H. Lamb, of the Meteorological Office, and Commander G. P. Britton jointly in a paper (*Geog. J.*, 349; September 1955) quoting evidence of strong topographical effects on the atmospheric circulation in the Antarctic, and had previously been suggested in more general terms by Lamb (*Met. Mag.*, 111; 1948). Peculiarities of wind flow are often explicable from the geography of the regions in which they occur, but this is believed to be the first time that the argument has been successfully used in reverse and meteorological evidence used to predict the discovery of a major geographical feature.

The meteorological evidence is also thought by Lamb (*Geog. J.*, 59; 1948) to point to the existence of a mountain range or ice-cap crest of the order of 12,000–15,000 ft. or more in height in the heart of the hitherto unvisited region of 'East Antarctica'; the suggested approximate position and alignment were in the region about 80° S., 80° E., and parallel with the 140° E. meridian. There are indications also of low-lying regions in some parts of East Antarctica (W. Schmitt, *Notos*, 193; Pretoria, 1952) sufficiently extensive for the accumulation of deep cold air masses which acquire significance in the general circulation of the atmosphere over the Southern Ocean. Meteorologists thus have a strong interest in the discovery of the main geographical features of the still unexplored parts of Antarctica.

New Out-station for the Atomic Energy Research Establishment

The Atomic Energy Authority is acquiring two built-up areas on Grove Airfield, near Wantage, as a site for a small out-station of the Atomic Energy Research Establishment, Harwell. These two areas are part of the airfield which the Air Ministry had decided to relinquish. The new out-station is mainly to provide laboratories to allow the Technological Irradiation Group to develop more rapidly. This Group, a part of the Harwell Isotope Division, was formed in June 1955 in order to assist industry in making full use of the large amounts of radioactive material which will become available from the expanding atomic energy programme. The additional laboratories at Grove are seven miles from Harwell and less than two miles from Wantage. In the choice of the new out-station preference was given to sites which had existing buildings so that the work of the new group could be advanced as rapidly as possible. The location of the Technological Irradiation Group at Grove, rather than at Harwell, will reduce the formalities for those who wish to use the irradiation facilities, and so make it easier for industry to co-operate to the full. No radioactive waste will be discharged, as any small quantities which may arise will be transferred to the main plant at Harwell for treatment and disposal. A similar system has been used by the Radiochemical Centre at Amersham, and has proved to be satisfactory in practice. Later it is proposed to transfer the Isotope School from Harwell to the new site on Grove Airfield.

Course of Nuclear Engineering at the University of Glasgow

An undergraduate course in nuclear engineering, primarily for final-year students in the mechanical and electrical branches of the Engineering Faculty, has been in operation at the University of Glasgow since the beginning of the present session. The course provides a general background of nuclear and reactor physics for students who may later take up a specialized aspect of nuclear engineering; but as the subject becomes more firmly established further developments will be made, leading to the consideration in more detail of specialized topics. In addition to the university undergraduates, the course is being attended by a number of extra-mural students from local industry in Glasgow, and it is hoped and expected that this interest and participation will increase. Of the forty hours of lectures in the course, thirty are given by a member of the Natural Philosophy Department of the University, and the last ten by a member of the Engineering Department. The first few lectures are devoted to elementary atomic and nuclear physics, with emphasis on the energy bound in atoms, molecules and nuclei and on the possibilities of the release of this energy, and then the properties of neutrons and simple treatments of neutron thermalization are considered. This leads on to reactor physics, with calculation of the critical size of a homogeneous, graphite-moderated, pure uranium-235 reactor and simplified calculations for a heterogeneous reactor using natural uranium as fuel. A short account is given of the engineering problems caused by the fact that many materials have high cross-sections of thermal-neutron absorption. Further lectures deal with problems of irradiation, damage to reactor materials, health physics, radiation shielding, isotope separation, the breeding of nuclear fuel, and the uses of radioactive isotopes in industry. In the last ten lectures problems of heat transfer from the fuel elements to the coolants are discussed, together with the conversion of this heat energy into useful power. For the practical course, only ten two-hour periods are available, and the experiments are therefore simple, being designed either to demonstrate the orders of magnitudes of the relevant physical quantities or to illustrate points of nuclear engineering practice.

Technical College Libraries in Great Britain

A MEMORANDUM on libraries in colleges of technology and further education, which has been forwarded by the Council of the Library Association to the Scientific and Technical Information Committee of the Advisory Council on Scientific Policy, urges the need for a higher priority for college libraries in the expansion of technological and technical education and the allocation of more money for such libraries. Of the 555 institutions in Great Britain providing in some degree technical education, only 160 possess three hundred or more books housed in a room called a library, although this room is often used for other purposes and only is open as a library at specific times. 121 of these have some person other than a member of the teaching staff in charge, and altogether fifty-nine qualified librarians are employed in fifty-two libraries. The annual allowance for books, periodicals and equipment may vary from £50 to more than £2,000. Apart from meeting the needs of students and teaching staff for books and periodicals and providing an information service to assist students and staff in studies and research activities, a few of these libraries make useful contributions to the technical information service for industry; and the Library Association Council is convinced that the provision of adequate library services in technical colleges would make a valuable contribution to the dissemination of technical information and would also assist the training of qualified technologists.

For these reasons a statement of government policy regarding libraries for the various grades of technical colleges is urgently required to guide local education authorities and the Ministry of Education as to the development of existing libraries and the establishment of new ones. The Council also recommends that, in considering this development, due regard should be paid to co-ordinating the libraries with the services already provided by public, university and other libraries within the area served by the colleges, and all these libraries should be encouraged to co-operate in regional schemes for the provision of technical libraries, especially in subjects in which the college offers advanced courses. Special grants are needed to inaugurate and maintain libraries at a reasonable standard of efficiency, and the Council suggests that the 50 per cent subsidy on H.M. Stationery Office publications which is already enjoyed by public libraries and university colleges should be extended to all technical college libraries. National negotiation of salaries for qualified library staff by the appropriate Whitley Council is also recommended, as well as training in the use of libraries and books as part of the curriculum in all technical teacher-training colleges.

Ion-Exchange Resins for the Production of Pure Water

A LECTURE under the title "Will Ion Exchange replace the Laboratory Still?" was given to the Institute of Science Technology by Mr. W. F. Lorch (Elga Products, Ltd.) at King's College, London, on March 5. The considerable amount of power wastage in attempting to remove small amounts of impurities from large volumes of water was stressed. Ion-exchange resins, and the fact that most compounds ionize in water, gave the key to this problem. Three main methods of water treatment were outlined. The batch method, in which a quantity of mixed anion and cation resins is shaken with singly distilled water for one minute, is suitable for obtaining small amounts of very pure water. The two- or multi-column process requires flow through a cation and then an anion exchanger, or preferably a number of these in series since various equilibria are involved. Regeneration of the resins *in situ* necessitates the use of considerable quantities of rinse water. The single-column method uses a mixed bed of anion and cation resins, giving in effect a multi-stage process. With large-scale plants it is now possible to carry out regeneration *in situ*. The portable deionizer, which was demonstrated, is supplied with exchangeable cartridges of the mixed resins. Single-column exchangers can replace a distillation unit for most purposes. The cost of 'ion-exchange' water is in general much less than that of singly distilled water, while its conductivity is much lower. During the discussion it was mentioned that cartridges containing a dyed resin would soon be available, thereby enabling visual indication of exhaustion. The total solids obtained from an apparatus of this type is of the order of 2 p.p.m.

East African Agricultural and Fisheries Research Council: Report for 1954–55

THE East African Agricultural and Fisheries Research Council, which was established in 1954 as the governing body of the four East African Research Organizations, has issued its first annual report, covering the year 1954–55 (pp. 84; from the Librarian, Office of the Administrator, E.A. High

Commission, P.O. Box 601, Nairobi, Kenya; 1955; 3*s*.). Part 1 of the report gives a summarized account of the initial activities of the Council and the sequence of events leading to its formation. The details of its constitution and the Order approving its establishment are published as appendixes. Part 2 consists of reports from the four organizations themselves, namely, the East African Agriculture and Forestry, Veterinary, Fishery, and Marine Fisheries Research Organizations, respectively. They do not replace the annual scientific reports of these bodies, which will continue to be published separately. The aim is to give a general account in non-technical language of the individual problems, policies and achievements of the different organizations, and they certainly succeed in conveying the impression of well-planned research over a vast field. The agriculture and forestry report perhaps deserves special mention, for it reviews the work of the past seven and a half years, and in spite of the inevitable difficulties of a developmental phase, much has already been accomplished. The veterinary report provides an insight into the magnitude and variety of the problems confronting the livestock industry in East Africa, and the policy here will be to concentrate on relatively few, long-term and essentially East African problems. The establishment of the whole of this Organization at the new headquarters will simplify the necessary team-work. The fishery and marine fisheries reports are mainly concerned with fundamental investigations regarding the occurrence, life-cycles and feeding habits of freshwater and sea fish, together with complementary biological and hydrographic studies of their environment. Only on the basis of such knowledge can sound, economic fishery industries be built up.

Electronic Recording Machine for Financial Accounting

THE October issue (7, No. 9; 1955) of *Research for Industry*, the news bulletin of the Stanford Research Institute, Menlo Park, Calif., is devoted to a description of ERMA (Electronic Recording Machine, Accounting) which has been developed in the Institute's Computer and Control Systems Laboratories for the Bank of America. The machine credits individual accounts with deposits, debits withdrawals, remembers details of all transactions, maintains correct balances, prevents overdrawing of accounts, and sorts cheques. The electronic book-keeper has five input keyboards and two magnetic drums for recording up to thirty-two thousand accounts. Each cheque is identified by 'reading' information in coded-bars printed in magnetic ink on the back of the cheque. Detailed account information is stored on magnetic tapes, and monthly account statements are prepared from this information by a high-speed printer. ERMA contains 34,000 diodes and 8,000 other valves, weighs about 25 tons, uses 80 kW. of electricity and is cooled by an air-conditioning system. The first machine is to be moved to San Jose early this year to handle accounts in that area, and the Bank of America will need about thirty-seven machines to serve its branch banks in California.

New Permanent-Magnet Materials

THREE new commercial permanent-magnet materials, which are modified forms of 'Columax' and are known respectively as 'Alcomax II *S.C.*', 'III *S.C.*' and 'IV *S.D.*', are now being made by member firms of the Permanent Magnet Association (301 Glossop Road, Sheffield 10). The performances of these new materials are intermediate between those of 'Alcomax' and 'Columax', although precise specifications are not given; the development of the crystal structure is limited to certain shapes and sizes, plain solid cylinders of diameter greater than 19 mm., with length somewhat less than the diameter, being most effective. The *B*—*H* curves show considerable improvement in remanent induction, coercivity and fullness factor over those of normal 'Alcomax III'. The new materials are likely to be particularly useful to manufacturers of loud-speakers.

Auxin Transport in Woody Shoots

ALTHOUGH the polar transport of natural auxin has now been confirmed for many herbaceous and woody species of plants, the rate at which it takes place has so far only been examined directly in the coleoptile of *Avena* and in the gynophore of *Arachis hypogaea*. F. G. Gregory and C. R. Hancock (*Ann. Bot.*, N.S., 19, 76, 451; 1955) have now described a method for the estimation of the rate of movement and the quantity transported of the natural growth hormone in standard isolated segments of apple shoots. During controlled storage, diffusible auxin is collected, and later by dividing the standard length of stem into small sections the location of the auxin front is determined, from which the rate of transport is deduced. Temperature markedly affects both rate of transport and amount of auxin transported, a maximum occurring at 27–30° C., followed by a rapid fall to zero. The total diffusible auxin in a given length of stem is not affected by storage temperatures below 30° C., but falls to zero at 42° C. The rate of transport and amount transported are proportional to the oxygen tension over the range 0–5 per cent oxygen, and there is some evidence for destruction of auxin in tensions below 2 per cent.

International Association of Agricultural Librarians and Documentalists: *Quarterly Bulletin*

THE International Association of Agricultural Librarians and Documentalists was founded in 1955 to promote "internationally and nationally, agricultural library science and documentation, as well as the professional interests of agricultural librarians and documentalists". The interests of the members cover a wide field, as the term agriculture includes forestry, agricultural engineering, veterinary sciences, food and nutrition, etc. As a start, five working committees have been set up to deal, respectively, with the publication of a news bulletin, bibliography, professional problems, exchange of material and classification. The first number of the *Quarterly Bulletin* has now appeared, under the editorship of Mr. D. H. Boalch (Rothamsted Experimental Station, Harpenden), with the help of some twenty correspondents from various countries. It contains lists of new periodicals and reference books, and notices of forthcoming publications and congresses. Offers and requests for exchange and information regarding current professional literature naturally also find a place in a periodical of this type. The *Bulletin* is free to members of the Association only, the annual subscription for institutions, libraries, etc., being 50 Swiss francs or its equivalent, and for private individuals 10 francs. Inquiries regarding subscriptions should be addressed to the treasurer, Mr. T. P. Loosjes, Twentse Bank, Wageningen, Netherlands.

Low-Temperature Crystallography: Conference in Oxford

A CONFERENCE on low-temperature crystallography, organized jointly by the X-Ray Analysis Group of the Institute of Physics and the Low Temperature Group of the Physical Society, will be held in the Clarendon Laboratory, Oxford, during April 12–13. On the first day two sessions will be held on the following topics: physical problems in low-temperature crystallography (chairman, Dr. K. A. G. Mendelssohn), and X-ray methods and measurements at low temperatures (chairman, Prof. C. S. Barrett). The third, and last, session on April 13 will be devoted to a mixture of topics (chairman, H. P. Rooksby). On April 11, prior to the conference, the X-Ray Analysis Group will hold its annual general meeting, followed by a general discussion on the collection and classification of crystallographic data for determinative and reference purposes. The meetings are open to all interested, a fee of one guinea being charged to those who are not members of the Institute of Physics or the Physical Society. Registration forms and further information can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Discontinuance of the Physical Society's Reprint Scheme

DURING the past three years the Physical Society has run a reprint scheme whereby members and subscribers could purchase reprints of individual papers published in the Society's *Proceedings*. A survey conducted at the end of the three years has shown, however, that only about 5 per cent of the members have utilized the service and that the scheme has proved very costly, of the order of £600 a year compared with about £200 income from the sale of reprints. Accordingly, the Society has regretfully decided to discontinue the scheme as from the beginning of this year and the publication of Abstracts Bulletin No. 38.

Announcements

THE following elections have been made in the Paris Academy of Sciences: Prof. C. Bressou, director of the National Veterinary School of Alfort, to be a member of the Rural Economy Section in succession to the late Prof. M. Javillier; and Prof. F. van den Dungen, professor of analytical mechanics in the University of Brussels, to be *correspondant* for the Mechanics Section in succession to Prof. T. von Kármán, recently elected a foreign associate of the Academy.

THE Institution of British Agricultural Engineers is again offering two scholarships to candidates who are eligible for taking the final examination in 1957 for the National Diploma in Agricultural Engineering. The awards are the Farm Mechanization Scholarship (£100) of the Temple Press, Ltd., and the Dunlop Rubber Co., Ltd., Scholarship (£250), which is for a university graduate wishing to obtain the Diploma as a specialist qualification. Application forms, to be returned by May 1, and further information can be obtained from the Secretary of the Institution at 6 Buckingham Gate, London, S.W.1.

THE Society for Psychical Research is offering a prize of fifty pounds for an essay of less than 3,000 words on one of the following topics: (*a*) the best programme of research for the first one hundred hours of work with the next successful card-guessing subject discovered; the design should be supported by argument; (*b*) the best discussion of the logical and/or scientific implications of precognition, assuming this to be established statistically from the work of card-guessing subjects. Entries should be submitted under a pseudonym, and should be sent not later than October 1, 1956, to the Secretary, Society for Psychical Research, 31 Tavistock Square, London, W.C.1.

AWARDS are being offered from the Life Insurance Medical Research Fund of Australia and New Zealand, and as in previous years these will consist of grants-in-aid to non-profit institutions conducting medical research, fundamental or clinical, and research fellowships to medical graduates or those with equivalent scientific training for full-time research in problems broadly related to cardiovascular function and disease. The grants-in-aid are designed to cover all the financial requirements of a particular line of research and are usually £1,000–£3,000 a year for one to three years. The research fellowships may be taken up in Australia and New Zealand (£1,800–£2,000) for one year initially, or may be travelling fellowships for two years abroad and a third year in Australia or New Zealand (£2,000–£2,250 a year). Application forms for the awards, to be returned by July 1, and further information can be obtained from Dr. John H. Halliday, Medical Director, Life Insurance Medical Research Fund of Australia and New Zealand, 87 Pitt Street, Sydney, N.S.W.

THE Royal Society of Medicine, Section of Experimental Medicine and Therapeutics, is arranging a symposium on "Anti-tumour Agents", to be held in the rooms of the Society on May 7. Two groups of anti-tumour drugs will be discussed, namely, cytostatic agents (such as the nitrogen mustards) and antimetabolites, from the point of view of their physico-chemical properties, metabolic reactions and anti-tumour activity for both experimental and human cancers. Further information can be obtained from Dr. T. M. Chalmers, The Middlesex Hospital, London, W.1.

A SYMPOSIUM on "Corrosion Prevention in Packaging and Storage", organized by the Corrosion Group and the Birmingham and Midland Section of the Society of Chemical Industry, will be held during April 11–12 in the Chemistry Lecture Theatre of the University of Birmingham. Owing to the printing-trade dispute, it will be impossible to provide preprints of the papers; but summaries of all the papers and, where possible, complete copies of some of them will be sent to those registering for the symposium. Non-members of the Society can participate on payment of a fee of one guinea. Registration forms, to be returned by April 3, and further information can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

BEGINNING this year, the *Physical Review* will no longer reprint the programmes and abstracts of papers contained in the *Bulletin of the American Physical Society*. The *Bulletin* will be published as a separate journal eight times a year and will appear previous to each meeting of the Society, so as to contain the detailed programme and abstracts of all papers to be presented at the meeting. Abstracts that appear in the *Bulletin* will not necessarily be published in the *Physical Review* or in the Society's other publications.

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1954

THE ninth annual report of the South African Council for Scientific and Industrial Research, covering the year ended October 4, 1954*, is, as usual, bilingual but now printed in double column. The research unit set up last year within the National Chemical Research Laboratory to deal with the needs of the Department of Nutrition has now been given independent status, and the number of major national laboratories directly controlled by the Council is now six. The Council's staff exceeds seven hundred, including 158 research scientists; but reference is made to the acute shortage of experienced scientists and engineers, particularly at the management-level, both in government technical departments and in industry. Postgraduate bursaries were awarded to sixty men and women during the year to enable them to extend their research experience, and also sixteen senior bursaries to research workers in universities and scientific institutions. An increasing proportion of the Council's operating expenses is now being met from funds other than Parliamentary appropriations, while, of the £90,000 now available annually to the five industrial research institutes subsidized by the Council, more than half is received from the industries concerned. Two new medical research units were formed during the year—for dental and for heart research, respectively, the latter being chiefly on investigation of myocardial infarction and coronary arteries. At the end of the report are a list of research bursaries and assistantships awarded during the year and also a list of publications by the Council and its staff or bursars.

In the National Chemical Research Laboratory, where a shortage of technical assistants in relation to research staff severely handicaps most divisions of the work and more experienced staff for process development is also needed, studies of South African clays have continued and further fundamental data were obtained on the electrode potentials of chromium and iron in acid solution in the presence of a mercury electrode. A fundamental study of the mechanism of autoxidation of branched-chain hydrocarbons has been initiated, and the conditions established under which pure 5-methylnonane autoxidizes without extensive gross degradation. The Laboratory is also examining the catalysts to be used in the Fischer–Tropsch process reactors and the products obtained with them. Considerable progress has been made in the desalting of brackish waters containing up to 10,000 p.p.m. of dissolved salts by electro-dialysis through ion-exchange membranes, and a pilot plant with a capacity of about 250 gallons per hour when desalting from 3,000 to 1,000 p.p.m. of sodium chloride has been operated day and night for several months to obtain design data for large-scale apparatus for gold mines in the Orange Free State to deal with brackish water. Problems involved in the purification of sewage effluents for re-use have again received priority, and operation of an experimental solar distillation unit has indicated that a unit of only 32 sq. ft. pan area is sufficient to supply drinking water for a normal household in places where only saline water is available.

Work on wool and marine oils has continued vigorously, and the optical configuration of wool wax and brain α-hydroxy acids was established by the synthesis of a series of Ls-α-hydroxy acids from Ls-malic acid. Continued study of sugar-cane cuticle wax has indicated that the main constituents are long-chain alcohols, and in view of the growing production of sisal in the Union the cuticular and wax coatings of the leaves of an *Agave* species have been studied. Fundamental structural studies are being made on the agar from *Gracilaria confervoides*; the mechanism of polymerization of certain natural fats has been further studied and the structure of methyl linoleate dimer investigated by a dehydrogenation–oxidation procedure. In the field of nutrition much attention is being given to the production of fish flour in a form suitable for enriching bread, and to its nutritional evaluation. Investigation of pentachlorophenol and other substances as inhibitors of corrosion of concrete by sulphuric acid - producing bacteria indicated that use of bactericidal cements is unlikely to prevent corrosion of concrete sewers in warm climates and that the solution must be sought in designing the sewer so as to prevent the build-up of hydrogen sulphide concentrations. The surface diffusion of adsorbed molecules has been further investigated and also the uptake of the systemic insecticide, OO′-diethyl *o*-ethylmercaptoethyl thiophosphate, from the point of view of its possible toxicity for human consumption.

The National Physical Laboratory is also experiencing difficulties in recruiting staff, particularly nuclear physicists and biophysicists, from abroad. Satisfactory progress is reported, however, with the erection of the cyclotron, which should have been complete by December 1955. Assistance is being rendered on an increasing scale to the Geological Unit of the Atomic Energy Board. A new method, based on an exchange reaction using radioactive iodine as tracer element, is being investigated for determining thyroid hormone in the blood, and the first phase of a study of hookworm infestation with iron-59 as tracer has been concluded. Progress is reported in the construction of a highly sensitive mass-spectrometer for the analysis of age of minerals with low uranium content, and electron-microscope observations on grain boundaries, sub-grain boundaries and slip traces on aluminium–copper alloys have provided direct evidence of the presence of dislocations. X-ray diffraction studies show that nickel, cobalt and zinc acetates have normal structures unrelated to those determined for cupric and chromous acetates. A curved crystal monochromator has been designed and built for the study of plastic deformation in metals, and a photometric method has been developed for the determination of sodium, potassium and calcium and also methods for determining the trace elements cobalt, molybdenum, zinc, lead, vanadium, chromium, nickel and sulphur. Further work has been done towards the establishment of primary temperature standards, and a new building for acoustic research completed and occupied. Electronic circuits for a direct-reading spectrograph have been designed so as to eliminate the photographic plate and thus speed up spectrochemical analysis.

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* South African Council for Scientific and Industrial Research, Ninth Annual Report, 1953–54. Pp. x+142. (From the Council, Pretoria, 1955.)

Considerable progress has been made in establishing facilities for research in mechanical engineering. An investigation on the influence of pre-deformation on the plastic properties of metals continued, and a fundamental investigation was commenced into the effect of interrupted loading and periodic overloading on the fatigue of metals. Considerable progress was made with the construction of apparatus for examining the use of South African coal as gas-turbine fuel and for the study of heat transfer between solid boundaries and fluids, while equipment has been designed for the study of heat transfer under condensing conditions. Facilities are also being developed for testing and calibrating instruments to measure accurately the low air-speeds which often prevail in ventilated spaces, and a study of fan design in relation to noise has been started.

The work of the Telecommunications Research Laboratory has included the measurement of radio noise-levels at 100 kc./s. with the view of assessing the effect of atmospheric radio noise on navigational aids, the study of the occurrence of precipitation static and corona effects in aircraft in flight, a survey of the effect of soil and terrain on the propagation of low-frequency radio waves in South Africa, and the study by radar of lightning discharges, while for the Department of Defence radar equipment specially suited to South African conditions is being developed. The National Building Research Institute has occupied its new Building Research Laboratory; although the move considerably interrupted laboratory work, fundamental work was carried out on foundations on expansive clay soils and on the behaviour of the hydration products of cement minerals in aggressive solutions; a brochure of house plans for the urban Bantu was prepared as well as a guide to the planning of Bantu primary schools and a paper of climatic data for use in the design of buildings in the Union.

The work of the National Institute for Personnel Research has been handicapped by a shortage of graduate staff and a labour turnover as high as 27 per cent. Considerable work continues to be done on personnel selection, although the work generally is now directed to the efficient use of personnel, including aptitude tests for native labour, field studies of the mentality of indigenous African peoples, and studies on the nature and measurement of personality and of the forensic and sociological implications of electroencephalography. Defence research included a study of methods of assessing flying proficiency and a new general screening and classification test for the Union Defence Forces. Besides collecting data on road accidents in a large passenger transport corporation, the Institute is investigating the causes of motor-cycle accidents.

The Leather Industries Research Institute records progress in its studies on the structure and molecular weight of wattle tannin fractions, the structure of the chromium complex, the theories of vegetable and chrome tannage, the physical properties of the globular proteins of hides and the shape characteristics of various South African groups of feet. Much of the work of the Fishing Industry Research Institute was again on a short-term basis, but it included attempts to discover a satisfactory objective test for freshness and to determine nutritional values and trace elements in marine products. The Sugar Milling Research Institute continued to study methods of juice clarification, and much attention was paid to the occurrence of starch in cane juice and in sugars. The Paint Industries Research Institute's examination of paint performance has indicated that the climate in Durban is exceptionally severe, and that the simpler kinds of finish do not give good results. The most notable achievement of the South African Wool Textile Research Institute has been the development of a theory of the origin of medium- and long-term irregularity in worsted yarn which permits detection of a machine that is not drawing properly and also forecasts the minimum number of drawing operations required to draw and spin a given wool top. The Bituminous Binder Research Unit has completed a preliminary investigation of photo-oxidation in the weathering of binders on the road and is attempting to establish the physical mechanism of binder failure under traffic. Medical research has included further work on the culture of amœba, the pathology of bilharziasis in experimental animals, the serological diagnosis of cercariæ, the use of the ballistocardiogram in assessing the functioning of the heart, studies in the nutrition of Bantu infants and young children, the macromolecular syndrome and the experimental physiology and metabolism of the baboon, physico-chemical studies on animal viruses, and studies on bacteriophage inhibitors and the isolation of viruses.

TECHNICAL CO-OPERATION SCHEME OF THE COLOMBO PLAN

IN June 1955 the Technical Co-operation Scheme of the Colombo Plan, the main purpose of which is to help member countries to raise the level of technical skills among agricultural, industrial and other workers, in co-operation with the technical assistance programmes of the United States and of the United Nations and its Specialized Agencies, completed its fifth year, and the report for 1954–55*, issued by the Council for Technical Co-operation in South and South-East Asia, records that all four main developments noted last year gathered momentum.

There was an increased flow of technical aid experts, trainees and equipment: 1,023 training places were provided in 1954–55, compared with 508 in 1953–54, bringing the total to 2,676, of which 440 were for training in agriculture, 428 in administration, 331 in engineering, 305 in education, 293 in medicine and health, 219 in industry and trade, 195 in transport and communications and 146 in power and fuel. Australia took 916 trainees, Great Britain 853, India 340, Canada 311 and New Zealand 226. The demand for experts, 129 of whom were provided in 1954–55 (compared with 86 in 1953–54), making a total of 392 against applications for 672, was heaviest in medicine and health (117), with transport and communications (54), engineering (51), food, agriculture and forestry (47), education (42) and industry and trade (27) following. Great Britain provided 157 experts, of whom 65 went to Ceylon, 64 to India and 23 to Pakistan; Australia 115 (35 to Malaya, 28 to Ceylon, 28 to Pakistan), Canada 59 (26 to Ceylon, 11 to Pakistan); New

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* Colombo Plan. Technical Co-operation Scheme. Report for 1954–55 by the Council for Technical Co-operation in South and South-East Asia. (London: H.M.S.C., 1955.) 1*s.* 3*d.* net.

Zealand 44 (14 to Pakistan, 10 to Ceylon) and India 14 (10 to Ceylon, 4 to Indonesia). Posts of professors at universities and technical institutes remain hard to fill, and recruitment of some types of engineers and technicians is difficult. More inquiries are being made about the availability of firms of consultants. As regards equipment, the trend is towards equipment for establishing or expanding training and research facilities in the region with the object of training instructors. Equipment has already been supplied, ordered or offered to the value of £1·5 million against requests for more than £2 million, including £344,000 worth of laboratory equipment for research, £927,000 of training equipment and £97,000 of equipment for food and agriculture, most of this coming from Great Britain.

The movement to create or expand and improve training centres in South and South-East Asia continued. Among many examples given in the report are the assignment by Great Britain of four medical scientists to help the new medical colleges established by the Government of India by lecturing and demonstrating for ten weeks in India new techniques in diagnosis and treatment; the library facilities given by Australia and New Zealand to the University of Malaya, Singapore; the supply to Pakistan by Britain of equipment, an engineer and three demonstrator instructors to assist the change-over from manual control to automatic telecommunications; and the training of twenty-two teachers to help organize and administer technical high schools being established by the Pakistan Government.

Mutual aid in the region also made some further progress, and greater use continues to be made of technical assistance to promote economic development and raise the standard of living. Among new projects in this field the emphasis has now shifted from measures to avoid loss from pests, weeds and disease to measures to preserve food. Australia is giving equipment to the Dairy Research Institute, Bangalore, and is also arranging a tour for milk commissioners from Bombay and West Bengal and the head of the Dairy Technology Division of the Indian Dairy Research Institute to observe the large-scale handling and manufacture of milk and milk products. The Ceylon Government is taking steps to establish a rice research organization to help the drive towards self-sufficiency in rice, and Japan is sending two leading rice physiologists to study conditions in the main rice-growing areas and submit a detailed scheme for the proposed research organization. Britain has assigned an expert to the Indian Central Cotton Committee to review cotton research at the Institute of Plant Industry, Indore, and is supplying equipment to the newly established Pakistani Institute of Cotton Research and Technology at Karachi. Under the Colombo Plan agriculture is being promoted, along with industry, by irrigation and power projects, while output is being increased by the improvement of transport and communications. Britain, for example, is training the assistant director of soils for the Central Road Research Institute, Delhi, and has sent the Deputy Chief Engineer of the B.B.C. to review installation work already carried out by Radio Pakistan and to advise on the technical aspects of the future development plans; it has also assisted the Indian Central Glass and Ceramic Institute and the Central Leather Research Institute with technical facilities. Australia is providing research equipment for the brick and tile industry of Ceylon and is training a Pakistani officer who is to be employed on wool research testing, as well as five sugar technologists for Pakistan's new sugar factories.

While more trainees were sent abroad under the Scheme in 1954–55 than in any previous year, the training was also more closely fitted to the needs of the development projects. Under the Colombo Plan, including United States assistance, the countries of the area have now sent abroad 5,701 trainees and received 1,341 experts, mostly from outside the region; with the United Nations figures, the totals are 7,159 trainees and 3,741 experts. A large measure of co-operation has now been achieved, and the co-operating governments have a better idea of what forms of assistance the respective agencies can best provide.

MAN-POWER IN THE BRITISH COAL INDUSTRY

In a lecture to the Royal Institution of Public Administration on November 28, 1955, Mr. A. H. A. Wynn, scientific member of the National Coal Board, discussed the momentum of decline of the coal industry, which continued in spite of any increase in demand. Behind a fall in production from 287 million tons in 1913 to 174 million tons in 1945, the industry's ability to produce has also fallen. Mr. Wynn did not discuss many of the factors contributing to this momentum of decline, but pointed out that because of the gradual exhaustion of reserves in each individual mine, the productive capacity of the coal industry must decline by two or three per cent each year, if there is no large-scale reconstruction and no new collieries are opened. This decline affects adversely the standards of the industry's technology, its staff structure, its world reputation and its ability to recruit staff. Mr. Wynn did not discuss these imponderable psychological and educational problems, however, but rather the creation and growth of special administrative structures, some of which would be the responsibility of scientists and engineers. These organizations, he thought, are the most hopeful means of reversing the decline. He suggested that they fall under four headings: exploration, or the survey of natural resources; capital investment; the improvement of methods of production, primarily by promoting technological progress; and research and development, directed to increasing the commercial value of the industry's products. All are closely related; but only the first is peculiar to an extractive industry, and the inadequacy of our knowledge of coal resources is a factor in the momentum of decline that has delayed the reconstruction of the industry. The Board has also had to establish from slender resources the Planning Branch of the Production Department responsible for the large-scale reconstruction of old mines and the development of new ones, and its task has been made more difficult by the scarcity of suitable staff and the urgent demands for more coal.

Before 1947, the resources of the industry of Britain for promoting technological development were few; but the industry was profoundly dependent on heavy labour. A Mechanization Branch of the Production Department was established in 1947, supported by an Engineering Branch, and recently the Board has established a Central Engineering Establishment, near Burton-upon-Trent, for pursuing the development of new machines and providing guidance to manufacturers; and a Mining Research Establishment was set up at Isleworth in 1952. The Safety in Mines Research Establishment of the Ministry of Fuel and Power is still the largest mining research establishment in Britain, and the National Coal Board has inherited very few men experienced in mining research. In the post-war man-power situation, the Board has found difficulty in recruiting the scientific and technical staff it needs, and this is the main limit on the Board's expansion plans. Mr. Wynn emphasized that production depends on the outcome of a race between increased mechanization and falling man-power in the mines. Two other organizations, however, have also been established which can do much to improve productivity. The Scientific Department has established a Field Investigation Group, analogous to the operational research teams of the Service departments, and the Production Department has set up a Method Study Branch. These establishments are in close touch and will play a big part in reducing man-power requirements.

SOCIAL PROBLEMS OF INDUSTRIAL DEMOCRACY

THE Department of Social Science, University of Liverpool, has published, as Occasional Papers No. 2, "Industrial Democracy: a Revaluation", by W. H. Scott (pp. 40. Liverpool: University Press, 1955; 3*s*. 6*d*.). This essay is intended to meet the needs of industrialists, trade unionists and others who wish to acquaint themselves rapidly with some of the broad conclusions resulting from systematic research and current thought on this topic. It is limited, however, primarily to problems arising at the factory- or plant-level and is essentially a stock-taking. Industrial democracy is regarded as implying the participation, to a greater or lesser extent, of those who work in industry in determining the conditions of their working lives. The review answers the question, "Is industrial democracy desirable ?" with an emphatic affirmative, and Mr. Scott also believes that industrial development has justified our faith in the efficacy of democracy to check the arbitrary use of power.

While an extension of the democratic principle at the formal policy-making level of a firm is important, its application in day-to-day executive leadership is equally vital, and these two processes are interdependent. Mr. Scott makes some constructive comments here, and on the position of the trade unions, which are of especial interest at the moment. He notes the need to develop "consultative leadership" as part of the administrative routines of a firm at every level, as an essential concomitant to more effective formal procedures at the policy-making level, pointing out that higher management must take and maintain the initiative in both these respects. He also directs attention to the presupposed attitudes of leadership and administrative ability and to the implications in respect of selection and training for such posts. Similar considerations apply to the trade unions, and if the excessively bureaucratic tendencies of some unions are to be checked, and a balance achieved between the need for a measure of centralized administration and the desirability of developing local initiative and responsibility, then similar criteria must be applied to the selection and training of full-time trade-union officials.

Just as the effective working of any new procedures within the firm calls for a capacity for consultative leadership on the part of managers, so the delegation of greater responsibility to lay-representatives by the unions, which is so essential to industrial democracy, requires appropriate attitudes on the part of officials if it is to be used creatively. Moreover, industry does not exist *in vacuo*, and Mr. Scott points out that to achieve stable and enduring changes in industry, we must also concern ourselves with developments in other institutions of our society and particularly those which are basic and most formative of personality.

FIBRE MICROSCOPY

A WELL-ATTENDED symposium and exhibition organized by the Industrial Section of the Royal Microscopical Society was held at the British Pharmaceutical Society in London on November 16, three sessions of papers being given in the lecture theatre, while an exhibition was staged in the hall. Opening the first session of papers, Dr. R. C. Faust discussed the use of the interference microscope in the examination of fibres. The degree of molecular orientation and closeness of molecular packing at different regions of an anisotropic fibre have been studied by means of multiple-beam interference with the conventional microscope and by means of two-beam interference with the Baker interference microscope. Mr. D. S. Gowers then described the study, by interferometric methods, of the adhesion between fibres. When an artificial point of contact between a fibre and a quartz plate is examined by incident illumination, Fizeau fringes give a contour map of the fibre surface. The area of contact can be determined by the intensity distribution across the central dark spot. The effect of humidity, temperature and contaminants in the fibre was discussed.

The first two papers in the second session were devoted to the methods of producing replicas for use in the electron microscope. With textile fibres it is the surface that is of main interest, and this may be studied by means of replicas of the fibres, examined under the reflexion electron microscope. The curvature of the fibre presents an added difficulty in obtaining a successful replica, and Dr. J. Dlugosz described the various methods of replication investigated to obtain a successful routine method.

A method of producing solid metal replicas of fibres, for use in the reflexion electron microscope, was then described by D. E. Bradley, who discussed the advantages of this method over that of direct examination, and Dr. K. Little considered the use of the electron microscope in conjunction with other techniques, such as X-ray diffraction, histology and chemical investigations, in the study of fibres in human connective tissues. Each method of microscopy has its advantages and its limitations. H. W. Emerton's paper, read by D. H. Page, described how, by using three methods—namely, light microscopy, reflexion electron microscopy and transmission electron microscopy—in the study of natural fibres, a more complete picture can be obtained. By means of a plastic metal replica, the same fibre can be examined by all three methods.

The third session was opened by Dr. A. E. J. Vickers with a short historical survey of the production of quartz fibres, accompanied by a demonstration. Their physical properties, and their recent use in optics for the rapid transmission of images, were discussed. H. M. Appleyard described how the causes of faults in textiles, many of which are not obvious until the fabric has been dyed and finished, can be ascertained by microscopical examination. Faults may be due to adulterant fibre in the blend or to solid matter attached to the fibres, such as pieces of skin. Identification tests include normal histological techniques or microchemical tests followed by examination under the conventional or phase-contrast microscope. The systematic study of the removal, from a variety of textile fibres, of compounds of the same type as those found in fatty dirt from worn garments was described by R. E. Wagg. He discussed the action of several different classes of detergent, builders and other additives.

The measurement of the diameter of glass fibres, either mechanically drawn or steam-blown fibres, can be carried out by means of a projection microscope, and A. Pimblett described this method, together with the techniques required to prepare mounts of cross-sections of fibres. By this method of viewing, variations in diameter and cross-sectional shape, and the bonding together of steam-blown fibres to form insulation products, are revealed. The appearance and handle of acetate fabrics are profoundly affected by the cross-sectional shape and surface of the filament. These characteristics require to remain constant in a given spinning run, and L. Krause described how, as a method of control, yarns are examined microscopically for lustre and cross-sectional shape.

At the exhibition held in conjunction with the symposium, D. E. Bradley showed electron-micrographs of various fibres examined under the reflexion microscope by means of replicas. Faults causing electrical failure in thin oriented polystyrene-film capacitors have been identified microscopically as particles of dandruff introduced by the machine operators, and H. F. Church exhibited several of these faults, together with photomicrographs illustrating their structure. Dr. M. Dempsey and Miss B. M. Haines demonstrated a melting-point apparatus, adapted for measuring microscopically the shrinkage temperature of isolated leather fibres, and H. W. Emerton, J. Watts and D. H. Page showed photo- and electron-micrographs of various paper-making fibres.

The penetration and distribution of stain in a damaged rayon fibre can determine the type of damage, and Dr. D. G. Drummond and J. E. Ford exhibited photomicrographs illustrating the different types of fibre damage. Electron-micrographs of the surface of textile fibres made by the replica technique in the transmission electron microscope were also shown. Photographs of apparatus and of Fizeau fringes around points of contact between fibres and a quartz plate were shown by D. B. Gowers, while C. F. Griffiths exhibited specimens and photomicrographs of glass fibres containing crystalline inclusions; the inclusions may originate from the raw materials, or the refractories of the furnace or devitrification of the glass itself, and they can be identified by means of the polarizing microscope or by the X-ray diffraction method.

Photomicrographs illustrating the differences between textile fibres of vegetable origin were contributed by C. J. Jarman; from the size of the cell and the number of cells to a fibre it is possible to identify the fibre. Photo- and electron-micrographs of the fibres in human connective tissues were shown by Dr. K. Little, and J. A. Mason displayed samples of 'Perspex' and polythene that had been used for insulations and were exhibiting erosion and breakdown in the form of dendritic channels formed by local stress and heating by electrical discharges. T. S. Millen and R. S. Page demonstrated the use of the electron microscope for the examination of the surface of fibres by the reflexion method.

Slides and photomicrographs were used by A. Pimblett for demonstrating the method of measuring the diameter of glass fibres, and Dr. F. Stern showed photomicrographs and X-ray diffraction patterns of coir fibre, demonstrating the special fibrillar orientation of the cellulose microfibrils. Quartz fibres and photographs illustrating the methods for producing the fibres were exhibited by Dr. A. E. J. Vickers, and R. E. Wagg and Miss Gayner Stephens showed by means of photomicrographs the effect of various detergents on fatty dirt contaminating textile fibres. C. R. Watts contributed photomicrographs illustrating various yarns and fabrics, including modern developments in bonded and coated fibres; some common faults and their causes were also shown.

Electron micrographs and stereomicrographs showing the surface characteristics and microfibrillar texture of keratin fibres were exhibited by Mr. H. J. Woods and Dr. J. Sikorski. Miss E. Frei and Prof. R. D. Preston exhibited longitudinal and transverse sections of coniferous woods 300 A. thick for study in the electron microscope; the electron-micrographs showed the fine spiral structure of the various layers of the wall.

RHEOLOGY OF PROTEINS

A SYMPOSIUM on the "Rheology of Proteins" was held in London on January 20 by the British Society of Rheology. Four papers were presented, each of which aroused considerable discussion. The chairman, Mr. A. G. Ward (British Gelatine and Glue Research Association), in his opening remarks, outlined the wide scope covered by the title of the symposium. Proteins, the mechanical properties of which play a vital part in their functioning in living organisms, include serum proteins, epidermal and connective tissue proteins, muscle proteins, many cellular proteins, mucoproteins, and mucopolysaccharides, etc. The rheological properties of certain of these also contribute to their subsequent use in meat, egg and other protein foods, in protein fibres, in gelatin and animal glue, and in other products. In the background, for all these substances, rest the two common problems of the covalently bonded structure of the protein molecules and the secondary forces—ionic, hydrogen bonding, and van der Waals interactions—which link the molecules together to form macroscopic aggregates. Only by isolating the simplest systems will it be possible to solve the many complex problems.

Dr. E. J. Ambrose (Chester Beatty Research Institute), in his paper on the formation of structure in protein solutions, was concerned with the conditions in which a two-phase system can be formed, the protein or related component being organized or ordered in the concentrated phase. The properties of a macromolecule determining its tendency to form such structures are particle size and flexibility, the latter influencing the disturbance by Brownian movement, shape, the interaction forces, and the degree of reversibility of the changes. If the interaction forces are strong, there is a greater tendency to a disordered separation of the second phase, whereas weak forces suffice to make the necessary links only when a degree of order is attained. These considerations were illustrated by the structures obtainable with *poly*-γ-benzyl-L-glutamate in chloroform solution, and with insulin. Birefringent structures show orientation to be occurring when phase separation occurs.

Primary interest is on the behaviour of the cell nucleus and its component nucleo-proteins. Whereas nucleic acid alone fails to give phase separation, nucleoprotein forms fibrous structures, showing birefringence and dichroism. The existence of different structures at different concentrations for nucleo-proteins is shown by a discontinuity in the relation between concentration and diffusion constants. No discontinuity is observed for the nucleic acid alone. The techniques and theories have been applied to the structure of chromosomes and also to the formation of the tail of the sperm during meiotic division.

In the second paper, Dr. A. Wassermann (University College, London) described his work on a viscosimetric investigation into the influence of *p*H and ionic strength on molecular shape of a structural muscle protein. Two views have been put forward concerning the actomyosin molecule, the first regarding it as a stiff rod or elongated ellipsoid of revolution and the second treating it as a flexible random coil. Use of the mixed-bed ion-exchange resin column enables actomyosin solution of very low salt content to be prepared. Alkali additions give solutions, the 'intrinsic viscosities' of which extrapolated to zero rate of shear, and to zero concentration, are a maximum in the region of *p*H 8–9. At higher *p*H, lower values are obtained. No peak is observed on the acid side. The absence of change below *p*H 4 is assumed to arise from anion binding neutralizing the charges developed. The peak is considered to arise from the stretching out of the molecule by the repulsion of negative charges present at the *p*H's concerned. Beyond a certain *p*H the concentration of counter ions becomes sufficient to reduce the forces between the charges, so that a reduction in 'intrinsic viscosity' occurs; similarly, the addition of neutral salt in sufficient amount reduces the changes in intrinsic viscosity to zero. All these observations are fully compatible with the random coil hypothesis but are inconsistent with the stiff rod theory.

In the third paper at the symposium, on some rubber-like and relaxation properties of gelatin, Mr. D. W. Jopling (Kodak, Ltd.) demonstrated that gelatin films maintained at a water content of 25–30 per cent by immersion in 85/15 alcohol/water or by exposure to high humidity show rubber-like extensibilities of up to several hundred per cent. This is best shown when the ordered arrangement, brought about by drying, has been destroyed by immersion in boiling methanol.

By cross-linking gelatin molecules with formaldehyde, measurements on the resultant film can be carried out at temperatures at which normal gelling forces are absent, for example, 60° C. Stress relaxation then follows the Maxwell relation log (stress) $= A - B$ (time), whereas at room temperature stress is proportional to log (time). It is assumed that at 25° C. the mechanism is primarily the release of secondary bonds, with a wide spectrum of relaxation times, whereas at 60° C. only primary bonds are broken. At 40° C. both processes can be observed to occur in succession. The form of the extension–tensile stress relation for gelatin cross-linked with formaldehyde at 60° C. follows the theoretical curve for an ideal rubber-like system up to extension ratios of 4 : 1. The values for the chain molecular weight between cross-links deduced from the theory appear high; the reasons for this are not clear.

The final paper, by Dr. J. Brooks and Mr. H. P. Hale (Low Temperature Research Station), on the mechanical properties of the ovomucin gel of the egg, was given by Dr. Brooks. The thick white fraction of the hen's egg consists of a gel in which a transparent phase is separated by a series of parallel bands of microscopic fibres. After the egg is laid, the volume of thick white decreases at a rate depending on the temperature. The mechanical properties of the gel have been investigated by a method originally devised by Freundlich, in which the displacement of a minute nickel particle inserted in the gel is measured microscopically. The force is applied by means of a magnetic field. For stresses of short duration, the displacements are elastic in character in both the transparent phase and the bands. The bands are anisotropic. The relative values of the rigidities are converted into absolute units by means of a series of measurements on gelatin gels. Measurements have been made on fresh eggs and on eggs stored at 25° and 0° C., and it has been found that there is a close relation between the rigidity of the thick white fraction and its volume, irrespective of the reason for the volume difference.

A. G. WARD

SOME RECENT DEVELOPMENTS IN MAGNETISM

THE Electronics Group of the Institute of Physics held an informal symposium in London during September 23–24 on "Some Recent Developments in Magnetism", at which seven papers were read and discussed. The first speaker, Dr. E. W. Gorter (Philips Laboratories Eindhoven), outlined the theory of the magnetic properties of the ferrite group of materials. They have the spinel type of structure, in which the metal ions occupy two different types of site, and the interactions between the ions are such that the total magnetic moment is roughly equal to the difference between those for the ions in the two types of site. Dr. Gorter showed why this relation might not be exact, and how various anomalous shapes of saturation/temperature curve can occur; he demonstrated a striking example, namely, a material the spontaneous magnetization of which is reversed as the temperature rises. The properties of ferrites can be used to infer the relative strengths of the interactions between ions in various configurations, and the evidence so obtained supports the theory of super-exchange.

Ferrites are insulators, some of them having resistivities of the order of 10^6 ohms, and can therefore be studied in fields alternating even at microwave frequencies, whereas any similar experiments with metals are largely prevented by the effects of eddy currents. J. Watkins (G.E.C. Research Laboratories, Wembley) described the Faraday rotation and the transverse phase-shift, two effects observed in such experiments. The latter effect is a variation in phase and attenuation for the two directions of propagation, observed when a magnetic material in a waveguide is subjected to a transverse magnetic field. The Faraday effect, observed when there is a static magnetic field along the direction of propagation, is non-reciprocal—that is, waves travelling either with or against the direction of the static field have their planes of polarization rotated in the same direction in space.

B. G. Parkin (Post Office Research Station, Dollis Hill) discussed the properties required in the magnetic cores used for the 'memory' circuits of computers and similar apparatus. These cores should have nearly rectangular hysteresis loops and must be capable of reversing their magnetization in a few microseconds in a field of about 1 oersted. The time required for reversal is governed not only by the decay of eddy currents but also by the damping of changes of alignment of electron spins. The operating conditions can be met both with ferrites and with metal tapes a few microns thick. A rectangular loop in metals may be produced by grain orientation as the result of severe cold-rolling, or by annealing in a magnetic field. In the discussion, Dr. Gorter explained the rectangular loops of ferrites as the result of one source of anisotropy outweighing all others.

Dr. R. Street described the experimental methods developed at the University of Sheffield for the measurement of spontaneous magnetization. In the interesting range near the Curie point, the magnetization is markedly dependent on field, and the problem is to find methods which allow extrapolation to zero field. There are two main techniques available: the measurement of mechanical force in a non-uniform field, and the measurement of temperature rise on the removal of an applied field. The use of photo-electric amplifiers with galvanometers has so increased the sensitivity attainable by the second method that results obtained by the two methods can now be compared. The approximations made in deducing Curie temperatures are such that the methods lead to values differing by, for example, 4 deg. C., but the existence of anomalous shapes of saturation/temperature curves has been established beyond question.

Particles of iron, if small enough, are known to be magnetized as single domains and therefore to have very high values of coercivity. This coercivity depends on the shape of the particles, being high if they are acicular, and is also high if the anisotropy of the material is large, as in manganese bismuthide or in cobalt. Dr. E. P. Wohlfarth (Imperial College of Science and Technology, London) indicated the types of formula that have been calculated for the effect of interactions between particles in an aggregate, and for several possible distributions of particle shapes. This work has applications not only to the manufacture of permanent magnets and magnetic recording tapes, but also to the study of rock magnetism. He is now extending the theory to the properties of particles which are large enough to contain a single domain-wall.

Dr. N. C. Tombs (G.E.C. Research Laboratories, Wembley) described experiments to produce iron powders showing the properties of a permanent magnet. For practical purposes, a coercivity of about 200 oersteds is needed, which cannot be obtained with spherical particles. Particles of hydrated alpha-ferric oxide are known to have acicular shapes, and with the help of a series of electron micrographs Dr. Tombs was able to demonstrate this property on a number of these powders prepared under laboratory conditions. X-ray analysis confirmed that the particles seen in the electron micrographs were in fact single crystals. If such powders could be reduced in a stream of dry hydrogen under carefully controlled conditions, without their shape and size being altered, then the resulting iron powder should exhibit useful magnetic properties. A further series of electron micrographs showed that during the reduction much of the acicularity of the particles was lost. Sufficient remained, however, to give a useful coercivity even after compacting. Although the $(BH)_{\text{max.}}$ product was much lower than the corresponding figure for barium ferrite, the ratio of B to H is so different in the two materials that each may be useful in particular applications.

Dr. G. E. Bacon (Atomic Energy Research Establishment) reviewed the rapidly expanding field of neutron-diffraction studies of magnetism. Elastic scattering of neutrons from either ferromagnetic or antiferromagnetic substances gives regular diffracted beams which are superposed on the ordinary scattering, and from which the order of the atomic magnetic moments can be inferred (though not without ambiguity unless the specimen is a single crystal). The evidence so obtained supports Néel's theory of ferrimagnetism in ferrites, and neutron diffraction is the main source of evidence for antiferromagnetism. Ordered forms of alloys such as Ni_3Fe have been detected. Inelastic scattering also occurs; in magnetic materials it disturbs the atomic magnetic moments and causes further inelastic scattering by which the disturbance can be detected. The most serious experimental difficulty is the weakness of the available 'monochromatic' beams of neutrons, the intensity of the beams used for X-ray diffraction being about 10^5 times as great. There is great scope for further experimental work, but much of it must necessarily wait until powerful sources of neutrons are more widely available in research establishments.

Each of these seven papers was followed by questions and discussion, and Dr. Gorter's contributions should be mentioned as being particularly helpful.

A. C. LYNCH
J. WATKINS

DAILY MAPS OF THE SUN

IN the study of solar-terrestrial relationships, obtaining solar data of a homogeneous nature over a period of years or of decades is one of the principal difficulties. Where daily observations of the Sun are required, co-operation between a number of observatories is essential if there are to be only a small number of unrepresented days. The difficulty then arises of obtaining uniform quality of original material from the different contributing observatories. Although suitable means of doing this have been available for many years in the case of solar photographs in integrated light, similar co-operation with instruments showing the features only visible in monochromatic light has in the past been hindered by difficulties in reaching agreement on the precise instrumental requirements, in maintaining the observing routine and standard of quality; and in providing suitable means for reduction and publication of material. A fresh attempt at co-operation between a number of observatories has now been started by the Fraunhofer Institut, of Freiburg-im-Breisgau, Germany, for the purpose of producing daily maps of the Sun showing photospheric and chromospheric details and coronal intensities for λ 5303.

Among the observatories contributing chromospheric data are those of Freiburg, Kodaikanal, Wendelstein, Tokyo and Sydney. The coronal data are provided from the observatories of Climax, Sacramento Peak, Pic du Midi, Kanzelhöhe and Wendelstein. Istanbul, Potsdam, Arcetri and the German and Swedish stations on Capri also contribute material. The reduction of data and production of the daily maps are carried out at Freiburg and the printing is by a half-tone process to a scale of 15 cm. to the solar diameter. Conventions are used to show the areas occupied by calcium *plages* of low, intermediate and high intensity, and the shapes of dark filaments and limb prominences are shown, all against a background of lines giving heliographic co-ordinates. Limb coronal intensities and the positions and Zurich types of the sunspot groups are shown schematically. The aim is to produce these maps at intervals of two weeks with a delay of two weeks from the date of the latest map. Only a small number of gaps are expected to occur throughout the year.

These maps will provide a series for reference which with regard to the chromosphere should be more valuable than all other similar information published elsewhere. It remains to be seen how well the standards of indicating the various phenomena fluctuate from day to day and deviate from the initial standards over long periods of time. The possibility of such variations must be kept in mind when investigating solar – terrestrial relations, and it would be interesting to know if any special safeguards have been adopted in the present instance, where quantitative assessment apparently takes no part in the stages prior to publication. It certainly seems possible to draw quantitative information from these maps in a satisfactory manner; but it is the responsibility of the person who uses the information to make sure that it is inherently suitable for his purpose. Only the considerable task of collecting the raw material and making it available has been taken for him.

P. A. WAYMAN

B.B.C. ENGINEERING MONOGRAPHS

THE *B.B.C. Quarterly*, which has been issued since April 1946, ceased publication in the autumn of 1954, and in order to provide a vehicle for the publication of technical papers of the type hitherto included in this journal, the British Broadcasting Corporation has recently issued the first four of a series of "B.B.C. Engineering Monographs", about six of which will be produced every year (annual subscription £1); each monograph will deal with a technical subject within the field of television and sound broadcasting and will describe work that has been done by the Engineering Division of the Corporation, including, where appropriate, a survey of earlier work on the same subject. The series will also contain, from time to time, selected reprints of articles by B.B.C. authors that have been published in technical journals.

The first monograph, "The Suppressed Frame System of Telerecording", by C. B. B. Wood, A. V. Lord, E. R. Rout and R. F. Vigurs, summarizes the fundamental and practical aspects of a telerecording system using standard 35 mm. film. The recording cycle consists of exposure during one whole television frame while the film is stationary in the gate, followed by pulldown of the film during the next, or suppressed, television frame. Thus the picture photographed on the film corresponds to a 202½ line structure; but with the use of spot-wobble to broaden the lines, the recording is found to give an acceptable picture when the film is re-scanned by the standard 405 lines in the telecine machine. Three photographs accompany the description of the equipment; and the results of tests have shown that the construction of an apparatus of this type using standard film-transport mechanism has been fully justified.

No. 2 in the series is a paper on "Absolute Measurements in Magnetic Recording" by E. D. Daniel and P. E. Axon, and describes work carried out in the B.B.C. Research Department to establish methods of measuring the absolute sensitivity of the component parts of the recording–reproducing system. Another contribution from the Research Department is the third monograph, that on "The Visibility of Noise in Television", by R. D. A. Maurice, M. Gilbert, G. F. Newell and J. G. Spencer. This describes a comprehensive investigation of the effect of random noise on a television picture, its dependence on the non-linearity in the relevant portions of the transmission channels and the visibility of the noise as a function of frequency. The third part of this monograph comprises four photographs illustrating the effect of noise on a television picture for four values of the signal-to-noise ratio.

The fourth monograph is entitled "The Design of a Ribbon Type Pressure-Gradient Microphone for Broadcast Transmission", by D. E. L. Shorter and H. D. Harwood. This describes work leading to the development of an improved studio microphone for both sound and vision broadcasting, with a greatly reduced weight and volume and an extension in the range of uniform frequency-response.

Summaries of recent patent applications by the B.B.C. are also included in two of the monographs, each of which is issued in a distinctive two-tone blue cover. It is likely that the series will be of interest and value to engineers engaged in broadcasting and telecommunications generally both in Great Britain and overseas.

THE METEOROLOGICAL OFFICE

ANNUAL REPORT FOR 1954–55

THE annual report for 1954–55 of the Director of the Meteorological Office* records another year of steady progress and of honest endeavour by the Office to meet the ever-increasing demands for its services. There appears to be little need for special comment regarding two of its main functions: the provision of meteorological services for civil and military aviation, for shipping, for the general public by television, radio, telephone and through the Press, for special customers such as the railways, electricity and gas undertakings, farmers, river and road engineers; and the collection, distribution and publication of meteorological data. These routine duties, which do not often reach the headlines (except when a forecast goes badly wrong on a Bank Holiday!), but which assume an ever-increasing importance in modern society, bear heavily on the Meteorological Office, which is under-staffed, poorly housed and under-financed. The total annual budget of the Office is less than £3 million—little more than the cost of a modern bomber. This is not a large sum on which to carry out its multifarious activities at home, to meet its overseas and international commitments, to develop new instruments and improved techniques and to undertake an extensive programme of research in meteorology and geophysics.

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* Annual Report of the Director of the Meteorological Office, presented by the Meteorological Committee to the Secretary of State for Air, for the Year April 1, 1954, to March 31, 1955 (M.O. 594.) Pp. 68. (London: H.M.S.O., 1955.) 2*s.* 6*d.* net.

It is, of course, largely by the quality and scope of its research that the vitality and scientific reputation of such an organization must be judged. Considerable progress has been made during the past few years, and the present report shows that this has been maintained. There have been encouraging developments in the study of numerical forecasting with the aid of electronic computers, and it has recently been announced that the Office is to have a machine of its own. The Meteorological Research Flight has continued its investigations on the distribution of water vapour and ozone and the occurrence of clear-air turbulence at high altitudes, and into the structure and constitution of clouds. Progress was made in the measurement of solar radiation and in the development of the new radar-sonde. Some attention has also been given to the possibility of increasing rainfall by cloud-seeding, and preliminary field-trials have been started on Salisbury Plain.

The pace of all this work has necessarily been limited by the availability of personnel, and the Director stresses that the continued shortage of scientific staff and the high turnover-rate (about 20 per cent per year) of assistants are matters of some concern. The total number of scientific officers on the staff of the Office is only 155, not all of whom are actively or mainly engaged on research. More serious still, only four new officers were recruited during the year—barely enough to compensate for losses through retirement and resignation. How to attract sufficient numbers of high-quality physicists and mathematicians into a field which, after all, has great opportunities for research, is perhaps the main problem facing the Meteorological Office at the present time. One welcomes, therefore, the continued and extended co-operation between the Office and the universities, both of which have a responsibility for ensuring that Britain is not left behind in the great expansion now taking place in atmospheric physics.

B. J. Mason

PHYTOPLANKTON OF LAKE TANGANYIKA

FOR one who is not conversant with all the recent work in the biological study of lakes, there is much of interest in the volume by L. van Meel, entitled "Le Phytoplancton", one of a series of reports of the Belgian Expedition (1946–47) for the "Exploration Hydrobiologique du Lac Tanganika" (Institut Royal des Sciences Naturelles de Belgique. Bruxelles, 1954. 4, Fasc. 1. *A*, Texte (pp. 681); *B*, Atlas (pls. 76)). Likewise it will be particularly interesting to all those whose experience is limited to small temperate lakes. On the other hand, the title does not prepare the reader for the table of contents, which shows that geobotany, geochemistry and geophysics of all the central and eastern African lakes (and of nineteen in particular) fill pp. 7–250. The next two hundred and twenty-five pages are devoted to a list of the algae of these lakes, and the third section dealing with the ecology of the plankton occupies one hundred and seventeen pages, the phytoplankton of Lake Tanganyika being covered in thirty-four. This indicates that a more suitable title should have been chosen for a volume which is mainly a compilation of the available information of certain aspects of these African lakes, with the additional information collected by the Expedition about the phytoplankton of Lake Tanganyika. As a compilation, it will be a most useful book of reference to many, and the information gathered together here about any one lake will provide the basis for a fuller and more searching investigation of it. The contribution by British workers to our knowledge of these lakes is clearly brought out.

The size of Lake Tanganyika is one of its most striking characters. It is the second largest of the African lakes, with a volume approximately half that of the North Sea. It is also very deep (1,470 metres in the deepest trough), being exceeded only by Lake Baikal. These facts, together with its situation near the equator and the protection given by high land from the full force of the south winds, are some of the factors combining to preserve the stratification of the water and to reduce mixing to a minimum. It is stated to have greater thermal stability than any other lake, the variation in temperature at two hundred metres being less than 5/100 deg. throughout the year. The water is clear and well-oxygenated down to a depth of 40–100 m., depending on the place and season, but from 100–225 m. to the bottom (the equivalent of three-quarters of the volume of the lake) there is no oxygen but an abundance of sulphuretted hydrogen. This is the result of the stratification (scarcely ever disturbed at these depths) and the reason for the statement that a total 'turn-over' would have disastrous consequences. It is supposed that even a partial 'turn-over' may not take place annually.

Tanganyika is a diatom lake, and in his investigations van Meel found no new species in the phytoplankton. The new information concerns rather the geographical distribution of the algæ, chiefly at the surface. The plankton of the bays is much richer than the pelagic plankton, which is poor in species (*Oocystis*, *Nitzschia*, *Anabaena*, *Anabaenopsis* being the common genera) rather than in individuals. During the Expedition's stay, the volume of plankton, however, was poor throughout most of the year, but an increase occurred in October 1946, at the end of the dry season. The permanent stratification of the deepest layers of water would appear to be an obvious reason for the poverty of the plankton, as the author suggests; but van Meel considers the inhibiting effect of light on chlorophyll to be an added reason. This would seem to control its position in depth in the Lake rather than its quantity. A certain amount of sampling at different depths leads to no obvious conclusions. With a small amount of plankton in such a large body of water, it is possible that its distribution is uneven due to currents and micro-stratifications. One set of readings appears to show a correlation with the diurnal movement of the zooplankton; but as a result of the general consideration of the food-supply of the latter, van Meel puts forward a hypothesis that it may be provided by a bacterial flora rather than by the phytoplankton.

It is concluded that Lake Tanganyika should be classed as pseudo-eutrophic since it shows characters of both oligotrophic and eutrophic lakes. On the other hand, this unusual combination of characters might suggest the need for a revision of the classification of lakes.

This is a very lavish production, information being well displayed with the aid of a liberal supply of maps, tables and diagrams. A separate volume of seventy-six plates illustrates many species of the phytoplankton of these African lakes.

KATHLEEN M. DREW

THE PRODUCT OF THE HUMAN BLOOD GROUP *A* AND *B* GENES IN INDIVIDUALS BELONGING TO GROUP *AB*

By PROF. W. T. J. MORGAN, F.R.S., and DR. WINIFRED M. WATKINS
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INTEREST in the chemical nature and serological relationships of the substances which are responsible for the differentiation of human red blood cells into well-defined groups arises from two sources: these materials are of importance in the field of immunochemistry because each possesses a distinct serological specificity, and in the field of biochemical genetics because each characteristic specificity is believed to be the result of the action of a single gene.

The only human blood-group substances for which the chemical nature is known with any degree of certainty are those which characterize the *ABO* and *Lewis* systems, since these specific materials occur in the tissue fluids and secretions in a water-soluble form. The *A* and *B* substances have been isolated in an essentially homogeneous condition and a thorough study has been made of the chemical, physical and serological properties of these materials[1]. Comparatively little work has been carried out, however, on the material showing both *A* and *B* properties which is secreted by individuals belonging to group *AB*. The question arises whether the secretions in these heterozygous individuals contain molecules which carry both *A* and *B* specific groupings, or whether they contain a mixture of molecules some of which carry *A*, and others *B*, specificity. Wiener and Karowe[2], in their development of a diagrammatic representation of human blood-group reactions, assumed that in group *AB* individuals the molecules possess dual specificity; but chemical or serological evidence for the association of both specificities with one molecular species, or for the presence of molecules with single specificity only, has been lacking.

The close chemical and physical similarity of the *A* and *B* substances means that they are not separable by the usual fractionation procedures, including electrophoresis and ultracentrifugation, and therefore an attempt has been made to obtain evidence on this question by means of serological precipitation tests. The methods employed involved the precipitation of the specific group substance in (i) an artificial mixture of *A* and *B* substances, and (ii) the material obtained from *AB* individuals, with anti-*A* or anti-*B* precipitating sera; the specific activity of the original materials, the solutions remaining after removal of the precipitates and the redissolved precipitates was determined by means of agglutination inhibition tests. It was hoped thus to separate the specific materials contained in an artificial mixture of *A* and *B* substances and to determine the behaviour of the *A*- and *B*-specific activities present in the secretions of an *AB* person.

The blood-group materials used were preparations derived from human ovarian cyst fluids[3] which had been subjected to the phenol-extraction procedure[4], or fresh saliva samples which had received no treatment other than heating in a boiling water-bath, followed by centrifugation to remove insoluble material. Anti-*A* and anti-*B* sera prepared in the rabbit were used as precipitating reagents, and some additional experiments were carried out with a purified extract of Sieva Lima beans[5], which contains powerful anti-*A* precipitins. The precipitating reagents were freed from heterologous agglutinins or precipitins before use. The concentration of *A*, *B* or *AB* substance giving suitable precipitation with the appropriate reagent was determined and 1 ml. of a solution containing this concentration of material was then mixed with 1 ml. of the precipitating reagent. The mixtures were incubated 1 hr. at 37°, followed by standing over night at 0–4°, and the precipitates were then spun down at 0°, redispersed by high-speed stirring, washed three times with ice-cold saline, and dissolved in 0·2 ml. of $N/10$ sodium hydroxide. The solution was neutralized and the volume made up to 1 ml. with saline; finally, when rabbit precipitating sera were used, the solutions were heated 10 min. in a boiling water-bath to destroy the activity of any remaining antibody. This step was unnecessary when Sieva protein was used because its specific anti-*A* properties are rapidly destroyed by treatment with dilute alkali.

The results of an experiment using a rabbit anti-*A* serum as precipitant with a mixture of *A* and *B* cyst materials and with a substance obtained from a group *AB* cyst are shown in Table 1. The agglutination inhibition tests were carried out using a twofold dilution series of the test substance and a constant amount of antibody. The inhibition is expressed as the number of tubes which failed to show agglutination. When one considers the results obtained with the artificial mixture of *A* and *B* substances, it is evident that the supernatant solution remaining after removal of the specific precipitate has lost its capacity to neutralize the agglutinating action of anti-*A* serum on *A* cells, but retains, unimpaired, its capacity to inhibit the action of anti-*B* serum on *B* cells. The results given by the redissolved precipitate from the *A* and *B* mixture support these observations; the precipitate shows *A*-inhibiting activity but is without *B*-activity. These findings demonstrate, therefore, that it is possible to separate an artificial mixture of *A* and *B* substances by the precipitation technique.

Examination of the results obtained with the *AB* cyst material, on the other hand, reveals that after removal of the precipitate the supernatant solution shows an almost complete loss of *B* activity in addition to loss of *A* activity, and the precipitate

Table 1. PRECIPITATION OF AN ARTIFICIAL MIXTURE OF *A* AND *B* CYST SUBSTANCES AND AN *AB* CYST SUBSTANCE USING RABBIT ANTI-*A* SERUM

Agglutination inhibition given by (*a*) the untreated solutions, (*b*) the supernatant fluids remaining after removal of the precipitates, and (*c*) the redissolved precipitates

Agglutination system used for final test		Preparation tested for inhibition	No of tubes showing agglutination-inhibition
Human anti-*A* serum + A_1 cells	(*a*)	Untreated	
		A + *B* mixture	7
		,, *AB* substance	6
	(*b*)	Supernatant from	
		A + *B* mixture	0
		,, *AB* substance	0
	(*c*)	Precipitate from	
		A + *B* mixture	7
		,, *AB* substance	6
Rabbit anti-*B* serum + *B* cells	(*a*)	Untreated	
		A + *B* mixture	5
		,, *AB* substance	5
	(*b*)	Supernatant from	
		A + *B* mixture	5
		,, *AB* substance	1
	(*c*)	Precipitate from	
		A + *B* mixture	0
		,, *AB* substance	5

possesses both *A* and *B* activities in the same ratio as in the original solution. These results are typical of those obtained with three purified *AB* cyst materials which had originated from different individuals, one native cyst substance, five different A_1B saliva samples and two A_2B saliva samples. Substitution of the Sieva Lima bean precipitant for the rabbit antibody gave essentially similar results. When rabbit anti-*B* serum was used as the precipitating reagent, the reverse picture was obtained with the *A* and *B* mixture; that is, *B* substance only was precipitated and removed from the mixture, whereas both the *A* and *B* activities were carried down in the precipitate from the *AB* cyst substance.

The evidence obtained from these experiments strongly indicates, therefore, that in the tissue fluids and secretions of secretors belonging to group *AB*, a large proportion, if not all, of the macromolecules showing blood group specificity possess both *A* and *B* properties. The fact that it has been possible to separate artificial mixtures of native *A* and *B* salivas into their serologically specific components indicates that the failure to separate the group factors in the saliva of an *AB* person is not due to the simple formation of complex aggregates when both specific substances are present. As an additional control, fresh native *A* and *B* saliva samples were incubated together at 37° for 1 hr., then heated at 100°, and examined as described above; complete separation of the specific activities was again accomplished. The implications of these findings are of importance from the point of view of any biochemical approach to the nature of the materials secreted by *AB* individuals, and also must be considered in the application of quantitative precipitation tests to these substances.

It appears, therefore, that in heterozygous *AB* individuals the *A* and *B* genes give rise to a molecular species which differs from that produced by either gene in the homozygous state, and this fact is of considerable interest in human biochemical genetics. The interaction of genes in the heterozygote has received much attention in relation to hybrid vigour in plants and animals. In man, however, only two examples of the interaction of genes at a single locus have hitherto been worked out in biochemical terms. Haldane[6] quotes the findings of Filliti-Wurmser, Aubel-Lesure and Wurmser[7], on the molecular size of β-agglutinins, as an example where the heterozygote produces a product which differs from that produced by either of the genes in the homozygous condition. These authors found that the molecular weights of the β-agglutinins in *OO*, A_1A_1 and A_1O individuals were 170,000, 300,000 and 500,000, respectively. However, there is some difference of opinion as to whether the formation of the naturally occurring isoagglutinins is under direct genetical control[8]. The second example relates to the hæmoglobins produced in individuals carrying the sickle-cell trait. Neel[9] and Beet[10] put forward the hypothesis that the sickle-cell trait and sickle-cell anæmia occur respectively in individuals heterozygous and homozygous for the same abnormal gene. This gene was afterwards shown to be responsible for the production in the homozygote of a hæmoglobin which differs in its electrophoretic mobility and solubility from that present in normal individuals, and the sickle-cell gene is believed to be an allele of that which produces normal hæmoglobin[11]. In the cells of individuals heterozygous for this condition, that is, those carrying the sickle-cell trait, both the abnormal and normal types of hæmoglobin are found to be present and to migrate independently on electrophoresis.

It is evident, therefore, that no general rule as to the influence in man of genes heterozygous at a single locus can be drawn from the examples known at present. When one considers the results of Filliti-Wurmser *et al.*[7] on the molecular weight of β-agglutinins, and the behaviour of the *AB* blood-group substance reported here, the product in the heterozygote would appear to differ in molecular nature, although not in general specificity, from the product produced by either of the genes when present in the homozygous condition; in the example of the hæmoglobin genes, on the other hand, the allele giving rise to the sickle-cell type of hæmoglobin and that producing normal hæmoglobin each gives rise to its own characteristic product in the heterozygote.

The method of approach outlined here involving the use of serological precipitation tests to determine whether more than one specificity is associated with a single molecular species is now being applied to preparations of *A*, *B* and *Lewis* substances showing *H* specificity[12]. It is hoped thus to obtain information which will help in the elucidation of the genetical relationships of the *H* character to the products of the *A*, *B* and *Lewis* genes.

We wish to thank Prof. W. C. Boyd for a gift of purified Sieva bean protein, and Drs. Glynn and Holborow for some of the anti-*A* and anti-*B* rabbit sera used in this investigation. These studies were aided by a grant from the Nuffield Trust. [Jan. 19

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LETTERS TO THE EDITORS

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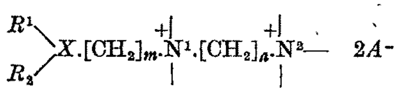
New Series of Ganglion-blocking Agents

Powerful ganglion-blocking properties have been found in the diquaternary-amino-carbinols (I), alkenes (II), -alkanes (III), -nitriles (IV), -ethers (V) and -esters (VI) :



$$\begin{matrix}R^1\\R_2\end{matrix}\!\!>X.[CH_2]_m.\overset{+|}{N}{}^1.[CH_2]_n.\overset{+|}{N}{}^2— \quad 2A^-$$

$I ; X = C(OH)CH_2$ $\quad IV ; X = C(CN)CH_2$

$II ; X = C:CH$ $\quad V ; X = CH.O$

$III ; X = CH.CH_2$ $\quad VI ; X = CH.CO.O$

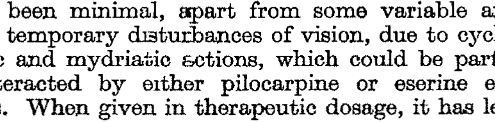
R^1 and R^2 are phenyl or *cyclo*hexyl groups in the compounds described in this communication, but preliminary results show that ganglion-blocking action also occurs when R^1 and R^2 are pyridyl or thienyl groups. $\overset{+}{N}{}^1$ and $\overset{+}{N}{}^2$ are fully substituted quaternary nitrogen atoms.

These compounds are structurally related to the large group of tertiary and quaternary amines of the benzhydrylalkyl type which has already yielded a number of clinically useful drugs. Thus, the new compounds I–III are related to the series of spasmolytics, antihistamines and analgesics which we have previously studied, for example, tricyclamol, procyclidine, triprolidine and the thiambutenes ; while series IV, V and VI are related to the methadone series of analgesics, the antihistamine diphenhydramine, and the spasmolytic 'Trasentin' respectively. The introduction of the group consisting of two quaternary nitrogen atoms linked by a short polymethylene chain, in place of the tertiary or quaternary amino-group of the known compounds, has conferred ganglion-blocking activity on all these classes of drugs and divested them of their previous types of activity. The new compounds have a structural feature in common with the methonium type of hypotensive agent, namely, two quaternary amino-centres, which in our compounds should preferably be separated by two or three methylene groups.

The pharmacological actions of a large number of these compounds have been examined in several species. The most prominent actions include lowering of blood pressure, antagonism of the hypertensive effect of intravenous doses of the ganglion-stimulating compound, N^1 : N^1-dimethyl-N^2-phenylpiperazinium iodide (DMPP), inhibition of vagal bradycardia and augmentation of the hypertensive effects of intravenous adrenaline and *l*-noradrenaline in anæsthetized cats and dogs. It is of interest that somewhat larger doses than those producing these effects have generally been required to block the effect of short periods of preganglionic stimulation on the nictitating membrane, which preparation is the one most commonly employed in the laboratory for the assessment of experimental ganglion block. However, the compounds have so far invariably prevented contractions of the nictitating membrane caused by preganglionic stimulation, but not those due to postganglionic stimulation or intravenous adrenaline. Some are powerful inhibitors of gastric secretion in pyloric-ligated rats ; in contrast to atropine-like compounds, they have been effective at doses considerably lower than those dilating the pupil. Mydriasis occurs after parenteral but not after local administration of the compounds ; their activity in this respect has so far been relatively greater in some species, for example, mice and cats, than in others, such as rats, dogs and man. They inhibit powerfully the peristaltic reflex of isolated guinea pig ileum, but not the peripheral muscarinic effects of acetylcholine on the isolated ileum or on the blood pressure of the cat. These findings indicate that the main pharmacological effects of the compounds are due to block of autonomic ganglia. The main toxic action is closely associated with neuromuscular block, which with many of the compounds has not occurred until after at least a hundred times the dose causing some ganglion blockade.

A number of relationships between structure and activity have emerged, based mainly on mydriatic action in mice but supported by other findings. As *m* has been increased from 1 to 7, activity has reached a maximum at $m = 3$ or 4 and then has declined, while duration of action has progressively increased. Toxicity in mice has slightly increased with the value of *m*, and when *n* has been increased from 2 to 6 toxicity has often increased as much as threefold. Activities have been greatest when the substituents on $\overset{+}{N}{}^1$ and $\overset{+}{N}{}^2$ have been no larger than ethyl, this also applying when $\overset{+}{N}{}^2$ formed part of a pyrrolidinium, piperidinium or morpholinium ring.

Some of these compounds are considerably more active in many laboratory tests than hexamethonium and pentolinium, and their effects last very much longer. A few have been successfully used clinically in the treatment of hypertension. These are highly effective in lowering blood pressure and relieving certain hypertensive symptoms, when given subcutaneously in doses of up to 40 mgm. or intravenously in smaller dosage ; the effects are slow in onset and persist for several hours. Like other quaternary ammonium salts, they are poorly absorbed after oral administration, the minimal effective dose by this route being about ten times the subcutaneous.



356*C*54

In these clinical trials the compound 356*C*54 has so far been one of the most promising. Subcutaneous injection of an effective dose of this drug has usually lowered the blood pressure for 7–12 hr. Side-effects have been minimal, apart from some variable and often temporary disturbances of vision, due to cycloplegic and mydriatic actions, which could be partly counteracted by either pilocarpine or eserine eye drops. When given in therapeutic dosage, it has less frequently caused recurrent postural syncope than have hexamethonium and pentolinium.

Another outstanding feature is that these drugs have not caused paralytic ileus or severe constipation, and apparently have only a slight effect on propulsion in the small intestine. However, they have powerfully inhibited gastric acid secretion and motility. This and the animal pharmacology suggest that another possible use of these compounds might be in the treatment of peptic ulceration.

Full investigation into the chemistry, pharmacology, clinical activity and use of these and related compounds is being actively pursued, and the results of these researches will be published in detail elsewhere.

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Effect of Cortisone on the Blood

Nicol and Snell[1] showed that the phagocytic activity of the reticulo-endothelial system becomes depressed during the first two weeks of cortisone treatment and recovers to about the normal level during the third and fourth weeks if the cortisone injections are continued. The present communication shows that cortisone also produces changes in the blood.

Twelve male guinea pigs were given a daily intramuscular injection of 10 mgm. of cortisone acetate (Roussel) for a period of five weeks. Blood was removed by heart puncture on the day prior to the commencement of the cortisone injections and thereafter at the end of each week. The blood films were stained with Giemsa's stain.

Erythrocytes. During the first two weeks of cortisone treatment, the degree of polychromasia and anisocytosis seen in the normal blood picture[2] became increased, and at the end of the second week immature red cells were present in greater numbers. No significant change was noted in the red-cell count; but there was a drop in the hæmoglobin-level from 81 to 70 per cent when tested by the Sahli method.

Leucocytes. The changes in the leucocytes are shown in Table 1.

Table 1. Leucocyte Counts from 12 Guinea Pigs each of which received 10 mgm. of Cortisone Daily for 5 Weeks

No. per cu.mm.	Control	Experimental results No. of weeks of cortisone treatment				
		1	2	3	4	5
Total number of leucocytes	8,700	6,950	4,200	5,100	10,200	9,300
Lymphocytes	5,600	4,800	1,300	1,700	2,700	1,500
Pseudo-eosinophils	2,800	1,900	2,900	3,400	7,200	7,600
Monocytes	300	250	—	—	300	200

The control results in Table 1 show the average number of leucocytes in the twelve animals on the day before the commencement of the cortisone injections; the experimental results give the average number of leucocytes in the animals at the end of each week of cortisone treatment.

It can be seen that the total leucocyte count dropped below normal during the first three weeks of the cortisone injections, then rose above normal during the fourth and fifth weeks of treatment. These changes were accounted for by a sustained fall in the number of lymphocytes and a gradual rise, after the first week, in the number of pseudoeosinophils. Moreover, when the pseudoeosinophil count dropped at the end of the first week, a high proportion of the cells showed multiple nuclear lobes, whereas from the second to the fifth week, as the pseudoeosinophils increased in number, a greater proportion showed a single nuclear lobe indicating increased production of polymorphs.

Yoffey[3] has shown that the administration of compound *E* (cortisone) in doses of 5 mgm. per day for seven days appears to stimulate the formation of red cells in the normal male guinea pig, together with a possible increase in the myeloid cells of the bone marrow. Antopol[4], working on the mouse, reported that a single dose of 2·5 mgm. of cortisone subcutaneously produced depression of the circulating lymphocytes and also an initial granulocytopœnia followed by granulocytosis. He also found that the erythrocyte count showed no significant difference between control and treated animals.

The above results show that the depression of the reticulo-endothelial system which occurs during the early stages of cortisone treatment[1] is accompanied by a fall of the total leucocyte count in the blood. The recovery of the phagocytic activity of the reticulo-endothelial system during the third and fourth weeks of cortisone administration is, however, not associated with a return to normal of the differential leucocyte counts, since the lymphocytes remain reduced in number and the pseudoeosinophils become markedly increased.

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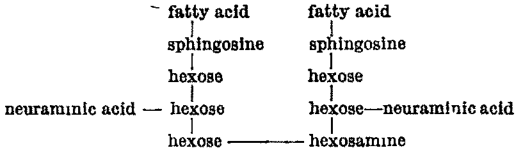
Composition of Gangliosides from Human Brain

Gangliosides are lipids closely allied to the cerebrosides. They were so named because of their occurrence mainly in the ganglion cells of the nervous system, although gangliosides seem to exist in most parenchymatous organs. Klenk *et al.*[1], for example, have isolated gangliosides from brain, spleen and red cells. The composition of ganglioside from brain as given by Klenk had to be modified after the isolation of chondrosamine from brain ganglioside by us[2], and in a recent paper Klenk *et al.* suggested its composition as follows:



In the same paper they also assert the existence of only one type of ganglioside from brain.

The value given for hexosamine by Klenk (7 per cent) is rather low when compared with the value earlier given by Blix[3] and later by Yamakawa and Suzuki[4].

Klenk *et al.* have also investigated the amount of ganglioside in human brain by determining the content of neuraminic acid. On testing the result with another extraction method, I found values 2–3 times higher than those reported by Klenk.

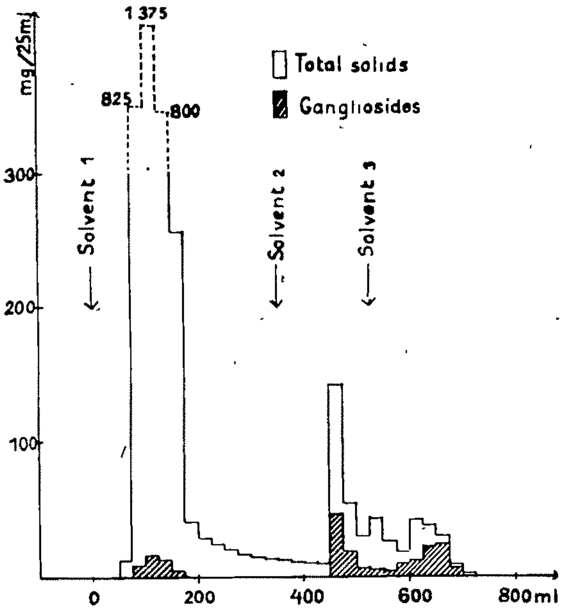


Fig. 1. Chromatogram of 4 gm. of brain lipids on a cellulose column 30 × 400 mm. Solvent 1, chloroform : ethanol : water = 16 : 4 : 1; solvent 2, chloroform : methanol : water = 5 15 : 1; solvent 3, methanol : water = 9 : 1

By the use of an improved method for the separation and the purification[5] of the gangliosides, these discrepancies have been found to be due to the existence of more than one type of ganglioside in human brain.

Grey matter from human brains was homogenized and dried with acetone. The dry substance was extracted with methanol : chloroform (2 : 1 v/v) in a Soxhlet apparatus and the extract evaporated *in vacuo* to dryness. The lipids were dissolved to make a 5 per cent solution in the solvent phase of a mixture of chloroform : ethanol : water (16 : 4 : 1) and placed on the top of a column of cellulose. The column was run with the same solvent until fractions with negligible amounts of solids appeared. The solvent was then changed to chloroform : methanol : water (5 : 15 : 1) and finally to methanol : water (9 : 1). As is seen in Fig. 1, two fractions of gangliosides were separated.

The ratio sialic acid : hexosamine was in the first fraction 3 : 1 and in the second one 12 : 1. (Sialic acid has been isolated from brain gangliosides[6] and is supposed to be the naturally occurring acid in gangliosides.) The gangliosides from the first fraction were contaminated with a large amount of low-molecular substances and formed strands just as the so-called strandin of Folch[7].

The chloroform : methanol eluates from several runs were taken together, dialysed against distilled water at 4° C. and rechromatographed. A main fraction of fairly pure ganglioside was obtained and crystallized from ethanol : water. The crystals, small birefringent rods, were found to be the potassium salt of ganglioside.

Analytical data (calculated on the free ganglioside acid): P, 0 per cent, total-N, 2·97 per cent, hexose (calculated as galactose), 24·6 per cent, chondrosamine (free), 11·6 per cent, sialic acid, 24·1 per cent.

With regard to these data it is likely that the summary formula is as follows:

Fatty acid—sphingosine—hexose—hexose—chondrosamine—sialic acid

I have not yet succeeded in crystallizing the second fraction.

In some pathological conditions, especially in Tay-Sach's disease, the nerve cells are distended by gangliosides. In the brain of an individual suffering from the infantile type of this disease I found mainly gangliosides of the type described above.

A detailed report of this work will be given elsewhere.

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Nov. 24.

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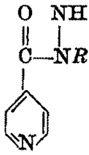
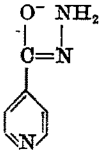
Mode of Action of Isoniazid

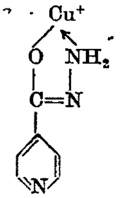
ISONIAZID (*iso*nicotinylhydrazide), which has proved remarkably successful in the treatment of human tuberculosis, has an affinity for the ions of heavy metals. This affinity is only slightly less than those of the common amino-acids[1]. It has been claimed that the action of isoniazid (I, *R*=H) against the tubercule bacillus *in vitro* is increased in the presence of copper[2]. Hence it was suggested that chelation (formation of cyclic metallic complexes) played a part in the therapeutic action of this drug.



(I)



(II)



(III)

In order to form metal complexes, for example, (III), isoniazid must first form the anion (II), which is the chelating species. No anion can be formed by 1-*iso*nicotinyl-1-methylhydrazine (I, *R* = CH_3). This substance has recently been synthesized and found to be virtually inactive[3], thus giving strong support to the hypothesis of chelation.

In the present communication, the determination of the avidity of other hydrazides for heavy metals is recorded. It is seen from Table 1 that of the two isomers of isoniazid, nicotinic hydrazide (which is biologically inert) has approximately the same affinity for metals as isoniazid, whereas picolinic hydrazide, which is about eight times less effective biologically, has 10^3–10^5 times the affinity for metals. Table 1 also includes an aromatic, and an aliphatic, hydrazide which have much the same avidity for metals as isoniazid but have far less biological activity. Thus, although the ability to form chelate compounds seems to be essential for the functioning of isoniazid, it now becomes clear that some other factor is of over-

Table 1. PHYSICAL AND ANTI-TUBERCULAR PROPERTIES OF HYDRAZIDES

	*Iso*nicotinic	Nicotinic	Picolinic	Benzoic	Cyanacetic
Ionization constants (as pKa)					
NH_2	1·85 ± 0·04	1·86 ± 0·03	< 1	3·03 ± 0·01	2·34 ± 0·02
Ring-N	3·54 ± 0·04	3·29 ± 0·04	2·86 ± 0·01	none	none
Acidic	10·77 ± 0·05	11·47 ± 0·04	12·27 ± 0·04	12·45 ± 0·03	11·17 ± 0·04
Stability constants					
Cu^{++} log K'	8·0	8·7	12·4	9·0	8·5
log K''	*	7·5	9·1	*	7·1
log K_s	—	16·2	21·5	—	15·6
Ni^{++} log K'	5·5	6·0	10·7	6·3	6·0
log K''	*c.* 4·3	4·7	9·5	*	*
log K_s	*c.* 9·8	10·7	20·2	—	—
Co^{++} log K'	4·8	5·4	9·6	*	5·3
log K''	*	*	7·8	—	*
log K_s	—	—	17·4	—	—
Zn^{++} log K'	5·4	*	8·4	*	*
log K''	*	—	7·2	—	—
log K_s	—	—	15·6	—	—
Fe^{++} log K'	*	*	8·4	*	*
log K''	—	—	*	—	—
log K_s	—	—	—	—	—
Biological action					
In vitro µgm. per ml. greatest dilution permitting survival (*a*)	0·025	25·0	1·5	12·5	3·0
In vivo mgm./kgm. smallest daily dose permitting survival (*b*)	3	no action	25	no action	**
(*c*)	2	**	**	**	10

* Precipitate.
** Not attempted.
— Calculation impossible because of precipitate.
(*a*) Prof. R. Knox, unpublished results on *H* 37 *Rv.* strain in Dubos medium (semi-solid). All substances were tested simultaneously.
(*b*) Berenstein, J., Loft, L., Steinberg, B., and Yale, H., *Amer. Rev. Tuberc.*, **65**, 357 (1952). Survival of mice, *H* 37 *Rv.* strain (drug given orally).
(*c*) Barnett, M., Bushby, S., Goulding, R., Knox, R., and Robson, M., *Brit. Med. J.*, ii, 647 (1955). Survival of mice, *CN* 3679 strain (human). Drug given subcutaneously, the isoniazid-treated mice survived longer than those treated with cyanacetic hydrazide.

riding importance. The incorporation, by the living cell, of isoniazid into diphosphopyridine nucleotide[4] (in the place of nicotinamide) does not explain its antitubercular action, because cyanacetic hydrazide is not a structural analogue of nicotinamide. Yet cyanacetic hydrazide, although weak, has been used successfully in human tuberculosis[5], and is apparently acting in the same way as isoniazid, because organisms resistant to one are resistant to the other[6].

The specificity of these hydrazides for *M. tuberculosis* has yet to be explained: none of the substances in Table 1 was bacteriostatic to *Staph. aureus* or *Strept. haemolyticus* in broth at pH 7·3 (37° for 24 hr.) even at 10^{-2} *M*, whereas 8-hydroxyquinoline (control) inhibited both organisms at 10^{-5} *M* (Marshall, J. H., unpublished work).

The ionization constants were determined by potentiometric titration at 20°, the two basic functions being separated by the method of Noyes[7]. The stability constants (K' for the 1 : 1 complex, for example, III, K'' for the complex formed by adding one more ion of ligand, and K_s, which is the product of K' and K'') were obtained by potentiometric titration in the presence of one equivalent of the metal ion[8].

Prof. R. Knox and Dr. J. H. Marshall are thanked for permission to quote from their unpublished biological results; and Mr. E. P. Serjeant for skilled technical assistance; also Mr. D. E. Seymour, of Herts Pharmaceuticals, Ltd., for gifts of nicotinic and picolinic hydrazides, and Dr. Maxwell Savage, of S. Maw, Son and Sons, Ltd., for the cyanacetic hydrazide.

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Formation of Iron-binding Compounds by Micro-organisms

THE metabolic activity of certain micro-organisms is well known to be dependent on the iron concentration of the culture medium. For example, where cultured at controlled levels of iron, *Corynebacterium diphtheriae*[1] and *Aspergillus niger*[2] produce large amounts of toxin and citric acid respectively. Recently we have reported[3] the production of ferrichrome A by *Ustilago sphaerogena* when this fungus is grown under conditions of controlled iron supply.

In the present investigation a study has been made of the tendency of various microbial species to form iron-binding compounds under conditions similar to those used[3] for the production of ferrichrome A. The results demonstrate that at least three species (*Bacillus subtilis, Aspergillus niger* and *Bacillus megaterium*) can be induced to form such compounds. Several strains of *Bacillus subtilis* and *Bacillus megaterium* were examined and found to give essentially similar results.

The analytical measure employed to follow the formation of the iron-binding substances consisted in the addition to 4 ml. of the cell-free medium of 1 ml. of a solution containing 1 mgm. per ml. of ferric ion or, alternatively, ferrous ion followed by aeration. The optical density of such solutions was then measured at the wave-length of maximum absorption of the principal coloured iron complex present. These wave-lengths, as established on the extracted and purified substances, were 510, 440 and 440 mµ for the *Bacillus subtilis, Aspergillus niger* and *Bacillus megaterium* cultures, respectively.

In a series of experiments designed to show that only intermediate levels of iron are effective, the basal medium[3] was treated with 8-hydroxyquinoline and extracted with chloroform prior to sterilization and inoculation. The formation of the ferric-ion binding agent by *Bacillus subtilis* as a function of time and initial iron concentration is shown in Fig. 1. The product of this fermentation, the ferric derivative of which exhibits a deep purple colour at neutral pH, has been purified by solvent-extraction procedures and appears to have the general properties of a polyhydric phenol. The chemical nature of the compounds formed by *Aspergillus niger* and *Bacillus megaterium* (Table 1) is unknown, although judging from their spectra they may be more closely related

Table 1. FORMATION OF FERRIC ION-BINDING COMPOUNDS BY *Aspergillus niger* AND *Bacillus megaterium*

	Optical density (cm.$^{-1}$ at 440 mμ)					
	A. niger			*B. megaterium*		
Iron (μgm./l.)*	nil	20	100	nil	20	100
Time (hr.)						
22	0·14	0·12	0·15	0·20	0·34	0·13
32·5	0·09	0·07	0·09	0·42	0·62	0·24
46	0·20	0·34	0·08	0·41	1·20	0·29
57	0·52	0·56	0·27	0·27	0·90	0·21
79·5	1·50	0·95	0·39	0·17	0·60	0·14

* No detectable iron-binding compounds were observed with initial iron concentration of 500 μgm./l. or greater.

to ferrichrome[4] or ferrichrome A [3]. The ferric chelate of citric acid, although yellow in colour, does not have an absorption maximum in the higher wavelength region employed in the present work.

Escherichia coli and a *Pseudomonas* species, when grown in the unpurified medium, gave no visual evidence of the formation of iron-binding agents. It is, of course, conceivable that some of these compounds might provide colourless derivatives with ferric ion; in that event they would be more difficult to detect. Our success in finding the substances with the three species described above may be connected with the more vigorous growth and higher iron requirement of the bacilli and fungi.

From our results (Fig. 1 and Table 1) it is clear that the extracellular appearance of the iron-binding substances is strongly dependent on the initial iron-level of the medium. This suggests that these compounds are involved in an iron sequestering and transferring system, the latter either initiated or magnified by the organism during iron deficiency. The substances mentioned here form very stable ferric derivatives, probably chelate compounds, since the bound iron cannot be precipitated even at pH values of 10–11. We have repeatedly observed that, when the test organisms are grown in stainless steel fermentation equipment, no trace of iron-binding substances can be found.

An alternative explanation for the mode of action of the new compounds would be that they act as a by-pass around the normal terminal electron transport chain. It is of interest that all of these ferric chelates can be reduced with hydrosulphite and are very rapidly autoxidizable.

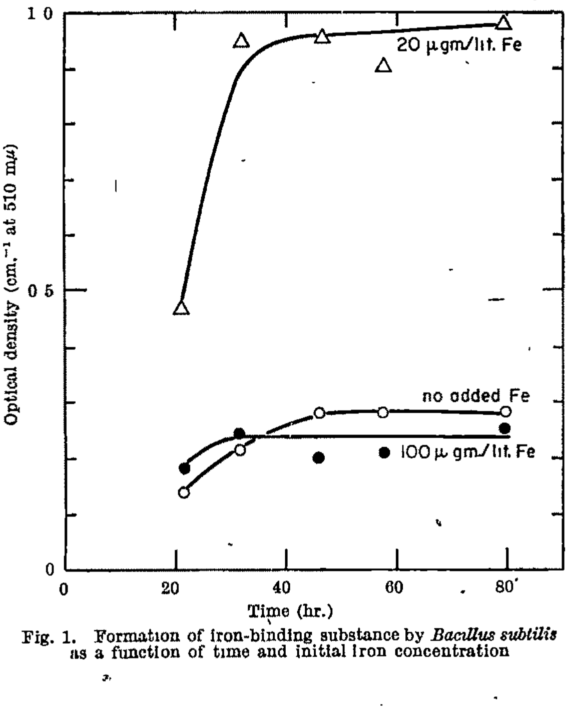

Fig. 1. Formation of iron-binding substance by *Bacillus subtilis* as a function of time and initial iron concentration

Bacillus subtilis, but not *Bacillus megaterium* or *Aspergillus niger*, excretes large amounts of porphyrin in addition to the ferric ion-binding agent described above. This porphyrin has been shown by P. M. Townsley in this laboratory to be mainly coproporphyrin III.

Further experiments are in progress with the iron-binding substances produced by micro-organisms. Of particular interest is the study of their structure, specificity for metal ion (stability) and biological activity.

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Amino-Acid Secuence in a Hypertensin

THE isolation and purification of a hypertensin peptide, resulting from the action of rabbit renin on ox serum, have been described recently by one of us. Its amino-acid composition was consistent with a decapeptide structure containing the following eight amino-acids: leucine (1), phenylalanine (1), tyrosine (1), proline (1), aspartic acid (1), arginine (1), valine (2) and histidine (2). Application of the fluorodinitrobenzene technique of Sanger showed that the N-terminal residue was aspartic acid[1]. The amino-acid sequence in this peptide has been determined by the following methods:

(1) Treatment with carboxypeptidase in the presence of di*iso*propyl phosphorofluoridate revealed leucine as the C-terminal amino-acid. The two adjacent amino-acids were shown to be phenylalanine and histidine; but their sequence could not be determined by the technique used.

(2) Partial acid hydrolysis with concentrated hydrochloric acid (36 per cent w/w) at 37° for three days, followed by paper chromatography to separate the products, yielded histidyl leucine. The remaining peptides could not be purified. It follows that the C-terminal sequence is · · · ·Phe·His·Leu.

(3) Stepwise degradation by the Edman method[2] indicated the N-terminal sequence Asp·Arg·Val·Tyr· · · ·.

(4) Trypsin digestion split off the peptide Asp·Arg which was isolated by paper chromatography. Application of the fluorodinitrobenzene technique to the whole digest showed that valine was the N-terminal residue of the other peptide. This confirmed the N-terminal sequence Asp·Arg·Val · · · · in hypertensin.

(5) Chymotrypsin digestion gave three products which were separated by paper electrophoresis; two tetrapeptides, (*a*) and (*b*), containing Asp, Arg, Val, Tyr, and His, Pro, Val, Phe, respectively, and the dipeptide His·Leu. Treatment of the digest with fluorodinitrobenzene revealed Asp, Val and His as the N-terminal residues of these peptides. Valine was therefore the N-terminal residue of peptide (*b*).

The C-terminal sequence · · · ·Val·Tyr was confirmed in peptide (*a*) by means of carboxypeptidase. Peptide (*b*) gave only phenylalanine even after digestion for 18 hr. at 37° with the enzyme at an enzyme : substrate molar ratio of approximately 1 : 40. This indicated the sequence · · · ·Pro·Phe, and this was supported by the results of the Edman degradation on peptide (*b*), which showed that the sequence of the first three residues was Val·His·Pro· · · ·.

(6) The action of aminopeptidase[3]: although not useful in our hands for elucidation of the sequence in hypertensin on account of the very rapid liberation of all the amino-acids present, aminopeptidase liberated free aspartic acid and not asparagine. In view of the optical specificity of this enzyme, the amino-acids in hypertensin must have the L-configuration.

The sequence of residues in this hypertensin is therefore Asp·Arg·Val·Tyr·Val·His·Pro·Phe·His·Leu. Confirmation of this structure is being attempted by synthesis.

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The Pigment, Trichosiderin, from Human Red Hair

Sorby[1] first described the pink pigment extractable from human red hair by hot acids, and its properties were further investigated by Flesch and Rothman[2]. In strongly acid solutions, the absorption curve shows a hump above 475 mμ with a maximum at 535 mμ (Fig. 1, curve 4), but this disappears at alkaline *p*H. Complete extraction of trichosiderin does not appreciably change the hair colour, and the contribution of this substance to the total pigmentation is uncertain.

In the present work bright red hair from a single subject, chosen because of its very high yield of trichosiderin, was studied. The washed hair was suspended in *N*/10 sodium hydroxide (100 mgm./10 ml.) at room temperature for 12 hr.; the hair swelled but did not disintegrate. The resulting orange-yellow extract (curve 1) was carefully neutralized and a further amount of concentrated hydrochloric acid (specific gravity, 1·18) was added to give a final concentration of 6 per cent. A white precipitate was centrifuged off, leaving a pale yellow supernatant (curve 2). Since the *p*H of the acidified extracts was in the region of 0·2, it is clear from the absorption curve that trichosiderin could not have been present. On heating the extract in a water-bath at 100° C., however, a pink colour developed within five minutes, and the solution also showed a reversible change to yellow at alkaline *p*H and pink pigment could be precipitated out at *p*H 7·0 as described by Flesch and Rothman[2]. It seems, therefore, that weak alkali extracts a precursor whi is readily converted to trichosiderin on heating acid. Approximately the same amount of trich siderin is obtained either by direct acid extracti or by alkali extraction followed by acidification a heating (curves 3 and 4).

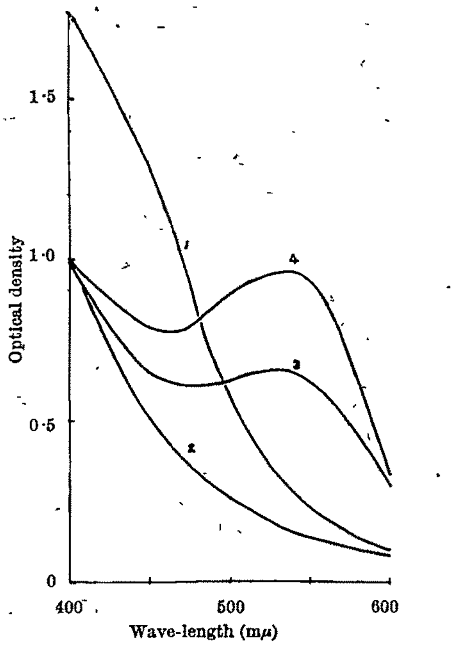

Fig 1. Absorption curves of hair pigment extracts from strong red hair of a single subject. Cell length, 1·0 cm.; 100 mgm. hair/ 5·0 ml. solvent. (1) Extract in N/10 sodium hydroxide for 12 hr. at room temperature. (2) Curve 1 acidified to 6 per cent with conc. hydrochloric acid. (3) Curve 2, after holding at 100° C for 30 min. (4) Direct acid extract with 6 per cent hydrochlori acid for 2 hr. in a sealed tube

The use of *N*/1 sodium hydroxide results in parti destruction of the trichosiderin precursor and al extracts other red pigments which are insoluble acid and may be the main pigmentary component

If acidified but unheated alkali extracts (*N*/ sodium hydroxide) are chromatographed on a tal 'Celite' column[3], the orange-yellow pigment remai at the top and the colourless eluate yields no tra of trichosiderin on acidification and heating. If t pigment is then run off the column by addition dilute ammonia, the yield of trichosiderin from t fractions is clearly related to the intensity of the initial yellow colour. The pigment from alk extracts can also be adsorbed at the top of a ma nesium carbonate column[4], forming a strongly re brown layer which is not shifted by a variety of s vents, including aqueous solutions of ethylene chlo hydrin or of urea. If the pigment is removed l extrusion, a strong pink colour develops on heati it in acid solution. It is likely, therefore, that t trichosiderin precursor is an acid-soluble yellow orange pigment.

Some twenty specimens covering a wide range non-red hair colours and including albino hair yield pale yellow alkali extracts which became paler acidification but did not yield trichosiderin wh heated. The absorption curves of these yellow alk extracts have a simple concave form, whereas t alkali extract of strongly red hair (curve 1) distinctly sigmoid.

I wish to thank Dr. S. P. Datta for making *p* measurements with the glass-electrode, and t

Department of Biochemistry of this College for the use of a Unicam spectrophotometer. Mr. John Welch rendered technical assistance.

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Determination of Arginine

The orange-red colour produced by arginine and other mono-alkyl guanidines in the presence of α-naphthol and hypochlorites or hypobromites[1] would probably be more widely used in analysis, were existng methods capable of a stable calibration or more reproducible.

In 1948, Sakaguchi[2] introduced oxine in place of α-naphthol with some improvement; but his adaptation used the rather inferior analytical procedure of Weber[3]. The substitution of oxine for α-naphthol in Macpherson's method[4] brings about a most striking all-round improvement. Sensitivity is increased, the blank colour in the absence of arginine is reduced, a inear and stable calibration can be obtained and the tandard error of a single measurement is reduced o rather less than 1 per cent compared with 4 per ent for the original Macpherson procedure. The ntensity of colour varies with temperature; thereore, the reagents prior to mixing, and the solution up to the time of measurement, should be kept in a hermostat. The calibration of a Spekker absorptiometer (using Kodak Non-Photographic Filter No. 549) has not varied over two years.

7-Chloro-oxine gives yet higher sensitivity and ower blanks than oxine. The concentration of the ypobromite solution should, however, be only 60 per ent of that used for oxine and α-naphthol. When rginine is determined in whole protein hydrolysates, ome density is always contributed by other aminocids[5]. The absorption spectrum due to the other mino-acids differs from that of the Sakaguchi olour, but overlaps it and cannot be eliminated by hoice of filter. The density due to other amino-acids produced with 7-chloro-oxine amounts to only about alf that obtained with oxine or α-naphthol. 5 : 7-Dihloro- and 5 : 7-dibromo-oxine show still lower blank ensities; but the lower solubility of these two compounds makes it difficult to employ a sufficient oncentration to get the highest sensitivity. They eplace oxine with advantage in the detection of lkyl-guanidines on paper chromatograms by methods nalogous to that of Jepson and Smith[6].

A number of other derivatives of oxine α-naphthol nd related compounds are being examined.

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Electrical Activity in the Cockroach Cerebrum

Information concerning electrical activity within the central nervous system of the higher invertebrate phyla is unusually meagre. This has been partially due to the inadequacy of recording techniques. It has proved possible, however, using capillary microelectrodes of less than 0·5μ tip diameter, to make recordings from the cockroach (*Periplaneta americana*) proto- and deutero-cerebrum, and to correlate particular types of activity with specific structures within the brain. In the central nervous system of insects, as in most other invertebrates but unlike the vertebrates, the neuron somata are separated from the synaptic (neuropile) regions.

The cockroach was fixed with pins and 'Plasticene' so that the thoracic and abdominal spiracles remained open for respiration while the head was bathed with a perfusion fluid[1] made isotonic with 0·1 *M* sucrose. The brain was exposed by removing the ocelli and frontal surface of the head capsule. After desheathing the protocerebrum and antennal lobes, microelectrodes filled with 3 *M* potassium chloride could be inserted at will. Electrode positions were roughly determined by measurement from the surface contours and later verified in the fixed and sectioned brain. Electrical stimulation was applied to the antennal nerve 1–2 cm. from the head.

Characteristic responses to stimulation were found in the antennal glomeruli, where sensory fibres join up with association neurons, and in most structures of the homolateral protocerebrum. The most prominent response, however, came from the homolateral corpora pedunculata. This was a large, extracellularly recorded, negative spike (often more than 30 mV. in the calices and peduncle) which apparently resulted from synchronized activity in the processes of the globular cells of the corpora pedunculata. It rapidly became fatigued at stimulation frequencies of more than 1 per sec., and had a rather variable latency (40–70 m.sec.). Occasionally the spike was repeated once or twice at approximately 10-m.sec. intervals; but in most preparations it was single. The form of the spike in the different regions of the corpora pedunculata suggests that it originated in the calices and passed down the peduncle to the α- and β-lobes, where it terminated (Fig. 1). This was substantiated by latency differences between the calyx and the α- and β-lobes. Pre-spike activity was most prominent in the calices, and was presumed to result from activity in association fibres coming from the antennal glomeruli. In addition to the large synchronized spike, repetitive discharges in single units and slow potential changes were recorded from various regions of the corpora pedunculata. In some of the cases, slow potentials seemed to be associated with an inhibition of small amplitude, spontaneous activity.

Cockroaches usually jump suddenly when an antenna is pinched or otherwise strongly stimulated. It was first thought that the large corpora pedunculata spike described above might be associated with this generalized response. Recordings from the thoracic nerve cord eliminated such a possibility, however, for the latency of the giant fibre responses in the thorax which mediated the jump response was less than 10 m.sec. These thoracic responses also remained when the major portion of the homolateral corpora pedunculata was removed, indicating a direct connexion between the antennal nerve and giant fibres

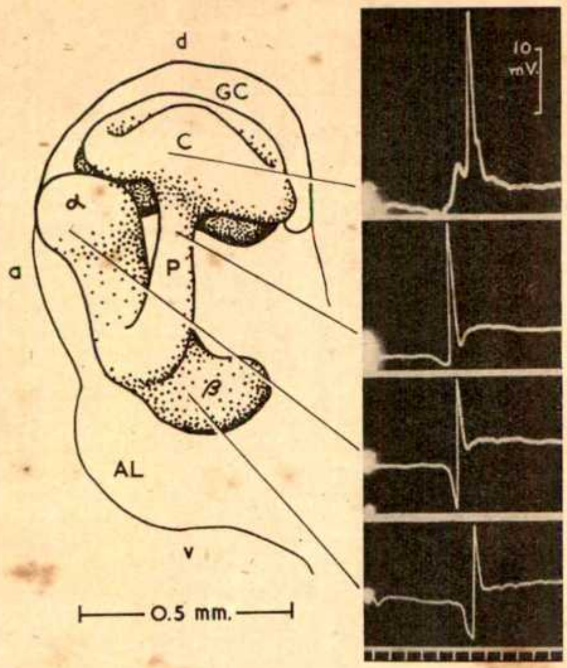

Fig. 1. Diagram of cockroach brain (lateral view) showing responses to antennal stimulation obtained in varying portions of corpora pedunculata; *C*, calyx; *P*, peduncle; *α*, *α*-lobe; *β*, *β*-lobe; *GC* globular cell bodies the processes of which form most of the corpora pedunculata; *AL*, antennal lobe; *d*, dorsal; *a*, anterior; *v*, ventral. Upwards on records is negative; 10-m.sec. time marker; stimulus artefact triggered sweep

leaving the lower portion of the deutero-cerebrum. Although further ablation studies suggested that the corpora pedunculata are important in antennal function and locomotion, the role of the large spike remains unknown. If tracts connect the α-lobe of the corpora pedunculata with the antennal lobe, as recently described in the Hymenoptera[2], the large spike could be a link in a circular pathway: antennal glomeruli – corpora pedunculata (calyx to α-lobe) – antennal lobe.

More complete analyses of the corpora pedunculata responses and other activity in the cockroach brain are in progress and will be reported elsewhere.

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A New Quantitative Method for Antigen–Antibody Titrations in Gels

VARIOUS methods have been devised for the quantitative analysis of precipitating antigen–antibody systems in gels[1-4]. Because they each involve intricate and time-consuming measurements there still exists the need for a simple assay technique in which conditions are readily stabilized and duplicated, and in which the end-point does not depend on the precise measurement of precipitation band distances. Such a method is now reported.

It is a modification of the Ouchterlony[5] punch-plate double diffusion technique. A stainless steel punch was designed to cut simultaneously a large central well and six smaller equidistant peripheral wells in poured agar plates. The body of the punch and central cutter were machined from a solid billet of stainless steel, the cutter being bored to $\frac{15}{32}$ in. inner diameter and turned to $\frac{1}{2}$ in. outer diameter. The peripheral cutters were made from $\frac{1}{8}$ in. bore stainless steel hypodermic tubing and set into holes drilled in the punch body. All cutters were chamfered on the inside to provide a razor-fine cutting edge. Distances between opposing edges of central and peripheral cutters, as measured with a travelling microscope, are 5·78 ± 0·06 mm., an accuracy of ± 1 per cent.

In practice, 1 per cent clarified New Zealand agar in saline, with 1 per cent sodium azide as preservative, is poured into 2½ in. Petri dishes, 8 ml. per dish. After the gel has set in the refrigerator, the punch is placed centrally on the gel and pressed down with a firm, quick thrust. A capillary tube attached to a water vacuum pump is inserted down the shaft of each cutter in turn and the agar plug removed by suction. On withdrawal of the punch a pattern of clean-walled, uniformly placed wells is left in the agar. Dozens of identical plates can be prepared quickly in this way.

Into the large centre well 3–4 drops of antiserum are deposited and a glass or aluminium plug, about three-fourths the diameter of the well, placed centrally. The latter serves merely as a space-filler to spare antiserum. The Petri dish is closed and stored at 37° C. over saline in a canister, to prevent drying. 48–72 hr. later, depending on predetermined conditions for each antigen–antibody system, accumulated saline is removed from the peripheral wells and suitable dilutions of antigen added in clockwise direction, the starting well being noted by a pencil mark on the Petri dish. Each well is filled flush with its rim. After further incubation for 24 hr. the precipitation lines have formed and remain constant indefinitely thereafter.

At those wells where antigen concentration is relatively high the precipitation bands develop as an arc or parabola. Around wells of lower antigen concentrations a circle of precipitate is formed, completely surrounding the well. The first well which is completely encircled is taken as the end-point.

This end-point is objective and unequivocal. It seems capable of distinguishing between differences in concentration of the order of 10 per cent. Plates set up in duplicate and triplicate have uniformly given identical end-points. Though the end-point seems constant from one time to another if conditions are carefully controlled, for routine assays it is probably preferable to include a reference antigen as a standard.

So far this study has been based mostly on a system of anti-golden rod pollen rabbit serum versus a commercial golden rod pollen extract. As the extract came as a 50 per cent glycerine–saline solution, 50 per cent glycerine–saline was used as the diluent. Dilutions used began at 1 : 10 and rose by steps of 2 through the next five wells to 1 : 20.

Other systems have also been briefly examined and the technique described seems to be generally applicable. It has been noted that where two major antigens are present in a system it is possible to titrate for each independently, each antigen presenting a well-circling precipitation band at its own distinctive dilution. When conditions are suitably chosen the two end-points may appear on a single plate.

I am indebted to Mr. C. G. Green and Mr. R. D. Peters of the Instrument Section for construction of the punch.

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Irradiation of Thiourea: Effect of Dose-rate upon the Chain Reaction

THIOUREA in aqueous solution is known to exert a highly protective power in radiation experiments[1]. When thiourea is irradiated with X-rays, gamma-rays or electrons, free sulphur is liberated[2].

A quantitative investigation of this reaction reveals interesting and unusual features. Apart from dependence upon *p*H and concentration and certain shifts of the *p*H in unbuffered solutions, oxygen has a greater effect than in other oxygen-dependent reactions. The yields, which are very low in absence of oxygen, are increased about four times in air-saturated solution and increase further to twelve times for oxygen saturation at dose-rates between 400 and 1,000 r./min. The most important characteristic, however, is that this reaction is a chain reaction with a very marked dependence upon dose-rate.

When the logarithm of G_s (number of sulphur atoms per 100 eV. of energy absorbed) for various dose-rates is plotted against the radiation dose, a family of curves results which have the following characteristics: there is an induction period during which the G_s values increase to a maximum and then remain constant when the radiation dose is further increased. Each dose-rate has its own maximum G_s value, which is the greater the slower the dose-rate (for example, 17,000 for 0·71 r./min.). The attainment of the maxima is shifted towards bigger doses with decreasing dose-rates. It is in practice scarcely possible to reach the maximum experimentally at very low dose-rates, because the radiation times required would be inconveniently long. The value of the maxima can, however, be satisfactorily extrapolated since the results for medium and higher dose-rates establish that G_s is nearly inversely proportional to the dose-rate (see Fig. 1).

The presence of oxygen is necessary for the chain reaction to occur. Lowering the oxygen tension from 100 per cent oxygen in the gaseous phase to 20 per cent causes a decrease of the G_s values but does not abolish the dose-rate effect. No after-effect of the irradiation has been observed.

The importance of this reaction, if other similar examples can be found, would appear to lie in the fact that the efficiency of ionizing radiations at very low dose-rates, as may occur with radioactive fall-outs, may be much greater than they are thought to be at present. A short summary of part of the results of this investigation is in the course of publication in the proceedings of the International Conference on Radiobiology held in Cambridge (August 14–17, 1955), and a full account with experimental details will be published elsewhere.

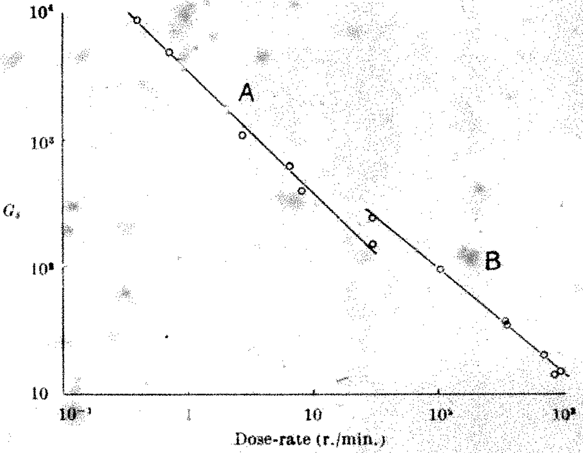

Fig. 1. Curves plotted for: (*A*) Total dose 10^4 r. before maximum G_s; (*B*) total dose 3×10^5 r. at maximum G_s

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Rhythmic Biting Activity of Certain East African Mosquitoes

IN a recent communication in *Nature*, Corbet and Tjønneland[1] have described bimodal flight activity in East African Trichoptera, with peaks of activity just after sunset and before sunrise. A similar pattern is apparent in the biting cycle of various forest mosquitoes, and some years ago I introduced the term 'eo-crepuscular' to describe this type of activity[2].

In most of the more specialized mosquitoes the pattern of biting activity is repetitive from day to day and in addition many show a marked preference for a particular level, such as the forest canopy[3]. Though the biting cycles of most common species have now been studied in some detail, the reasons for these activity patterns are still, in many cases, not fully explained. It is therefore a matter of considerable interest to find a close correspondence between the biting cycle of a common mosquito, *Taeniorhynchus* (*Coquillettidia*) *fuscopennatus* Theo., and the flight rhythm of *Cheumatopsyche* sp. nov. as shown by Corbet, more particularly as the methods of capture were entirely different and as the cycle shown by the mosquito is related to biting activity, whereas the caddis fly probably feeds little if at all in adult life.

The results shown here for *T. fuscopennatus* (Fig. 1) are taken from a long series of 24-hr. catches now in progress in a patch of forest near Entebbe, Uganda, about sixty-five miles south-west of Corbet's catching station at Jinja. These catches of biting females are being carried out 65 ft. above ground, in the forest

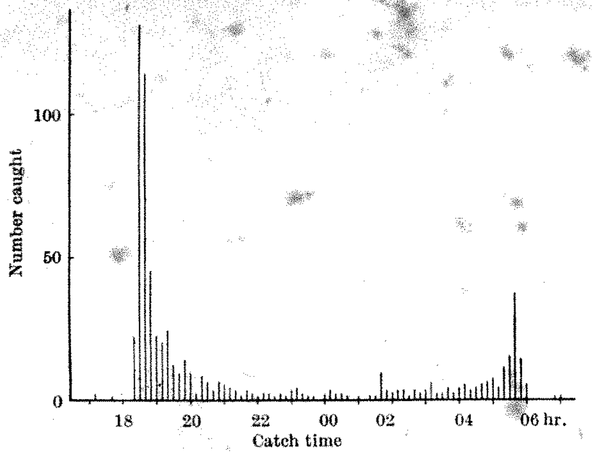

Fig. 1. Sunset at 18.00 hr.

canopy, with human bait, by methods described elsewhere[4]. The time of capture of each specimen is recorded to the nearest minute but, to permit comparison with Corbet's results, the figures have here been grouped by 10-min. periods. The sample under discussion was obtained in the twenty-five catches so far carried out, the number of *T. fuscopennatus* being 668. As the sunset period is most important in mosquito work and as the annual variation in sunset time is more than half an hour at Entebbe, Local Mean Time and East African Standard Time are not adequate for the work in hand. Instead, a special 'Catch Time' is used, this being accurately adjusted to the time of sunset, which is always recorded as 18.00 hr.[5]. In Corbet's communication East African Standard Time is given. It is found that on the evening of the catch he discusses (January 5, 1955) sunset occurred at Jinja at 18.56 ± 2, E.A.S.T. It is now seen that the first wave of activity in *T. fuscopennatus* reaches its peak in the third 10-min. period after sunset and in *Cheumatopsyche* in the fourth period. The sunrise peaks are similarly related to the period before sunrise. In both cases there is only ten minutes difference between the maximum for the mosquito and that for the caddis.

Corbet mentions that his study was concerned with the cyclical emergence of insects from Lake Victoria. It is not felt, however, that emergence cycles can have much effect on the biting-cycles of mosquitoes, as the females do not bite on the day of emergence, and many of them not until the third day of adult life. He also mentions that more intense reproductive activity at sunset may be the reason why the sunset peak is much larger than that at dawn. Elsewhere, Lumsden[5] has advanced the view that in mosquitoes with a double activity peak different age-grades may fly at different times, while Harker[6] has shown that, in the cockroach, activity rhythms may have a neurosecretory basis. I believe that in insects showing abrupt eo-crepuscular activity the control of this activity is mainly microclimatic.

The sudden nature of such activity peaks is well shown by the figures for *T. fuscopennatus*, where 37 per cent of the entire night catch was taken in the 20-min. period during 18.21–18.40 hr. The abruptness and short duration of the wave of activity suggest that a particular level of low light intensity may be important—it will be remembered that near the equator, as at Entebbe and Jinja, light intensity changes very rapidly indeed at dawn and sunset. Such an explanation is supported by current work on another mosquito, *Aedes* (*Finlaya*) *ingrami* Edw. This species reaches its peak of biting activity before sunset, and in this case the small peak at dawn occurs after, not before, sunrise. Under forest conditions in East Africa, the main climatic difference between dawn and sunset is in temperature. In both periods low light intensities prevail and in both saturation-deficiency is very low. While, however, sunset is a relatively warm period, dawn is the coldest period of the twenty-four hours[2,3]. This may be the main reason for the difference between the numbers taken biting at these times, as it is well known that in many species biting activity is reduced by low temperatures.

The complexity of mosquito biting cycles is not, however, fully indicated by catches confined to one level. Where catching goes on simultaneously at various levels, marked qualitative differences in the respective cycles may be found, as has been shown in *Anopheles* (*Myzomyia*) *gambiae* Giles[4]. Current work reveals a similar state of affairs in *T. fuscopennatus*. Broadly speaking, peaks of activity are shorter but more intense in the canopy than in the under-story, and in the under-story than at ground-level.

As Corbet was dealing with a very wide range of numbers, the scale of his histogram is of necessity logarithmic. Convenient though this scale may be, it does not bring out clearly the very abrupt nature of the peaks—nor the enormous quantitative difference between them. Deducing the arithmetical totals from his figure, it is found that the highest 10-min. period after sunset yielded more than twenty times as many insects as the highest dawn period. For this reason an arithmetical scale has been used in the present communication.

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Nov. 16.

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Insecticide Resistance in *Anopheles gambiae* Giles

Although authenticated cases of physiological resistance to insecticides on the part of anopheline mosquitoes have been reported from Europe[1], North America[2] and the Far East[3], no such occurrence has so far been reported from Africa. The following preliminary observations appear to constitute a *prima facie* case of such resistance and it has therefore been considered desirable to place them on record.

In connexion with the Western Sokoto (Northern Nigeria) Malaria Control Pilot Project, an area of about 300 square miles has been set aside for treatment with dieldrin. In this zone are two large communities in which all houses have been treated as follows: Birnin Kebbi—two sprayings with dieldrin 50 per cent wettable powder at 25 mgm. dieldrin per sq. ft. followed by one at 50 mgm. per sq. ft.; Gwandu—three sprayings with the same insecticide at 25 mgm. per sq. ft.; all sprayings were at intervals of six months, commencing in June 1954.

Table 1

Place	Mosquito material	Toxicant	Concentration per cent	No. of mosquitoes exposed	Per cent mortality
Birnin Kebbi (dieldrin zone)	Bred from wild larvæ	Dieldrin	4·0 2·0 1·0 0·5	64 62 70 61	83 45 16 5
Gwandu (dieldrin zone)	Wild-caught	Dieldrin	4·0 2·0 1·0 0·5	15 15 15 15	93 60 33 20
Birnin Kebbi (dieldrin zone)	Bred from wild larvæ	DDT	4·0 2·0 1·6 1·3 1·0 0·5	15 25 16 16 20 11	100 92 31 6 5 0
Argungu (unsprayed zone)	Wild-caught	Dieldrin	4·0 2·0 1·0 0·5	35 35 36 14	100* 100* 100* 100†

* 100 per cent knocked down during 1 hr. exposure period.
† 57 per cent knocked down during 1 hr. exposure period.

The test for susceptibility to insecticides devised by Busvine and Nash[4] was applied to *A. gambiae* from these two towns in the dieldrin zone and from an unsprayed town about fifteen miles outside the sprayed area. These tests consisted of exposing fed *A. gambiae* females (eight wild-caught or bred from wild-caught larvæ) for 1 hr. to filter papers impregnated with a mixture of one part of toxicant solution in Risella oil and two parts of trichlorethylene, followed by a recovery period of 24 hr. Controls were run using Risella oil diluted as before but without dissolved toxicant, control mortalities being low. Results are given in Table 1.

The median lethal concentrations, estimated graphically, for the Birnin Kebbi material were: dieldrin, 2·0 per cent; DDT, 1·6 per cent. Comparable figures for the mosquitoes from the unsprayed Argungu area cannot be given, because all were killed by the lowest concentration used (0·5 per cent). However, in the following communication, Busvine gives median lethal concentrations for susceptible colonies of *A. gambiae*, as follows: dieldrin, 0·25 per cent; DDT, 0·95 per cent.

The difference in DDT-tolerance indicated by the figures 1·6 per cent and 0·95 per cent may not be significant, but the eight-fold difference in tolerance of dieldrin, while by no means as striking as some reported cases of insecticide resistance, is probably sufficient to enable the species to survive the control measures at present in force. It may be mentioned that houseflies from the same two towns, which returned to normal numbers in the sprayed zone after the first year of treatment, have shown a seven-fold increase in their tolerance of dieldrin.

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Normal Resistance-levels of *Anopheles gambiae* to Various Insecticides

In several areas where large-scale residual spraying programmes have been undertaken against mosquitoes, some increase in their resistance to insecticides has been suspected after a year or two. Unless the increase is very great, it is not easy to establish from field-observations, which may be influenced by seasonal variations and, possibly, the inefficiency of operators. Laboratory comparisons of specimens from sprayed and unsprayed areas are desirable; but very little is known of natural variations in resistance of any species in different localities. There is much to be said, therefore, for preliminary determination of resistance-levels before undertaking large spraying campaigns.

This communication records some preliminary results on the normal resistance of the African mosquito *Anopheles gambiae*. The method of measurement was introduced by Busvine and Nash[1], but is more fully described in an annex to the Fifth Report of the World Health Organization Expert Committee on Malaria[2]. Two strains of *A. gambiae* were used, both of which had been reared for a number of generations in the laboratories of the Ross Institute in London, as mentioned by Wall[3]. One was a West African colony from Lagos, Nigeria, which had been reared for about twenty generations in captivity. The other had been obtained from Tengeni, Tanganyika, and reared in London for about five generations. The mosquitoes were reared at 27° C. and tested at the same temperature, a few hours after a blood meal.

Tests were carried out with each insecticide on four different days, over a period covering about three generations of the mosquitoes. On each occasion, about three replicates of five mosquitoes were exposed at each concentration tested. When the results were carefully examined, it was evident that there was no appreciable difference between the two strains in resistance to DDT or gamma BHC, so the results were combined. Only the West African strain was used in the tests with dieldrin. The results, corrected for the overall control mortality (8 per cent), were as follow:

Per cent DDT	2	1	0·75	0·5
Per cent kill	91	53	34	13
Per cent gamma BHC	0·06	0·03	0·02	0·01
Per cent kill	100	96	74	24
Per cent dieldrin	0·45	0·40	0·30	0·20
Per cent kill	100	95	59	29

Logarithms of concentration/probit mortality regression lines were drawn to these results, and the following median lethal concentrations were estimated visually: DDT, 0·95 per cent; gamma BHC, 0·015 per cent; dieldrin, 0·25 per cent.

Mr. J. G. Halcrow kindly allows me to quote some comparable results which he obtained in unsprayed areas of Mauritius in 1954, using the same method, with adults which emerged from larvæ collected in the field:

Per cent DDT	2	1	0·5
Per cent kill	100	75	41
Per cent dieldrin	0·5	0·3	0·2
Per cent kill	100	64	28

These figures indicate a slightly greater susceptibility to DDT (median lethal concentration, 0·7 per cent), but the resistance to dieldrin was identical with that of the laboratory colonies in London.

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So-called 'Glacier-Worms' in New Zealand

Some years ago, during an expedition to the St. Elias Mountains on the Alaska–Yukon boundary, I found some oligochaetous annelids, which are known to occur throughout the western coastal ranges of North America, and are usually referred to as 'glacier-worms' or 'ice-worms'[1]. In my report of this find I asked for any information that might be available upon the occurrence and distribution in general of species of the particular genus, *Mesenchytraeus*, to which these worms belong. However, not a single reply has since been received in answer to that inquiry.

Soon after coming to New Zealand in 1950, I heard that on the Franz Josef Glacier, Westland, small insects, which simulated worms, had been seen in the ice. Indeed, these creatures, and also spiders, had been reported by the pioneer surveyors, C. Douglas and A. P. Harper, in the early 1890's[2,3]. Having failed to find any of these insects myself during one or two visits to this glacier, I was very gratified recently to receive from Mr. R. J. Warburton of Waiho, Westland, several specimens which he had collected and preserved in spirit. Through the kindness of Dr. G. H. Satchell, of the Department of Zoology, University of Otago, these have now been identified, not as worms, but as larvæ, pupæ and one adult, of some species of chironomid fly. Moreover, as Dr. Satchell has remarked, it was only the presence together of larvæ and adult that made identification possible. The family Chironomidae has scarcely been studied at all in New Zealand, only a fraction of the species having as yet been described. Known colloquially as the 'Harlequin fly', they are, it seems, almost ubiquitous, chironomid larvæ being taken from such varied environments as hot springs, from the bottoms of deep lakes, from soil, from dung and from many other moist habitats. Yet here is one which selects glacier ice and melt-water for its temporary home. Douglas[2] had described the "small, worm-like things" as from a sixteenth to an eighth of an inch in length, very active, and when chased tending to dive into the almost invisible holes in the honeycombed ice. In considering them probably to be larvæ he anticipated modern determination.

The specimens kindly sent me by Mr. Warburton were found in small streams of melt-water in the centre of the glacier, either in the water itself or in the actual ice forming the bed and banks of the streams; but the majority of the larvæ were dug out of the ice, while the adult stage, the fly, was found crawling on the ice in the vicinity of the 'worms'. Most specimens seem to be more prevalent in streams which flow through comparatively clean ice. The largest 'colony' which Mr. Warburton came across was at the foot of the main ice fall of the Franz Josef Glacier at about 3,400 ft. Here there were literally hundreds of them in the ice in the bed of melt-water streams, although at the time (9 a.m.) the latter were scarcely flowing owing to the frost. Later, when the volume of water had increased, the 'colony' was found to be greatly reduced in numbers. In fact, it would seem that these creatures must have quite a precarious existence, for increase in volume of water, either from melting or rain (in a district of very high precipitation), must wash away the majority of them. They have not so far been discovered on the neighbouring Fox Glacier, nor on other glaciers of the Southern Alps; and their altitudinal range, on the Franz Josef Glacier, seems to be between about 1,400 ft. and 3,400 ft. The larvæ have been found active in dull weather and in sunshine, and at various hours between 9 a.m. and 3 p.m., from summer through autumn to winter, namely, January to June.

There would certainly seem to be ample scope for further study of this interesting species, and stage of development, of this chironomid fly; not even a name is as yet available for it.

Since I am about to return to England, any correspondence arising out of the above subject should be addressed to me, c/o Clare College, Cambridge.

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Maintenance of Adult Mosquito Tissue in a Tissue-Culture Medium

A series of experiments to be reported elsewhere has been performed to discover the nature of egg development in adult female mosquitoes. In the course of the work, a tissue-culture medium was used for suspending extirpated ovaries in various stages of development. This was done to see if development of the isolated ovaries could be induced or continued.

The anautogenous species used were *Aedes hexodontus* Dyar and *Aedes aegypti* (Linnaeus). *Aedes communis* (De Geer), a species of mosquito autogenous in the Churchill, Manitoba, region[1], was also used.

The ovaries were removed from the insects using a sterile technique in the following manner. The adult female mosquito was surface-sterilized by immersion for 2 min. in a 0·5 per cent solution of mercuric chloride in 50 per cent ethyl alcohol. The surface-sterilized insect was transferred to insect Ringer solution[2] and the last abdominal segment grasped with a pair of fine jeweller's forceps, while the thorax and upper abdomen were held with another pair of forceps. The genitalia, spermathecæ, ovaries and gut of the mosquito were stretched from the rest of the abdomen by steadily pulling on the last segment. The ovaries were then broken away from the vagina and separated from the insect. They were placed in a drop of tissue-culture medium on a polished, sterile, cover glass, and this cover glass was inverted over a deep depression slide. Finally, the cover glass was fastened to the slide with hot melted paraffin.

The chemically defined tissue-culture medium was the improved *M*199, now called *M*150, developed by Morgan[3]. This medium is similar to that used for growing monkey kidney for polio vaccine research. In *M*150 the muscle tissue of the ovaries of *Aedes hexodontus* and *Aedes communis* showed contraction for as long as seven days, but no egg development was noted. The muscle tissue of *Aedes aegypti* showed contraction for as long as sixty days in *M*150, but again no development of the ovaries took place. Controls of insect Ringer solution and of *Polyphemus* (Lepidoptera), and *Cynthia* (Lepidoptera) blood permitted muscle movement only for from two to three days; there was no development of the ovaries. No sign of mitosis was noted in any of the tissue-culture preparations, but some migration of the strands of tissue attached to the ovaries was noted along the polished glass surface.

Dr. J. F. Morgan, National Health and Welfare Laboratory, Ottawa, Canada, supplied the tissue-culture medium; Dr. H. A. Schneideman, Department of Zoology, Cornell University, supplied the Lepidoptera blood. The interest and advice of both these colleagues were most helpful.

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Polymorphism of Alkyl Sulphate Soaps

ALKYL sulphate soaps $NaSO_4C_nH_{2n+1}$, like the fatty acids and alcohols, may be expected to have a tendency to join together the hydrophylic groups of neighbouring molecules. In the crystalline state, this tendency will lead to sheets of double molecules with stretched chains more or less perpendicular to the sheets. We have measured the corresponding long spacing, using the classical method of copper $K\alpha$ reflexion, at a thin layer of soap on a glass slide, the distance plate to axis in the Muller camera being 10 cm. During the investigation, we saw a paper by Rawlings and Lingafelter[1], who made a complete determination of the unit cells. They found different modifications, the α-form with the smallest water content being the most stable. We have also found this α-modification. Moreover, we succeeded in making all our substances crystallize completely in this modification. This proves the chemical homogeneity (within some per cent) of our substances and their identity with Rawlings and Lingafelter's substances. As we have, however, also found a number of rather stable modifications not mentioned by them, we give here a short account of our procedure.

All our preparations were handled at room temperature in one of the following ways: (*a*) Taking the flaky crystals from the bulk material and pressing or smearing them on the glass slide. In Table 1 the solvent used at the last purification of the bulk material, usually not at room temperature, is given, except for the material from Du Pont, which we did not know. (*b*) Dissolving the crystals in various solvents and evaporating the clear solutions on a glass slide at room temperature. (*c*) Soaking crushed crystals for about an hour in more or less saturated solutions, finally smearing them on the slide. (*d*) Putting the crystals on a slide and wetting them with a drop of solvent in such a way that a superposition of the preceding two cases occurs. (*e*) A subsequent heat treatment was sometimes given by putting the slide in a simple thermostat for some time as indicated in the table.

The X-ray exposure took 5–50 min., the angle of incidence varying continuously from 0° to 12° (or 2° to 6°). Fig. 1 gives an idea of the photographs on which the table is based. The first three orders were always by far the strongest. Of the succeeding orders, either the fourth and fifth or the sixth (and eighth) were the strongest; this is indicated in the table by the signs * and † respectively against the spacing. It is rather difficult to make the surface of the soap and not that of the glass slide coincide with the axis of rotation. A correction was sometimes applied for this.

The columns of Table 1 indicate twelve modifications not given by Rawlings and Lingafelter. With C_8- and C_9-soaps we have found only the α-modification (28·5 and 31·0 A.). In the case of C_{12}-soaps, in

Table 1. DIFFERENT LONG SPACINGS INDICATING AS MANY DIFFERENT MODIFICATIONS OF CRYSTALLINE SODIUM ALKYLSULPHATE SOAPS
Spacings in A. at room temperature. w = weak. For * and † and other signs see text.

α	*p*	*q*	*r*	*s*	*t*	
			C_{16}			
—	45·0*	—	38·3†	—	—	(1) like (21) (*a*)
—	—	—	38·25†	—	—	(2) from ethanol (*b*)
47·3*	—	—	—	39·0*	—	(3)=(2) 2 hr. at 60° (*e*)
47·5	—	—	—	39·2*	—	(4)=(3) ,, ,, 70° (*e*)
47·5	—	41·8 (w)	38·4	—	—	(5) from acetone (*b*)
47·3	44·8*	—	—	39·3*	—	(6) soaked in acetone (*c*)
—	44·9	—	38·4†	—	35·3*	(7) with water (*d*)
			C_{14}			
43·25*	—	—	—	—		(8) Du Pont (*a*)
43·0 (w)	—	—	34·5†	—		(9) ,, from ethanol (*b*)
—	—	—	34·4†	33·6*		(10) ,, from water (*b*)
—	—	—	34·5†	33·8*		(11) this lab. ,, (*b*)
43·1	—	—	—	33·8* (w)		(12)=(11) 30 min. at 65° (same 6 hr.) (*e*)
43·0	—	35·6	—	33·9		(13)=(12) 1 hr. at 85° (*e*)
43·1 (w)	36·5	—	34·7†	—		(14) this lab. from acetone (*b*)
43·2	37·3	—	34·7†	—		(15) Du Pont ,, ,, (*b*)
43·0	—	35·5 (w)	—	—		(16)=(15) at 70° (same as (14) (*e*)
43·0	—	35·3	34·5†	—		(17)=(11) soaked in acetone (*c*)
43·0	—	—	34·5†	—		(18) Du Pont soaked in acetone (*c*)
43·0	—	35·5 (w)	—	—		(19)=(17) at 80° (*e*)
43·0	—	—	—	—		(20)=(18) at 80° (*e*)
			C_{10}			
33·8†	30·8 (w)	28·0†	27·2			(21) from butanol, then rinsed with ether (*a*)
33·9	30·3 (w)	27·9	27·2			(22) like (21)
33·9	30·3 (w)	28·0	—			(23)=(22) 4 hr. at 75° (*e*)
33·9	29·6 (w)	27·7	26·9 (w)			(24) from ethanol (*b*)
33·9	—	—	—			(25) from acetone (*b*) (same soaked *e*)
33·9	—	—	—			(26) from water (*b*)

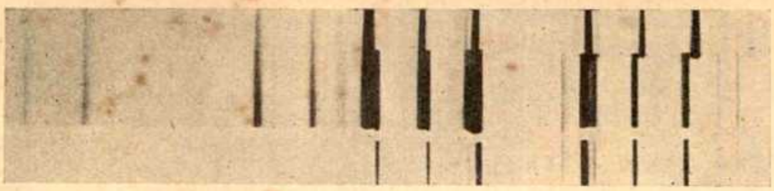

Fig. 1. Reflexion spectra of three layers of C_{16}-soap, marked (1), (3) and (4) in the table. All spectra have been taken on the same plate to allow a better comparison. In the centre left-hand part, the spectra of (1) and (4) have been superposed. The complete correspondence is:

	Left-hand	Right-hand
Upper part	(1)	(1)
Middle part	(1)+(4)	(4)
Lower part	(3)	(3)

Notice the strength of the first three orders and the blurred appearance of the lines of a smeared preparation (1) compared with preparations (3) and (4) crystallized on the slide

addition to the α-modification (38·5 A.) we got a new modification with $d = 32·8$ A. The search in these three cases has, however, not been as exhaustive as with C_{10}-, C_{14}- and C_{16}-soaps.

The different modifications are most probably connected with differences in tilt of the chains and number of water molecules added to the hydrophilic groups. It is less probable that an appreciable number of other solvent molecules were bound, as the same modifications arose from different solvents, which on the other hand always contained some water. It is curious that at room temperature all the modifications found are (meta)stable, as is proved by the constancy of their X-ray diffraction pattern after many days. Another curious fact (see Table 1) is that soaking sometimes has as much effect as recrystallizing: (11), (14), (17) and (21), (25). This may have useful applications.

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Low Audio-frequency Electromagnetic Signals of Natural Origin

NATURAL electromagnetic signals of very low frequency have been studied by several investigators during the past few years. In 1948 Willis[1] reported a series of measurements of 'magnetic noise' in the frequency-range 5–800 cycles/sec. but did not discuss the problem of the physical origin of the observed signals. That some of the signals reported by Willis are due to lightning is strongly indicated by observations of other investigators[2]. Aarons and Henissart[3], working in the frequency-range 1–20 cycles/sec., have reported correlations between low-frequency magnetic fluctuations and geomagnetic disturbance and solar phenomena. Therefore it appears that in the frequency-range 1–100 cycles/sec. there is a transition in the dominant physical cause of natural electromagnetic signals.

More than a year ago, we undertook a programme of measurement of natural electromagnetic signals in the audio-frequency range 25–130 cycles/sec. with the view of gathering evidence concerning their physical origin. In March and April of 1954, measurements in the frequency range 10,000–25 cycles/sec., conducted jointly with L. Liebermann of the University of California at La Jolla, established that a large number of signals at less than 130 cycles/sec. were accompanied by a high-frequency component with characteristic atmospheric wave-form, and presumably were produced by lightning discharges.

Subsequent to the joint tests, equipment for measuring low-frequency signals has been maintained by one of us (O. E. D.) in the Borrego Valley of Southern California at lat. 33° 25′ N. and long. 116° 20′ W. At this remote desert location, interference due to artificial signals from electromagnetic devices and power-lines was negligible. Both air-core coils and a vertical antenna have been used for detecting the signals. In both cases the half-power points of the overall system (detecting element and amplifier) were at 25 and 130 cycles/sec. While oscillographic recording has been used for examining signal wave-form, it was expedient to employ a rectifier, smoothing circuit, and pen recorder in the study of the temporal variation of the mean signal amplitude over long intervals, of the order of months.

The mean signal amplitude in the months of March and April exhibited a fairly regular diurnal oscillation which was strikingly similar in amplitude and phase to the diurnal variation of the atmospheric electrical potential gradient measured at sea. Fig. 1 presents the mean diurnal oscillation of the electromagnetic signal amplitude during 14 days in March and April and the mean diurnal oscillation of the potential gradient measured during the months of February, March and April on Cruise VII of the *Carnegie*[4]. Similar correspondence between the two diurnal oscillations was found during the fall months. The maximum ordinates of each curve lie between 14 and 21 hr. universal time. In precisely this interval it is mid-afternoon successively in Central Africa and in the Amazon Valley when these principal world thunderstorm centres reach their peak activity.

The diurnal oscillation of the low-frequency signal amplitude is quite different during the summer

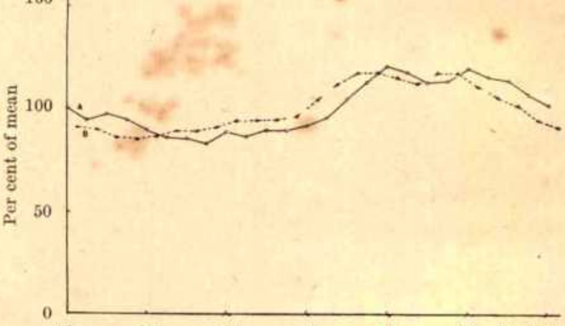

Fig. 1. Mean diurnal variation of (*A*) low-frequency signal amplitude, Borrego Valley, March and April 1954. and (*B*) potential gradient at sea, February, March and April 1929

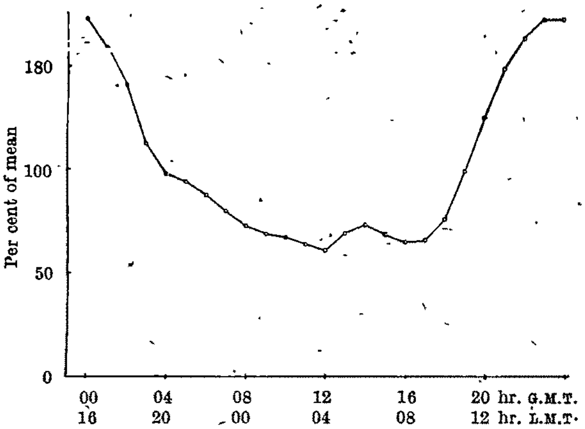

Fig. 2. Mean diurnal variation of low-frequency signal amplitude, Borrego Valley, August 1954

months, as shown in Fig. 2. Between 10 and 24 hr. local (120th meridian) time the amplitude is much larger than during the corresponding hours in spring and autumn, reaching a value about three times as great at 16 hr. local time. The interval of large signal amplitude corresponds to the time of greatest thunderstorm activity on the North American continent, within 35° of the observing station.

It is well known that the electrical potential gradient at sea executes a regular diurnal oscillation on universal time. The observation is usually interpreted as an indication of world-wide thunderstorm activity, on the hypothesis that thunderstorms supply an upward current to the ionosphere which leaks back to the earth in all regions away from the immediate vicinity of the storms. Over the oceans where the atmospheric conductivity varies only a few per cent during an undisturbed day, the potential gradient is nearly proportional to the leakage current density and, hence, approximately proportional to the number of thunderstorms in progress over the world. The implication of the correlation shown in Fig. 1 is that the mean amplitude of the low-frequency electromagnetic signal is also an approximate measure of world thunderstorm activity.

The most surprising feature of the implication lies in the fact that the two principal thunderstorm centres in South America and Africa are respectively 65° and 135° from Borrego Valley; hence, the amplitude of the signals from these centres might be expected to differ significantly. The apparent anomaly finds a plausible explanation if one assumes that the signal power is confined by the spherical wave-guide formed by the earth and ionosphere, and that to a first approximation at very low frequencies one may neglect the differences between signal attenuation over daylight and dark paths. In these circumstances the signal power would vary with angular distance, θ, from the source as $\exp(-\alpha\theta)/\sin\theta$. Assuming the attenuation constant, α, to be of the order of 1/60 deg.$^{-1}$ and taking account of the signal propagation over both the long and short great-circle paths, one finds that the mean signal power from similar sources between 70° and 150° from the observing station varies by less than a factor of 2. Thus, if there is no extensive thunderstorm activity close to the observing station, the mean signal amplitude should be roughly proportional to the number of storms in progress.

While the results presented here are not in themselves conclusive evidence, they strongly suggest that the majority of the electromagnetic signals between 25 and 130 cycles/sec. are atmospherics. Further, the signals in this frequency-range appear to have a sufficiently low attenuation to suggest that they are received from lightning in all parts of the world. In the case of properly selected observing sites, remote from large thunderstorm centres, the mean signal amplitude is roughly proportional to the number of storms in progress. Thus, it appears possible that an index of world thunderstorm activity may be obtained from one or a very small number of carefully selected low-frequency stations.

The measurements reported here have been continued and supplemented by additional measurements. A more complete account will be published elsewhere.

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[1] Willis, H., *Nature*, **161**, 887 (1948).

[2] Watson-Watt, R. A., Herd, J. F., and Lutkin, F. E., *Proc. Roy. Soc.*, A, **162**, 267 (1937). Hepburn, F., and Pierce, E. T., *Nature*, **171**, 837 (1953). Chapman, F. W., and Matthews, W. D., *Nature*, **172**, 495 (1953).

[3] Aarons, J., and Henissart, M., *Nature*, **172**, 682 (1953).

[4] Torreson, O. W., Gish, O. H., Parkinson, W. C., and Wait, G. R., Scientific Results of Cruise VII of the *Carnegie*, Carnegie Institution of Washington, Pub. 568 (1946).

Trinuclear Molecules in the Crystal Structure of Bisacetylacetonenickel(II)

The stereochemistry of four-covalent nickel(II) complexes has been a subject of great interest to chemists for the past two decades. Following the enunciation of Pauling's theories relating stereochemistry, bonding orbitals and magnetic moment, it has been shown that, in all cases where structural studies have been carried out, the diamagnetic four-covalent complexes of nickel(II) are square planar[1]. However, little work has been done to investigate the structure of the paramagnetic (presumably) four-covalent complexes such as bissalicylaldehydenickel(II) and bisacetylacetonenickel(II). These complexes have a magnetic moment indicating two unpaired electrons[2] and usually this has been assumed, without proof, to indicate that $4s4p^3$ tetrahedral bonding occurs. It has been shown by Curtiss, Lyle and Lingafelter[3] that the X-ray powder patterns of bissalicylaldehydenickel(II) and of its zinc analogue are identical. This has been taken as evidence in support of a tetrahedral arrangement of the four oxygen atoms around the nickel(II) atom because zinc(II) is known to display tetrahedral co-ordination. However, in the absence of definite proof that the zinc(II) atom has tetrahedral co-ordination in this instance, the case is not proved. It was decided, therefore, to carry out an X-ray investigation of bisacetylacetonenickel(II) and the preliminary results are summarized here.

Crystals of bisacetylacetonenickel(II), prepared by sublimation under reduced pressure, were found to be orthorhombic with $a = 15{\cdot}65 \pm 0{\cdot}02$ A., $b = 23{\cdot}23 \pm 0{\cdot}04$ A., $c = 9{\cdot}64 \pm 0{\cdot}02$ A. Absent spectra are: $(h0l)$ when h is odd and $(hk0)$ when k is odd. These absences show the space group to be either $Pmab$ or $P2_1ab$. Tests for pyroelectricity and piezoelectricity were negative, and a statistical survey of the intensities of the $(h0l)$ and $(hk0)$ zones by the procedure of Howells, Phillips and Rogers[4] did not give a conclusive result which would enable a choice between the two space groups to be made. The density of the crystals is 1·455 ± 0·001 gm./ml. and the number of formula units $Ni(C_6H_7O_2)_2$ in the unit cell is 12 (calculated 11·96 ± 0·07).

Examination of the three-dimensional Patterson function and, in particular, of Patterson–Harker sections, showed that there are three nickel atoms in the asymmetric unit, the space group being $P2_1ab$. The co-ordinates of these three nickels are given in Table 1; the three atoms are very nearly collinear and the distances between adjacent atoms are: $Ni_1 - Ni_2$, 2·72 A., and $Ni_2 - Ni_3$, 2·88 A.

Table 1. Co-ordinates as Fractions of the Axial Lengths

Atom	x	y	z
Ni_1	0 092	0·036	0 256
Ni_2	0·000	0 120	0 125
Ni_3	−0·098	0·208	−0 017

It is considered that, at the stage to which this work has been taken, the difference between these two values is not significant. The proximity of the nickel atoms implies either (*a*) an interaction between neighbouring nickels, or (*b*) a bridging of neighbouring nickels by other atoms. In either case the crystal must contain large molecules, each three times as big as hitherto supposed, namely, $Ni_3(C_5H_7O_2)_6$. The presence of these trinuclear molecules is shown plainly in the electron density projection on (001), $\rho(xy0)$, reproduced in Fig. 1. Direct and 'trial and error' methods of determining the positions of the other atoms have failed to lead to a unique solution. Many possible molecular models can be ruled out, but with trinuclear molecules the possibility of octahedral co-ordination of the nickel atoms must be taken into account; it is not simply a choice between tetrahedral and square-planar co-ordination.

It is apparent that further investigation of this compound using other physical techniques is essential before one can decide between the various possible structures with any confidence. With this object in view, further work is proceeding in collaboration with Prof. R. S. Nyholm. In particular, the magnetic susceptibility is being studied over a range of temperature, the molecular weight is being determined in various solvents and infra-red studies are to be carried out.

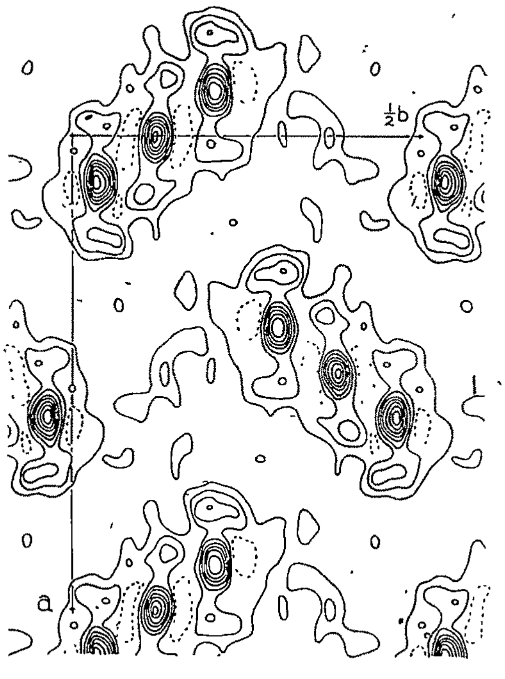

Fig. 1. Electron-density projection on (001). Contour interval arbitrary, some contours around the nickel atoms being omitted for clarity

I wish to thank both Dame Kathleen Lonsdale and Prof. R. S. Nyholm for their help and advice. The award by the University of London of the Arthur Jubber and other postgraduate studentships is acknowledged with thanks.

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[1] See, for example, Godycki, L. E., and Rundle, R. E., *Acta Cryst.*, 6, 487 (1953). Cox, E. G., Wardlaw, W., and Webster, K. C., *J. Chem. Soc.*, 1475 (1935).

[2] Mellor, D. P., and Craig, D. P., *J. Proc. Roy. Soc., N.S.W.*, 74, 475 (1940).

[3] Curtiss, D. H., Lyle, F. K. C., and Lingafelter, E. C., *Acta Cryst.*, 5, 388 (1952).

[4] Howells, E. R., Phillips, D. C., and Rogers, D., *Acta Cryst.*, 3, 210 (1950).

The Arrow of Time

It is widely believed that all irreversible mechanical processes involve an increase of entropy, and that 'classical' (that is, non-statistical) mechanics, of continuous media as well as of particles, can describe physical processes only in so far as they are reversible in time[1]. This means that a film taken of a classical process should be reversible, in the sense that, if put into a projector with the last picture first, it should again yield a possible classical process.

This is a myth, however, as a trivial counter-example will show. Suppose a film is taken of a large surface of water initially at rest into which a stone is dropped. The reversed film will show contracting circular waves of increasing amplitude. Moreover, immediately behind the highest wave crest, a circular region of undisturbed water will close in towards the centre. This cannot be regarded as a possible classical process. (It would demand a vast number of distant coherent generators of waves the co-ordination of which, to be explicable, would have to be shown, in the film, as originating from one centre. This, however, raises precisely the same difficulty again, if we try to reverse the amended film.)

Thus irreversible classical processes exist. (On the other hand, in statistical mechanics all processes are, in principle, reversible, even if the reversion is highly improbable.) Although the arrow of time is not implied by the fundamental equations, it nevertheless characterizes most solutions. For example, in applying Maxwell's theory, the initial conditions determine whether we choose to work with retarded or with advanced potentials, and the resulting situation is, in general, irreversible.

K. R. Popper

University of London.
Nov. 30.

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[1] See, for example, Max Born, "Natural Philosophy of Cause and Chance", especially pp. 25f. (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 19

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street. London, W.C 1), at 4.15 p.m —Prof Y. Cauchois (Paris): "The Present State of X-Ray Spectroscopy and Its Application to the Study of Solids" * (Further lectures on March 20 and 21.)

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "Electronics and Automation". Dr. H. A. Thomas. "Some Industrial Applications" (with films and demonstrations).

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP and AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 30 p.m.—Dr E. J. Miller: "Toxic Chemicals in Foodstuffs".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C 2), at 5.30 p.m.—Dr. J. T. Scales. "Biomechanical Problems in Orthopædics".*

INSTITUTE OF METAL FINISHING (at Northampton Polytechnic, St John Street, London, E C 1), at 6.15 p.m.—Dr. T. P. Hoar: "Some Problems in Bright Plating".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S W.7), at 8 30 p.m.—Prof. O. H. K. Spate. "Problems of Development in New Guinea"

Tuesday, March 20

INSTITUTION OF CHEMICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE at the Royal Institution, Albemarle Street, London, W.1), at 5 30 p m.—Mr. C. M. Nicholls, Mr. J. B. Morris and Mr. F. W. Fenning: "The Application of Fluidization Techniques to Nuclear Reactors".

SCIENTIFIC FILM ASSOCIATION (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m —Meeting on "The Making of Research Films".*

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Use of Pictures and Other Graphical Methods in Teaching Engineering".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W 1), at 7 p m.—Mr. P. T. Fink: "Experiments on Flow Over Swept Back Wings".

Tuesday, March 20—Thursday, March 22

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 10 a.m. daily—Spring Meeting.

Tuesday, March 20

At 10 a.m.—Annual General Meeting.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Horticultural Society's New Hall, Greycoat and Elverton Streets, London. S.W.1)—Eighth Technical Exhibition *

Wednesday, March 21

INSTITUTE OF BIOLOGY, LONDON BRANCH; ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION; INSTITUTE OF PHYSICS LONDON AND HOME COUNTIES BRANCH (at the Senate House, University of London, London, W.C.1), at 5 p.m.—Joint Symposium on "The Presentation of Science to the Public".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Meeting on "Developments of the Decca Navigator System".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p m —Mr. J. K. Bannon and Mr. A Gilchrist: "Variations of Temperature in the Troposphere and Lower Stratosphere"; Mr. E. B. Kraus: (*a*) "Secular Changes of Tropical Rainfall Regimes", (*b*) "Secular Variations of East-Coast Rainfall Regimes".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m. —Dr. R. H S. Phillips: "United Kingdom Indices of Wholesale Prices 1949–55".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m.—Mr. James H. Renwick: "Linkage in Human Genetics" *

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. P. J. Jackson and Mr. J. M Ward: "Operational Studies of the Relationship between Coal Constituents and Boiler Fouling"; Mr. A. M. Freedman "Full-scale Trials of the Humidification of Combustion Air to Prevent Boiler Fouling"; Mr B. Lees: "An Investigation into the Air-heater Corrosion of Oil-fired Boilers".*

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. K D. C. Vernon: "Finding the Answer".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. E S. Horning: "Some Anomalies in Endocrine Carcinogenesis"

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p m —Mr. J. H Askew: "A Novel Relay Amplifier".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 8.30 p.m.—Prof. H. J. Eysenck: "Psychological Theories and Psychiatric Practice".

Thursday, March 22

MINISTRY OF EDUCATION (joint meeting with the BRITISH ASSOCIATION FOR COMMERCIAL AND INDUSTRIAL EDUCATION, at the Royal Festival Hall, South Bank, London, S.E.1), at 10.30 a.m —Conference on "The Development of Sandwich Courses".

BIOCHEMICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 10.45 a.m —Annual General Meeting followed by Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 3 p.m.—Annual General Meeting and Symposium on "Loudspeakers". Lecturers: Dr D. M. Tombs, Mr. P. J. Walker, Mr. F. H. Brittain and Mr. S Kelly.

MINERALOGICAL SOCIETY (at the Royal Entomological Society, 41 Queen's Gate, South Kensington, London, S W.7), at 5 p m.—General Meeting.

INSTITUTE OF REFRIGERATION (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m. —Mr. R. F. Brown: "Thermodynamic Calculations for Programme Control of a Test Chamber"

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, South Kensington, London, S.W.7), at 7 p.m.—Mr. F Pollak: "Masking for Half-Tone".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Electrical Lecture Room, University College, Gower Street, London, W.C 1), at 7.30 p.m.—Dr. M. R A. Chance. "The Role of Sexuality in the Social Life of Monkeys" (Film and Paper illustrated by slides).

Thursday, March 22—Friday, March 23

INSTITUTION OF MINING AND METALLURGY (in the Lecture Hall of the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C 2)—Symposium on "The Extraction Metallurgy of Some of the Less Common Metals".

Friday, March 23

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Discussion of Papers of Geophysical Interest. Chairman. Mr B. C Browne. Speakers: Dr. A. H. Cook, Dr D. I. Gough, Dr. E. R Lapwood and Dr. E. R. Niblett.

ROYAL MICROSCOPICAL SOCIETY (in the New Chemistry Building, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr. J. R. G. Bradfield: "Electron Microscopical Contributions to the Study of Living Matter".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p.m.—Prof. P. M. S. Blackett, F R.S.: "Rock Magnetism and the Movement of Continents".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER IN BIOLOGICAL CHEMISTRY—The Secretary, The University, Aberdeen (March 24).

LECTURER (with special qualifications in physical chemistry or inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (March 24).

CHEMIST OR CHEMICAL ENGINEER (with an honours degree in chemistry or chemical engineering or equivalent qualifications, and preferably with operational research experience in the chemical, metallurgical, or fuel industries) IN THE PRODUCTION CONTROL SECTION of the Operations Branch, for duties which include liaison with works managerial staff on production problems, the analysis of operational data, the planning of programmes and the co-ordination of research and development concerned with existing plants and processes—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1319 (March 26).

LECTURER (man or woman, with suitable qualifications in physics) IN SCIENCE, to assist in General Science Courses (including a Supplementary Course for serving teachers)—The Principal, City of Leeds Training College, Beckett Park, Leeds 6 (March 26).

LECTURER (with experience in either experimental or theoretical physics) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (March 29)

PRINCIPAL SCIENTIFIC OFFICER (with at least a second-class honours degree in metallurgy or equivalent qualification, a good background in the engineering uses of the well-known metals and alloys, and a thorough understanding of modern theories of physical metallurgy) IN THE RESEARCH AND DEVELOPMENT BRANCH, U.K.A E.A., Springfields Works, Salwick, near Preston, Lancashire, to direct a section engaged in physical metallurgy and metallography—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, Lancs (March 29).

LECTURER OR ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, The University, Exeter (March 31).

Senior Technician (with considerable training and experience in animal histology, and a basic knowledge of hæmatology and bacteriology)—The Secretary, Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3, quoting "Histology" (March 31).

Lecturer (with qualifications in electronics), and Assistants (with qualifications in experimental physics, theoretical physics or electronics), in the Department of Natural Philosophy—The Secretary, The University, Aberdeen (April 1).

Chemistry Laboratory Superintendent at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 2).

Mathematician, Scientific Officer grade (preferably with a knowledge of aerodynamics or statistics, together with an interest in physics or engineering) with the Air Ministry, for operational research duties in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.96/6A (April 7).

Lecturer or Assistant Lecturer in Applied Mathematics—The Registrar, The University, Leeds 2 (April 9).

Demonstrator (with a good honours degree in physiology or biochemistry) in Physiology—The Registrar, The University, Manchester (April 10)

Imperial Chemical Industries Limited Research Fellows in Bacteriology, Biochemistry, Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology or Textile Industries (Chemistry of High Polymers (keratin and man-made fibres)), Textile Technology and Wool Textile Engineering—The Registrar, The University, Leeds (April 14).

Lecturer in Physics—The Registrar, The University, Reading (April 14).

Lecturer or Assistant in the Joint Department of Chemical Technology and Chemical Engineering (University of Edinburgh and Heriot Watt College)—The Assistant Secretary, The University, Edinburgh (April 16).

Lecturer (with special qualifications in the chemical aspects of plant physiology, and teaching and research experience) in Botany—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (April 16).

Assistant Lecturer in the Department of Biochemistry—The Registrar, The University, Liverpool (April 23).

Chair of Pure Mathematics tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 25).

Lecturer in Biochemistry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, April 30).

Professor of Experimental Physics at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 30).

Chairs (2) in the Department of Pathology and Microbiology, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 31).

Aerodynamicists and Aero Engineers (with a first- or second-class honours degree in physics, mathematics or engineering, or equivalent qualifications) at a Ministry of Supply Aeroplane and Armament Experimental Establishment, near Amesbury, Wilts, for duties which may include the testing of aircraft, development of test methods, interpretation of test results, and liaison with aircraft constructors—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.211/6A/AA.

Agronomist (with a university degree in agriculture, and experience in field experimentation, preferably with tropical crops) in the Department of Agriculture, British Guiana, to initiate and carry out crop and fertilizer trials where soil surveys are being carried out to determine optimum land use—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W 1, quoting BCD.79/30/01.

Biochemist (Basic grade), at the Derbyshire Children's Hospital, to work under the direction of the Group Pathologist and Principal Biochemist—The Group Secretary, No 1 Hospital Management Committee, Babington Lane, Derby.

Chemists (with experience in organic or physical chemistry), for developmental work on the preparation of isotopically labelled compounds, the separation of radioactive isotopes from irradiated materials at high levels of activity, the chemistry of natural radio-elements, and the investigation of radioactive effects in chemical compounds—The Personnel Officer, Radiochemical Centre, United Kingdom Atomic Energy Authority, Amersham, Bucks, quoting Ref. 504.

Editor (with a degree in metallurgy, physics or chemistry, and preferably experience in abstracting, and a knowledge of languages) of *Metallurgical Abstracts*—The Secretary, The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1

English Electric Co., Ltd., Research Fellow in Aeronautics—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks.

Lecturer (with experience in wind tunnel research) in the Department of Aerodynamics—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

Master to teach Physics, if possible to advanced level—The Headmaster, Malvern College, Malvern, Worcs.

Mechanical Engineer or Physicist (with a university degree or equivalent, and some knowledge of statistical techniques in research) in the Research Department, to undertake investigations into the strength of glued joints—The Director, Furniture Development Council, 11 Adelphi Terrace, London, W.C.2.

Physicist, and an Engineer, Assistant Experimental Officer o Experimental Officer grade (with the general certificate of education advanced level (or equivalent), in science subjects, and preferabl some teaching experience), to assist with the laboratory work of th Reactor School, including constructing, maintaining and demonstratin experiments in both physics and engineering—The Establishmen Officer, Atomic Energy Research Establishment, Harwell, Didcot Berks, quoting 511.

Physicist or Chemist (with a first- or second-class honours degre or equivalent in physics or chemistry, and research and developmen experience in the field of high polymers, particularly natural an synthetic rubbers) at the Ministry of Supply Headquarters in London for initiation and progressing of research and development work o rubbers for Service purposes and advising Service Departments o technical applications of rubber, also to maintain an up-to-dat knowledge of, and close contact with, basic research and technologica development at Universities and in industry—The Ministry of Labou and National Service, Technical and Scientific Register (K), 26 Kin Street, London, S.W.1, quoting A.81/6A/AA.

Physicist (with a first- or second-class honours degree or equivalen in physics or chemical engineering) at a Ministry of Supply Establishment at Waltham Abbey, Essex, for research on heat transfer phenomena at very high temperatures—The Ministry of Labour an National Service, Technical and Scientific Register (K), 26 King Stree London, S.W.1, quoting A.94/6A/AA.

Research Associates in Experimental and Theoretica Physics in the Molecular Excitation Group—Dr. R. W. Nicholl Department of Physics, University of Western Ontario, Londo Ontario, Canada.

Research Entomologist (preferably with an honours degree i biology and two years (three for appointment as S.S.O.) postgraduat training, or approved experience in scientific research) at the Wes African Institute for Trypanosomiasis Research, for duties whic include some minor routine work in connexion with the runnin of the Entomological Section of the Institute, and primarily to undertake research upon the behaviour, breeding and longevity of th tsetse fly—The Director of Recruitment, Colonial Office, Sanctuar Buildings, Great Smith Street, London, S.W 1, quoting BCD.197/198/0

Research Fellow (with a good degree in physics) in Instrumen Technology—The Professor of Instrument Technology, Physic Department, Imperial College, London, S.W.7.

Senior Experimental Officer or Experimental Officer (wit at least the general certificate of education, advanced level (or equivalent) in science subjects, or a good knowledge, preferably to degre standard, of physics and/or chemistry, and experience in the field o particle size analysis) in the Particle Size Analysis Section of the Chemical Engineering Division's Analytical Group, to organiz and supervise a section and provide a service of particle size analysi in the sub-sieve range, and to develop, or assist in the developmen of, new methods and instrumental techniques where required—The Establishment Officer, Atomic Energy Research Establishment Harwell, Didcot, Berks, quoting Ref. 514.

Senior Scientific Officer (with a first- or second-class honour degree in electrical engineering or physics, and three years postgraduate experience, and preferably with some experience in any o the following fields: (1) millimicrosecond pulse techniques, (2) missile firing trials or (3) development of missile test instrumentation), t lead a team responsible for the development trials of electrical and electronic equipment for use in weapons—The Senior Recruitmen Officer, Atomic Weapons Research Establishment, Aldermaston Berks, quoting 1059/34.

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(*not included in the monthly Books Supplement*)

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RESEARCH AND DEVELOPMENT IN THE ELECTRICITY SUPPLY INDUSTRY

THE Departmental Committee appointed by the Minister of Fuel and Power in July 1954, under the chairmanship of Sir Edwin Herbert, "to inquire into the organization and efficiency of the electricity supply industry in England and Wales in the light of its working under the Electricity Act, 1947, and to make recommendations"*, had wider terms of reference than that which, under Sir Alexander Fleck's chairmanship, reported last year on the organization of the National Coal Board. Indeed, it is the first comprehensive review of the working of a nationalized industry in Britain and, though its main recommendations are concerned with organization, the report also embraces matters relating to staff, finance, tariffs, research and development, as well as to the powers and duties of the Minister. The Committee approached its task with the sole object in mind of the improvement and welfare of this great industry, and its recommendations are intended to make the nationalized industry work better within the framework of public ownership. None the less, the report is a challenge to constructive thinking, not merely about the electricity supply industry in Britain, but also about the limitations and implications of nationalized industry in general. An important feature is its attempt to lay down criteria by which the efficiency of such an industry can be judged.

The report is thus of no less scientific interest than the Fleck report, for, while there is much common ground in the two reports, the whole approach of the Committee is in welcome contrast to the political prejudice which has bedevilled so much discussion of nationalization, both as regards its application to particular industries and the question of public accountability. The Herbert Committee does not indeed suggest easy criteria; but it does indicate factors, if not principles, which should guide decisions on both issues and which cannot wisely be ignored. It notes, for example, how impossible it is to avoid some political element in the whole structure of the industry, including the price structure of its product, because the amount of capital to be raised depends not upon the attractive power of the industry so much as upon the Government's decision as to how much capital shall be raised on the national credit on its behalf. While there is nothing in the Act which requires the industry to supply electricity on uncommercial terms to any customer or class of customer, or to conduct itself in such a way that it would have to face higher costs than a private business, the Committee considers that the industry is in the same position as any other undertaking borrowing money through the mechanism of the market, provided it sees that the Treasury guarantee is not called upon. The Committee accepts the need for a considerable degree of 'public accountability' in a nationalized industry, but suggests that there is some confusion of thought as to how far this extends to borrowed money.

The Committee approached its task by asking itself five questions. Is the industry making the best use of its man-power and physical resources? Is it making the best use of the capital it raises and the revenue it earns? Are the consumers being properly charged for the services rendered to them? Is the organization of the industry well adapted for securing the best use of capital, man-power and physical assets and for ensuring that proper charges are made to consumers? Is the organization well adapted and the staff sufficiently capable to secure the same ends in future?

The report begins by recording admiration for the zeal shown at all levels of the industry since vesting day. In the opinion of the Committee, the way in which the task of carrying out the amalgamations required was achieved with no friction so far as consumers were concerned, and a minimum of internal friction, reflects great credit on all concerned both in planning and execution. Since vesting day, in face of shortages of capital, man-power and physical assets, the industry has largely overcome the shortage of generating plant, and has gone far towards making good the war arrears of maintenance and reinforcement of distribution systems. It has made substantial technical advances and, at a time when coal has increased in price by 270 per cent and the general cost of living index by 137 per cent, is supplying electricity to consumers at an average price only 30 per cent above that ruling in 1939.

The main question with which the Committee has been concerned is not, however, whether the organization of the industry has served its purpose well in the period since vesting day, but whether it is the best form of organization for the running and development of the industry in the future, now that the initial reorganization has been effected. In particular, since the industry has lost the classical spur to efficiency—the possibility of failure or at least of showing up badly by comparison with others—the Committee was concerned as to whether the forms of control used in the industry are effective in securing that money is not spent on unnecessary projects and that full value for money is obtained out of expenditure on necessary projects. The Committee thinks it is necessary to retain a central authority, but that it is essential to remove from such authority both the executive responsibility for generation and transmission and the present vague general responsibility for the industry as a whole, and also to define clearly the functions to be retained at the centre.

Again, the Committee believes that the industry has a long way to go in the introduction of modern aids to good management. In budgeting, in work-study, in operational research, in incentive wage systems, it is not in the van, and in some respects is lagging, partly because it has been unwilling to face the problem of staff redundancy. The industry must also take very energetic steps to ensure that it attracts and retains an adequate supply of first-rate talent for both technical and managerial posts. Like the Fleck Committee, the Herbert Committee points out that part of the trouble lies in the low level of salaries at the top and in the limited number of independent commands. The advent of nuclear power offers the industry an opportunity of seizing once more the imagination of the young, recruiting talent, grooming it for responsibility, and giving it its head.

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* Report of the Committee of Inquiry into the Electricity Supply Industry. (Cmd 9672.) Pp. viii+189. (London: H.M. Stationery Office, 1956.) 6s. 6d. net.

These criticisms of structure, delegation, management aids and recruitment are all interlinked; but the very size of the industry and the remoteness of authority tend to lead to loss of morale unless it is built up by positive measures. The Committee rightly observes that the industry requires men as close to the field as possible, technically capable, and leaders with initiative and courage. It requires great names in the future as in the past—great engineers, managers and administrators; and it is clear enough that in the minds of the Herbert Committee the scientists and technologists can be expected to provide such names right at the top.

Beyond these criticisms, the Committee recommends that the Central Electricity Authority should be reconstituted, its responsibility for generation, including the construction and operation of the power stations, grid and super-grid being transferred to a new statutory central electricity generation board. The Authority would then be required, *inter alia*, to approve the general plans of both the generating board and the area boards and any proposal by an area board to construct a generating station, as well as to approve research arrangements and programmes. Its independent powers of scrutiny would place the Authority in a strong position to insist upon proper operational research and work-study and to encourage more attention to utilization research. The Committee visualizes the Authority as a body of men, independent of the boards and their day-to-day actions, but ready to help, to co-ordinate and to stimulate, and providing the Minister with an independent body of expert opinion within the industry capable of the critical scrutiny of finance and development which is now lacking.

One consequence of the passive attitude to redundancy adopted by the present Central Electricity Authority has been that work-study, operational research and investigations into restrictive practices are undertaken by management at all levels without enthusiasm—if they are pursued at all—and the most effective deployment of man-power is never possible. In the context of the development of nuclear power in the coming decades, this would clearly be fatal to efficiency. The nation can only afford the large investment of resources which nuclear power development requires if it is assured of the full benefits not only in the saving of fuel but also of man-power which nuclear energy permits. In urging the industry to adopt a more flexible and realistic attitude towards redundancy, the Committee understates the case when it observes that the national economy may well be damaged if men who are in short supply and may be badly needed elsewhere are retained by an industry which cannot itself fully employ them.

It is a marked feature of this report that such tendencies are kept carefully in mind, and the Committee's recommendations are framed to encourage the necessary flexibility and adaptability. This is noticeably true in its comments on the recruitment and promotion of staff. It has already been noted that the industry needs to face more realistically the problems which changing needs for different grades of man-power arising out of improvements in technique and organization may create from time to time; though curiously enough the Committee does not make the obvious comment that technical education and adequate training after entering the industry could do much to ease such problems, and foster the adaptability which is so important in an era of rapid technological change. Its preoccupation is rather that the industry should make the fullest possible use of the opportunity provided by the construction and operation of nuclear power stations to attract the best type of recruits for its technical and managerial posts. It looks at the industry rather through the eyes of a keen, intelligent, young man with a good engineering degree.

First, it recommends that the industry should urgently review the conditions which are causing well-qualified men of the calibre of potential leaders to turn to other fields, and that it should improve the terms of service, including starting salaries and differentials for graduate trainees. Next, it is disturbed by the attitude of the Central Authority towards the advancement of graduate trainees and its policy on training potential managers of the first rank. Here it recommends a deliberate system of selective training and posting of able young men, so that potential leaders may prove their qualities in successive posts and gain the experience which will fit them for higher management. It challenges the Authority's confidence that under the present arrangements future leaders will automatically be forthcoming, and it would like to see more extensive cross-posting of promising young men between the generation and transmission and distribution sides of the industry.

Like the Fleck Committee, the Herbert Committee attaches great importance to a deliberate policy in this matter; and the recommendations are broadly similar, as they are again in regard to research and development. This is discussed under two headings. First, of utilization research, the Committee challenges the adequacy of the allocation of only 5 per cent of the Central Authority's budget for research on utilization research, and recommends that facilities for this purpose be strengthened and provided with more resources. Because this work may not have such high scientific interest as other parts of the research programme, it is suggested that it has not been adequately supported.

The Committee is also critical of both the scale and organization of research and development within the industry. In 1954–55 expenditure for this purpose was about £700,000, or less than 0·2 per cent of the industry's annual revenue; and the Committee suggests that the industry is relying too largely for technical development and progress on research organizations outside the industry. The expenditure on research includes, in fact, an allocation of £60,000 a year for research in universities and technical colleges and more than £250,000 to co-operating research organizations, chiefly to the British Electrical and Allied Industries Research Association. Estimated expenditure on research for 1955–56 is given as £625,000 at the Authority's headquarters and £850,000 by the divisions or area boards and £270,146 to research associations (including £100,000 to the National Industrial Fuel Efficiency Service).

To determine how far the Committee's criticisms of the scale of research are sound requires a much closer examination than is given in this report, and at least some indication of the lines along which investigations are more profitably pursued within the industry rather than outside, and of the type of problem that is being neglected. The comment that an industry that has to have scientific knowledge pushed at it is never as strong as the industry which is organized to pull it in is fair enough; and the Herbert Committee appears to be disturbed rather with the present attitude to research and with the possibility that the present scale of research does not supply the industry with sufficient men inside scanning the horizon of knowledge and capable of interpreting what they see for its guidance. The Committee is also disturbed at the diffusion of responsibilities for research and development inside the Authority.

The Committee believes that the responsibilities of the Electricity Supply Research Council are much more limited than the Council's terms of reference indicate, and that the present organization established to deal with research and development is inadequate if science is to be put to work and bear fruit in this industry. It urges that in such a technical industry science should be represented at the highest level of management and that, with the exception of utilization research, a full-time member of the proposed generation board should be responsible for research and development, supported by a research staff of high quality. It believes that the area boards should also extend their research activities and be less dependent on the initiative of the electrical manufacturing industry for technical progress and innovations.

There can be no question that the Herbert Committee is right in holding that the electricity supply industry in Britain, by its very nature, should be in the forefront of industries organizing and applying research and development on an extensive scale; and its observations in regard to fuel requirements and nuclear energy indicate one direction in which expansion of that effort is required. It is better, the Committee suggests, for the Authority to build and operate a limited number of nuclear power stations than to wait on developments instituted by other authorities and organizations at home or overseas, and its criticism of the organization being established by the Authority to deal with its nuclear responsibilities reflects this concern. The recommendation that the post of deputy chief engineer, responsible for the construction, operation and development of nuclear stations, be created is reasonable; though there may be need for more attention to what is already being done in the way of research and development by the Atomic Energy Authority than is indicated in this report, bearing in mind the Committee's remark as to the desirability of the Central Electricity Authority being able to meet the Atomic Energy Authority and the manufacturing consortiums at scientific and technological levels on equal terms.

The Herbert report thus goes far to supply the efficiency audit which has often been adumbrated in discussions on the control of nationalized industries and their public accountability; and it is an important contribution to that debate. It indicates factors which are not peculiar to the electricity supply industry, but are valid in respect of accountability or efficiency of any such industry, such as the bearing on efficiency of opening every transaction to public examination and the repercussions of a monopoly, with the absence of alternative employment, on conditions of service and recruitment. Warm appreciation of the achievements of the industry has not prevented frank appraisal of its inherent dangers—and those dangers are not limited to this particular nationalized industry.

The report is also a valuable stimulus to constructive thought about the factors upon which technological progress depends. Even where the Committee's conclusions are accepted with reserve, they indicate none the less the importance of those factors for technical efficiency. No scientist or technologist could wish for a clearer and fairer statement as to the place of research and development in industry, or of the importance of a considered policy for the recruitment and promotion of staff. The need for flexibility and adaptability, for open-mindedness and ability to face the future and to consider the implications of technical change and advance, not merely in terms of finance and economics, but equally in relation to staff and society as a whole, are emphasized at every turn; and they are seen against the background of the nation's limitations in man-power and other resources. There is no shirking of difficult or unpleasant issues; and although the report says relatively little about technical education and the relation of the research organization of the electrical supply industry to that of Britain as a whole, it none the less makes it abundantly plain that any realistic appraisal of expenditure on research must take full account of what is being done by nationalized industries such as this, and of their relations with the Department of Scientific and Industrial Research and the research associations. Last but not least, the report supplies further evidence of the vital importance of an adequate system of education (technical and technological as well as general), if industry is to be supplied with the technicians and general operatives, as well as with scientists and technologists, possessing the adaptability which is so essential in an era of rapid technological development.

RALEIGH'S ATTEMPTED COLONIZATION OF VIRGINIA

The Roanoke Voyages 1584–1590

Documents to illustrate the English voyages to North America under the Patent granted to Walter Raleigh in 1584. Edited by Prof. David Beers Quinn. Vol. 1: pp. xxxv+496. Vol. 2: pp. vi+497–1004. (Works issued by the Hakluyt Society. Second Series, No. 104.) (London: Cambridge University Press, 1955.) 120*s.* net.

In these two most valuable and fascinating volumes Prof. D. B. Quinn has continued for the colonization of Virginia under Raleigh what he had earlier completed for Sir Humphrey Gilbert's ventures in New England and Newfoundland. Spain, through Columbus, discovered the Caribbean lands, and within fifty years or so her empire stretched from California to Tierra del Fuego. Portugal, using Vespucci, coasted Brazil and Argentina and began its colonization in earnest by 1550. But England, which through John Cabot had explored from Greenland to New England, made no attempt to establish a colony in the New World. The Tudor monarchs sensed, almost immediately, that such voyages westward would not lead easily to Cathay and the Spice Islands, and so, apart from the fisheries of Newfoundland, English interest in the Americas lapsed until 1578. Gilbert's warrant to establish colonies in North America lasted from 1578 until 1584, and thereafter Sir Walter Raleigh obtained the Queen's patent to do so, provided he did not interfere with the Newfoundland fisheries.

Hakluyt published many of the main sources for the voyages and colonization of Virginia undertaken between 1584 and 1590. The documents in these two volumes include those of Hakluyt supplemented by many minor documents and new material and interpretations derived from modern scholarship. Vol. 1 includes seventy-three documents dealing with the 1585 and 1586 voyages, while Vol. 2 has thirty-four English documents on the 1587–90 voyages, together with fifty-two Spanish documents, two of them published originally by Miss Wright, which deal with these English voyages to Roanoke Island in Virginia.

The introduction, of seventy-six pages, assesses the material, and at the beginning of each chapter a narrative is given of the events and material in the documents. Footnotes and annotations are most liberal and reveal the thorough and rich scholarship of the editing. Prof. Quinn considers that during 1584–86 the English ventures were not over-publicized, probably because of the danger of Spanish interference. From 1587 onwards, relations with Spain were open war if not official war, and after the defeat of the Armada there was no further fear of Spain. The documents published by Hakluyt were in the nature of propaganda for the colony, and Quinn believes that they suppressed some features of the expeditions to present the project in as attractive a light as possible. He also considers there is evidence to show that Raleigh and Grenville intended to establish a colony at about 36° N., which would be sufficiently north of Florida to avoid Spanish attack yet close enough to the West Indies to provide a base for privateering. It is this potential role of the Virginia colony on Roanoke which led the Spaniards to keep on searching to destroy it from 1590 until 1600, unaware that it had been abandoned in 1590.

The 1584 voyage located Roanoke Island, while Grenville's voyage of 1585 established a fort and colony on it. Lane was left with a garrison, expecting Raleigh to send a relief ship and stores by Easter 1586. It did not come until late June, and by then Lane and the colonists had been taken off by Drake, at their request. Grenville arrived with three hundred men two weeks later to strengthen the colony, but finding it deserted he left a holding party of only eighteen men, who were attacked by Indians and overcome. By such a narrow margin did the fair enterprise of Raleigh's colonization of Virginia fail to succeed: as Quinn notes, "the whole sequence of colonization was destroyed, inadvertently, by Drake". The drawings by White and the maps by White and Hariot, no less than their accurate descriptions of the Indians and the flora and fauna, are historical documents of unique value. There are appendixes on the map of Virginia as it was explored in these expeditions, on Indian words and on the archæology of the settlements. By 1950 the fort made in 1585 on Roanoke was completely reconstructed by Harrington. Sources and indexes of subjects, names and places complete a most comprehensive and brilliant study of this early venture in the origins of the British Empire. Prof. Quinn and the Hakluyt Society are to be warmly congratulated on this absorbing and scholarly addition to their famous series.

Arthur Davies

LUCUBRATORY BIOCHEMISTRY

Biochemistry

An Introductory Textbook. By Prof. Felix Haurowitz. Pp. xvi+485. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 54*s.* net.

According to the author, this text-book "is designed to form the basis of a one-semester course in biological chemistry intended for seniors and graduate students majoring in bacteriology, botany, chemistry, physiology, or zoology". After an introductory chapter, in which the development and scope of biochemistry, the fundamentals and special fields of the subject, and the literature, are all discussed, chapters are devoted to water and its functions, the mechanism of biochemical reactions, the chemistry and metabolism of carbohydrates, proteins and lipids, nucleic acids, porphyrins, mineral metabolism, enzymes, energy balances and nutrition, and human biochemistry. The balance of the book is different from the sort of volume that is produced for medical students, and includes both structural and dynamic aspects of the subject. It incorporates material on animal, plant and bacterial biochemistry.

Since the book is meant for seniors and graduate students it would seem all the more important that it should be accurate in detail, with an adequate discussion of the evidence on which the accepted ideas about metabolic processes are based. To produce a book for graduate students in a subject which is developing as rapidly as biochemistry advances to-day is a problem to be faced by all careful writers with some alarm and with intense care for detail and form. Dr. Haurowitz's book reveals little evidence of his awareness of these needs. Although the book is meant for seniors, references to original publications are not given in most instances. Such references as are included are largely to books and to review articles. One would hope that the senior student would have the time and stimulus to read at least a few original papers. In a number of instances Dr. Haurowitz includes a reference to a publication appearing in 1955 without documentation. For example, the section on p. 240 dealing with "Acetalphospholipids" includes the undocumented reference, "Klenk, 1955". One reader of this paragraph at any rate is left with complete bewilderment as to what Dr. Haurowitz means to say, and if indeed he intended to give an account of Klenk's interesting findings published in *Hoppe-Seyler's Zeitschrift* (299, 66–73 ; 1955) about acetalphospholipids and plasmalogens, he could have done so quite easily. References are also made in a number of cases to the possible role of hydride ions ($H:^-$) in the reduction of certain coenzymes ; but no references to the literature are given. On p. 386 the reader is told that as the result of studies with deuterium there is evidence that diphosphopyridinenucleotide and triphosphopyridinenucleotide accept hydrogen directly from substrates, and that if protons were transferred they would suffer exchange with the hydrogen ions of the solvent, a possibility ruled out on experimental evidence. Yet in numerous places the transfer is depicted as involving protons together with electrons, and occasional references are made to hydride ions. The discussion on p. 387 of the mechanism of action of alcohol dehydrogenase and acetaldehyde dehydrogenase is likely to confuse any critical student.

The text contains many misstatements, contradictions and unjustified generalizations, of which some will be quoted. On p. 42 we are told that "the compounds containing high-energy phosphate bonds are *unstable substances* [author's italics] readily hydrolyzed by water". According to p. 55, "transacetylase" and "acetokinase" are different names for the same enzyme. But this is not the enzyme for which the name "actokinase" was introduced by Ochoa and his colleagues (*J. Biol. Chem.*, 211, 737 ; 1954). On p. 64 occurs the interesting statement, "Natural isotopes are stable. . . . In contrast to the radioactive isotopes the natural isotopes are stable and do not emit damaging radiation. However, their determination requires a mass spectrometer which is an extremely expensive piece of equipment". Has Dr. Haurowitz never heard of naturally occurring radioactive isotopes, for example of potassium or of carbon ? From p. 78 we learn that "like all substances with asymmetric carbon atoms, the sugars are optically active". The intelligent student who has already learned about internal compensation will be puzzled by this. On p. 124 under the heading "Ketogenesis" occurs the following statement : "If carbohydrates are withdrawn from the food of diabetic patients, both hyperglycæmia as well as glycosuria disappear. However, another serious disturbance arises due to the formation of large amounts of acetoacetic acid CH_3—CO—CH_2—COOH, β-hydroxybutyric acid CH_3—CHOH—CH_2—COOH, and acetone CH_3—CO—CH_3. . . . Clearly, the diabetic patient oscillates between the two dangerous symptoms of glycosuria on the one hand and acidosis on the other. Both are relieved by insulin". Physicians who at one time treated diabetes by the administration of a diet rich in fat and who reduced diabetic ketosis by undernutrition or starvation would be most interested in this passage. On p. 132 the statement is made, "The amino acids are colorless substances that are soluble in water", although later the insolubility of cystine in water is mentioned (p. 156). According to p. 154, "Since arginine is formed from ornithine and ornithine from glutamic acid through its semialdehyde (see p. 150), arginine synthesis is a slow reaction which sometimes is not rapid enough to provide for the arginine requirements of the organism. Arginine is, therefore, one of the amino acids which are nonessential for some animals such as dogs, but essential for others such as chicks". That any modern biochemist should accept the validity of this sort of argument is astonishing. On p. 155 we are told : "In the muscle of invertebrates, which is free of creatine phosphate, its role of phosphate donor is taken over by arginine phosphate". Any generalization of this sort is dangerous in view of the existence of some invertebrates in which both creatine phosphate and another phosphagen are found (Baldwin, "An Introduction to Comparative Biochemistry", p. 74 ; Cambridge University Press, 1948 ; Baldwin and Yudkin, *Proc. Roy. Soc.*, B, 136, 614 ; 1950). P. 273 carries the following statement : "The low concentration of the hormones in the sex glands was primarily responsible for the failure of previous workers to isolate the hormones from the glands. Evidently the hormones are rapidly excreted into the urine. Urine in contrast to the organs, contains only small amounts of other lipids ; therefore the urinary benzene extract contains relatively uncontaminated hormones". After this astonishing dictum the incorrect numbering of the sterol skeleton on p. 265 seems to matter less. On p. 279 the formulæ for corticosterone and other adrenal steroids are also incorrect. On p. 276 we are told that "Attempts to prepare estrogenic hormones synthetically, led to the unexpected result that certain *stilbene derivatives*, [author's italics] such as dihydroxydiethylstilbene, are just as active as estradiol". That is historically incorrect, as can be seen by consulting the early papers of Dodds and his collaborators. Likewise, the statement on p. 277, that one of the simplest substances with estrogenic activity is 4-hydroxyphenylpropene, is wrong (see, for example, Lawson, *J. Chem. Soc.*, 4696 ; 1954). On p. 287, the following two sentences appear not far apart : "The high surface activity of soaps and of proteins is responsible for their ability to form foams". "The surface activity of the octyl alcohol molecules is much higher than that of proteins so that they displace the proteins from the water surface and the formation of the froth is prevented". A paradox indeed ! On p. 415 occurs the statement, "Owing to their insolubility in water and in the digestive juices, fats and oils are more slowly digested than carbohydrates and proteins. For this reason, fats are not the most efficient source of energy, although they can be used for this purpose as mentioned in the preceding paragraph". What does this mean ? Examples of this sort could be added to considerably ; but enough has been said to indicate the general flavour of the book and of the writing it contains.

The balance of the book is unusual. A very large amount of space is devoted to the chemistry and physical chemistry of proteins, and a picture of a Langmuir film balance is included on p. 287. The statement about the tricarboxylic acid cycle on pp. 59–61 is a category of the reactions involved, with the promise that details of the cycle and the chemical nature of its members "will be discussed later (pp. 249 and 119)". Unfortunately, we are nowhere given a discussion of the evidence from which the existence of the cycle and other metabolic pathways have been deduced by Szent-Györgyi, Krebs, Ochoa and many others, and this surely could have been included at the expense of some of the space devoted, for example, to alkaloids (pp. 177–180) or to terpenes (pp. 255–257).

A critical and accurate text-book of biochemistry for postgraduate students is needed which is not written with a medical point of view in mind and which includes both dynamic and static aspects of the subject within a reasonable size. Dr. Haurowitz has had the courage and tenacity of purpose to attempt this important task, and the 485 pages of his book might have provided such a volume. Unfortunately, they have failed to do so.

F. G. YOUNG

NORTH-AMERICAN PLANT TAXONOMY

An Introduction to Plant Taxonomy

By George H. M. Lawrence. Pp. viii+179. (New York and London: The Macmillan Company, 1955.) 23*s*. net.

THIS little book consists largely of a somewhat curious selection of material from "The Taxonomy of Vascular Plants" by the same author. According to the preface, it "is intended to serve as an aid to the non-taxonomist in the use of a manual or flora that accounts for the plants of any region of North America". A brief introductory chapter explains the nature and significance of taxonomy and distinguishes clearly between classification and nomenclature, two things which are frequently confused by the beginner. The survey of systems of classification, which occupies a dozen pages, seems of rather doubtful value to the non-taxonomist who simply wishes to use a flora. Engler's system is criticized once again for its lack of phylogenetic truth, in spite of the fact that it is admittedly based on artificial grades of perianth complexity and that its author never claimed any phylogenetic significance for it.

Nearly one-third of the book is occupied by what is in effect an elaborate illustrated glossary of the terms which may be used in describing vascular cryptogams and seed plants. The illustrations, though generally clear and helpful, are not uniformly accurate; for example, the fern sporangium (Fig. 8*f*) is shown with a stalk which bears no resemblance to reality. A more important point, however, is the great number of terms which are defined. These alone seem enough to discourage any non-taxonomist from attempting to use a flora, and many of them, in my opinion, are unnecessary words which, anyhow, are very rarely met with in modern works. The tendency nowadays is to reduce the number of terms used in description, even if it means a slight loss of precision or the substitution of a rather longer phrase in plain English. The greater precision which might be supposed to be obtained by using a word such as velutinous is largely illusory. The non-taxonomist will neither remember nor bother to look up afresh the precise meaning of such words, while specialists frequently differ over the exact application of the multitudinous terms used to describe qualitative features.

As long as botany consisted essentially of the systematics of flowering plants, this great abundance of descriptive words was all part of the game, but this period in the development of the science ended more than half a century ago. Taxonomists to-day need to make their work readily available to ecologists, physiologists and indeed to every kind of botanist, as well as to the host of happy amateurs. It is high time that many of these esoteric words were forgotten. It seems, therefore, regrettable that thirty-nine words describing hairiness and no fewer than sixty-two describing the shapes of leaves or parts of leaves are defined.

It is difficult to see how the summary of the International Code of Nomenclature or the brief account of phylogeny and biosystematics can help the kind of reader referred to in the preface, though the few pages dealing with collecting and identifying may well be of value to the beginner, and the chapter on taxonomy in North America is of interest to the historically minded.

The remainder of the book deals with important families (of flowering plants) in a rather chatty way. The same kind of information is to be found in more detail and more concisely expressed in most floras. Finally, it is perhaps worth pointing out that the cost per page seems to be about twice as much as that of comparable books printed in Britain.

T. G. TUTIN

NEWER TECHNIQUES IN ORGANIC ANALYSIS

Organic Analysis

Edited by John Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer and A. Weissberger. Volume 2. Pp. viii+372. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1954.) 8.50 dollars.

THE first volume of this work presented methods for the quantitative determination of a number of organic functional groups. The opening chapters of this second volume describe further specific determinations of the carboxyl group, the ester group, the nitro, nitroso and nitrate groups and of total nitrogen by the standard methods. The fourth chapter deals with the uses of lithium aluminium hydride in analysis. One application is to the determination of active hydrogen, and this provides an alternative to the Zerewitnoff method. Lithium aluminium hydride is so powerful as a reducing agent that its action upon various oxygen-containing groups is non-selective. However, the amount of the reagent consumed is proportional to the oxygen present in the groups attacked, and a method has been developed, using an indicator such as N-phenylaminoazobenzene, which gives a direct titration of the number of oxygen atoms present in a compound (ether oxygens being excepted). Great care is necessary to exclude moisture, oxygen and carbon dioxide; but the method should be very valuable.

The remaining five chapters of the book are concerned with special techniques. An account of coulometric methods does not open up many possibilities of their use in organic work. A chapter on polarography shows in detail the many pitfalls and difficulties which may arise with organic substances. Polarographic methods are rapid and convenient in certain instances, but great care and attention to detail are essential. A discussion of methods based on reaction-rate is of considerable interest, but their applicability would seem to be rather restricted. The most important field is probably that of enzyme and microbiological reactions, in which recent development has been rapid, but in this direction the account is disappointing.

A chapter entitled "Phase-Solubility Analysis" deals with tests for purity and the determination of impurities by precise solubility measurements. These methods are sound in principle, but are often very time-consuming. They have proved particularly valuable in the examination of some biological products where the criterion of melting-point is not available. The concluding section on "Countercurrent Distribution" is concerned with a method of highly organized multiple-solvent extraction. Convenient devices for carrying out many successive partitions systematically are described, and the theory of the fate of solutes present is worked out in detail. This technique has been developed largely by Dr. L. C. Craig and has been applied to the separation of acids, fats, bile constituents and protein degradation products.

The articles in this volume have been written by experts and they are in general well documented. It is not a serious disadvantage that some of the methods discussed have a restricted field of application. The production of the book is excellent, and the two volumes taken together will be of real value to the practical organic chemist. G. M. BENNETT

BIRDS OF THE KATHIAWAR PENINSULA, INDIA

Birds of Saurashtra—India, With Additional Notes on the Birds of Kutch and Gujerat

By R. S. Dharmakumarsinhji. Pp. liii+561+51 plates (33 colour). (Bombay: N. M. Tripathi, Ltd., 1955.) Rs. 50; 112*s*. 6*d*.; 18 dollars.

UNTIL twenty years ago, nearly all the works on Indian birds came from British pens. Then Salim Ali's books began to appear, which rank with the best of any previously published. Now, other Indian authors are following him, and the present volume, written by the brother of the Maharajah of Bhavnagar, and sumptuously produced, is an impressive addition to Indian ornithological publications. Saurashtra is the part of India which lies between the Gulf of Cambay and the Arabian Sea. It appears as Kathiawar on most maps, but Saurashtra is the older name. It is, therefore, a conveniently compact area for field-work. It contains no mountains more than four thousand feet high, and is mostly hilly and undulating. But there is a good deal of salt land and semi-desert (though the rainfall is locally heavy), so that rare or very local species, such as the great Indian bustard, its congener the florican and some of the sand-grouse, breed in fair numbers.

The author writes that he began his observations on birds when he was a schoolboy in England; but the whole of his adult life has been spent in Saurashtra, and this book is a remarkable testimony to the assiduity and care with which he has studied birds, with no neighbour to assist, throughout the years. The book is so full of first-hand and first-rate bird lore that it is not easy to comment on any special passages in a short review. The author is an expert on the eagles, which are among the most difficult birds to distinguish, and his field-notes on their sight-identity are of special value after the recent appearance of some misleading information on some of the same species from Russian ornithologists.

In some cases, rather fuller information would have been desirable. Thus, both the roller (*Coracias garrulus*) and the spotted flycatcher, which occur in this part of India in some numbers on the autumn migration, are claimed as winter visitors. The impression hitherto has been that neither species remains in India during the winter, and it has been assumed that they migrate some fifteen hundred miles across the sea to Africa. It is a pity that the author does not give his evidence in these and some other cases in more detail than a general statement.

The book is fully illustrated, with photographs, many of them taken by the author, and with coloured plates by an Indian artist, Somalal Shah. These plates are variable in quality. The larger birds are often felicitously shown; but the smaller birds look as if they had been based on mouldy skins, and fail to give the distinctive features. However, the book is an important addition to the knowledge of Indian bird-life. H. G. ALEXANDER

ANTIQUITIES IN BRITAIN

Buried London

Mithras to the Middle Ages. By William Thomson Hill. Pp. 192+40 plates+14 maps. (London: Phoenix House, Ltd., 1955.) 25*s*. net.

Furniture in Roman Britain

By Joan Liversidge. Pp. viii+76+69 plates. (London: Alec Tiranti, Ltd., 1955.) 10*s*. 6*d*. net.

MR. THOMSON HILL's book came in on the crest of the wave of public interest which broke—for reasons that are still not altogether clear—on the discoveries which were made in the Walbrook area of London in 1954. "Buried London" is essentially an expansion of newspaper articles dealing with current work in the bombed areas and with the very serious losses to the visible antiquities and historic monuments of the city which resulted from the bombing during the Second World War.

The book is not a scholar's book and the phrase "complete record" in the publisher's note should be read with the reserve appropriate to such declarations. The "complete record" cannot be made until the present phase of recovery of evidence (against time-limits) has ended, to release the energies of the small group of archæologists engaged for the next stage. In its primary form at least, the "complete record" must follow a very different pattern from that presented here.

The present popular enthusiasm for archæology has, inevitably, its good and its bad points. There is a strong element of irony in a situation which creates an earth-shaking sensation out of a discovery like that of the Walbrook Mithræum, in which (important as it was) there was a strong element of luck, while persistently ignoring results of equal historical significance the winning of which called for much greater application and technical resource. But that is how the world wags, and archæologists are not the only sufferers. Unlike most of his professional colleagues, Mr. Thomson Hill has tried to see his subject whole; but too often it has defeated him, and there are some surprising and sometimes serious mistakes.

"Furniture in Roman Times" is written for the general reader, but draws conveniently together for the student a mass of otherwise widely scattered material. Inevitably the amount of Roman furniture actually surviving in Britain is small: it would be even smaller were it not for the use that was made of Kimmeridge shale, a material only less perishable than timber. It is interesting to observe how the long-established Kimmeridge industry adapted itself to the imported classical style as yet another element in the uniform upper crust of material culture beneath which, at least in some parts of the Empire, a native non-Roman element often persisted.

Contemporary sculptures, on tomb-monuments particularly, augment and elucidate the fragments: sometimes conventionally as in the Chester series, sometimes more vividly as in the Simpelveld sarcophagus or the Toilet Scene from Trier. The final impression is that, technical skill and ingenuity apart, Roman furniture was not particularly beautiful and only a liberal use of soft furnishings could have made it comfortable. But as Prof. J. M. C. Toynbee has pointed out in her introduction, studies of this sort make the past live—and that not only for the general reader. For archæology not merely extends knowledge of man backwards in time; it also deepens and enriches understanding by the light that it sheds on aspects of his life that 'history' may fail to touch.

W. F. GRIMES

HEAT AND MASS TRANSFER IN COMBUSTION THEORY

Some Fundamentals of Combustion

By Dr. D. B. Spalding. (Gas Turbine Series—Vol. 2.) Pp. x+250. (London: Butterworths Scientific Publications; New York: Academic Press, Ltd., 1955.) 40s. net.

THE first of a series of volumes, edited by J. Hodge, of Power Jets, and describing various features of the gas turbine has already been published. The volume under review is the second of the series, and its author, Dr. D. B. Spalding, is reader in applied heat at the Imperial College of Science and Technology, London. The science, though not the subject, of combustion is a relatively new one. Prior to 1939 work had been concentrated on a limited field, concerned with the combustion of premixed gases in the petrol engine, and especially with the phenomenon of detonation, the principal obstacle to progress in the prime mover then of supreme importance in military and commercial applications. A stage had been reached when it appeared that further advances must be made by the chemist rather than by the engineer.

With the increased use of the diesel engine, the rise in cost of fuel and the advent of the gas turbine, the field of combustion research has greatly widened, while detonation has ceased to be of much importance compared with, for example, the necessity for producing high combustion intensity, or with flame stabilization and blow-out criteria. Consequently, a very large literature has grown up; but except to the specialist, difficulty is experienced in reading and interpreting results which the various kinds of authors—engineers, physicists and chemists—present with widely differing emphasis. In this book Dr. Spalding has set out to integrate the most important results of recent research, including a substantial contribution from his own work accomplished while he was at the Department of Engineering, Cambridge, and has in fact succeeded in developing a theory which combines the many isolated fragments of combustion research into a unified whole.

The first two chapters serve as an introduction to thermodynamics and fluid flow, but a serious student of combustion will require a much fuller explanation than is here contained. However, the clearly described and elaborate compressible-flow chart must be of interest to all concerned with high-speed flow of gases, while the thermodynamic approach is clear and rigid. It is, however, in the presentation in the next two chapters of the subjects of heat and mass transfer that the greatest originality lies. Here are developed the differential equations governing heat and mass transfer in the most general cases, such as when chemical reaction is also present. The solution of these equations is not usually possible; but by modifying Fick's Law so that it may be expressed in terms of concentration gradients instead of partial pressures and, when necessary, by assuming that thermal and mass diffusivities are equal, considerable simplification is achieved, so that in some special cases the equations can be solved and in general the form of the solution be derived, in functions of dimensionless groups (just as in heat transfer the Nusselt number is expressed as a function of the Reynolds and Prandtl numbers). It is shown that, with such simplifications, in all cases of mass transfer the results can be expressed in terms of the Reynolds, Schmidt and a new dimensionless number called the transfer number, which may have various simple forms according to the specific problem. The use of the transfer number is fundamental since it shows the different applications considered (for example, vaporization at liquid surfaces, combustion in gas jets and from solid and liquid fuels) to be special cases of a unified whole. The approximations involved are bold, but the quantitative results achieved are well within the usual limits of error associated with problems involving a multiplicity of variables, and lead to a clear conception of the controlling factors of each problem.

Chapter 5 is devoted to combustion processes in which the time-rate is important. There are excellent discussions of the propagation of flames in premixed gases, the conditions for flame extinction, flame stabilization and the criteria for blow-out conditions. The chapter is entitled "Chemical Effects in Combustion", somewhat misleadingly, as the properties discussed are much more physical than chemical. Conclusions developed from the theory are drawn in the short last chapter where there is some interesting criticism of the design of combustion chamber elements. There is no description of practical applications, as a further volume entitled "Combustion Practice" is scheduled to appear in the series.

All in all, this is an excellent book for every worker in combustion research, though its appeal to the practising engineer is much less. The style is crisp and authoritative, the references full, and the author is to be congratulated upon the lucid manner in which he interprets the rather bewildering array of non-dimensional numbers that confronts the student in this subject. He makes their use seem apparent and inevitable, and by their aid brings a hitherto not apparent coherence to a rather untidy subject.

F. D. ROBINSON

Asiatic Magnolias in Cultivation

By G. H. Johnstone. Pp. 155+34 plates. (London: Royal Horticultural Society, 1955.) 63*s*.

THE author of this work brings to his task not only a love of magnolias, but also a long experience of their culture, and it is particularly where his knowledge of them as living entities illumines the text that the horticulturist will find the pages especially worth perusal. In the first two chapters, where cultivation, pruning and propagation are treated, Mr. G. H. Johnstone has brought together the experience of others, enriched by his own, to provide a helpful guide to any who would essay the cultivation of this genus. The remainder of the text deals with the species individually. Of some forty-five known magnolias, exclusive of hybrids, the Asiatic species, which are here considered, number eighteen, and nine of these latter and their varieties are admirably portrayed in the fourteen coloured plates, mostly from paintings by Miss A. V. Webster.

For each species a diagnosis and formal description is provided, together with a more discursive consideration of matters of identity, culture and other aspects which will appeal especially to those who themselves share Mr. Johnstone's enthusiasm for growing magnolias. They range from tall trees such as the magnificent pink-flowered *M. campbellii* from the Himalayas or *M. obovata* from Japan, to shrubs such as the charming *M. sinensis* from China, with its exquisite drooping flowers and crimson stamens. The flowering period extends from the bleak days of March, when the white stars of *M. stellata* burst through their furry covering, to August and September, when *M. sieboldii* and *M. delavayi* contribute to the garden's fragrance as well as to its beauty.

Many species are diploid, with 38 chromosomes; but the members of the Yulania section, to which the beautiful *M. denudata* introduced from east China by Banks in 1780 belongs, are all hexaploids with 114 chromosomes, while the Chinese *M. liliflora* is a tetraploid with 76 chromosomes. The genus, in fact, presents a great diversity of interest to the student of plant life, and æsthetic attraction and problems of cultural skill to the grower, so that those who peruse this volume should feel indebted to Mr. Johnstone for its production and to the Royal Horticultural Society for its publication at what, in these days, must be regarded as a very reasonable price.

E. J. SALISBURY

Scientific and Technical Societies of the United States and Canada

Part 1: Scientific and Technical Societies of the United States. Compiled by the Library, National Academy of Sciences—National Research Council. Part 2: Scientific and Technical Societies of Canada. Compiled by John R. Kohr, National Research Council, Canada. Sixth edition. (Publication 369.) Pp. 447. (Washington, D.C.: National Academy of Sciences—National Research Council, 1955.) n.p.

BLESSED with vast rich natural resources, the North American people have not been slow to develop an economic system that seems naturally adapted to the rapid exploitation and enjoyment of these resources and a high standard of scientific and technological achievement that is both the outcome of economic growth and the means by which further and swifter advances are made. Probably no other people are more scientifically minded, and an indication of this is given by the present edition (the sixth) of the "Handbook of Scientific and Technical Societies of the United States and Canada".

As is remarked in the preface, during the twenty-seven years since the first edition, a large number of new scientific and technical organizations have been started in North America, and though they may be concerned with highly specialized topics and their membership small, the fact of their establishment is worth recording. Glancing over the pages, the reader is impressed both by the very large number of regions or localities that are associated with a particular organization and by the great wealth of topics that form the basis of the various organizations.

It is to be noted, too, that the earlier editions of this handbook covered both societies and institutions; but the latter are now omitted, as also are such other organizations as trade associations with research activities.

There are 1,506 entries for the United States and 206 for Canada, occupying more than four hundred pages. The size and content of the entries vary somewhat; but typical of the details given are the history of the society, its purpose, membership, meetings, library, research funds and medals, etc., and publications. The two indexes, one for the United States and one for Canada, are of the omnibus type: they include a subject classification of the activities, purposes and research funds of the societies (with the subjects appearing in capitals); periodicals (in italics); names of research funds, prizes, medals, etc., and changes in names of societies after 1948. The book is prepared jointly by the National Academy of Sciences—National Research Council of the United States and by the National Research Council of Canada. As such it bears the stamp of authority and can be relied upon.

The Chemistry and Fertility of Sea Waters

By Dr. H. W. Harvey. Pp. viii+224. (Cambridge: At the University Press, 1955.) 30s. net.

THIS excellent book deals more fully with the fertility of sea water than did its predecessor, "Recent Advances in the Chemistry and Biology of Sea Water" (Cambridge, 1945). Dr. H. W. Harvey recognizes five major processes, which in his unsemantic way he calls "conditions". Briefly they are: illumination; replenishment of nutrient salts; grazing of plants by animals; removal of plants from the upper, photosynthetic, layer of the sea by turbulence; and metabolism, which is at least partly governed by temperature. Chapter 5 collects and sets out succinctly the published effects of those processes on the growth of the plants in the plankton. A shorter chapter suffices for what is known about the production of animals. The two chapters together mark a notable advance in elaboration of knowledge, compared with that behind Chapter 10 of the preceding book—worth, with the better paper and printing, the extra cost.

The new book also gives more information on the chemistry, including how to determine phosphate much more accurately than has sufficed hitherto, and therefore less rapidly. Other additions on chemical methods are perhaps more useful, and all are described more precisely than in the earlier books. Harvey's study of sea water and the related biology forms an essential part of twentieth-century oceanography, and chemists may care to note this advance in their own subject in an unusual field.

MICHAEL GRAHAM

Optical Properties of Thin Solid Films

By Dr. O. S. Heavens. Pp. vii+261. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 35*s.* net.

WITHIN recent years the interest in the field of optical properties of thin solid films has been greatly stimulated and many papers have been published, due largely to the development in the methods of preparing thin films and their examination by optical and electron-microscopic techniques. Consequently, a large amount of information about the nature and behaviour of thin films and their optical properties has become available. Dr. O. S. Heavens's book is therefore a timely and welcome addition to the existing literature.

There are seven chapters, including the introduction. The second chapter is devoted to the techniques for the production of films, with special emphasis on the evaporation method which is so commonly employed these days. The next chapter briefly describes the structure of solid films as revealed by electron-optical studies. The fourth chapter is devoted to the calculation of the optical properties of thin films, namely, the reflexion-transmission coefficients and phase changes at a single film or a system of layers. This chapter will be specially welcomed by those who are starting work in the field and want to have a connected account for their calculations. In the next two chapters are given a discussion of the methods for the measurement of optical constants and thickness of the film, followed by a general survey of the results obtained. Many interesting applications of thin films in the laboratory and industry are covered in the last chapter.

The subject-matter of the book has been well arranged and is presented in a very clear style. Each chapter is followed by a list of references to the original papers. The book will be of use both to the research worker studying optical properties of thin films and those engaged in industry.

Reagent Chemicals and Standards, with Methods of Testing and Assaying Them

Also the Preparation and Standardization of Volumetric Solutions and Extensive Tables of Equivalents. By Joseph Rosin. Third edition. Pp. x+561. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 70*s.* net.

THE author of this book, formerly chief chemist and chemical director of Merck and Co., has had considerable experience of the testing of chemical reagents and is an expert in the field. In view of the rapid advances in analytical chemistry during recent years, some forty-five new reagents and solvents have been added to this edition. In each entry the physical properties and standards of the substance are given, and the methods used in testing for impurities and, in many cases, for assay are set out in satisfactory detail. Since the standards are now exacting, sensitive methods involving new reagents are often necessary, and it would be hard to find these in the literature. Some references to recent publications are given.

The book is a valuable storehouse of information which should be available in every chemical laboratory. Manufacturers of chemicals should in particular find it of great service in their laboratories; but it has a wider field of usefulness, since in preparative and research work the purity of the materials is often essential, and the methods of testing for traces of likely impurities should be at hand. In the case of substances used as standards in volumetric analysis, the best methods of assay are given. Indicators and solvents are included.

There seem to be scarcely any inaccuracies in the book, which covers in detail a wide field; but 'dithionate' on p. 413 should be 'dithionite', and the name Kolthoff is given incorrectly on p. 498. This is a sound and informative book which will be welcomed by all chemists. The paper, printing and binding are excellent.

Modern Gas Analysis

By Paul W. Mullen. (Interscience Manuals.) Pp. ix+354. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1955.) 5.50 dollars.

ABOUT two-thirds of this pocket-sized book are devoted to conventional absorptiometric methods of gas analysis, and the remainder to instrumental methods. It thus provides a wide survey of current practice; but the second part in particular is brief, and more information would be needed for the use of all the techniques described. Space has, however, been used prodigally in other ways, and it seems surprising that, among other examples of the historical approach, five pages should be devoted to the derivation of $PV = nRT$, or that a picture of a Fortin barometer which shows few details should occupy nearly a whole page. Most of the large number of illustrations are of the pictorial type found in catalogues, and some demonstrate little beyond the supplier's name; it would have been preferable to leave more room for the text by reducing the number of illustrations of American equipment and including a higher proportion of diagrams of universal application.

The book is well produced, attractive in appearance and gives a readable account of its subject which may be useful to a non-specialist such as myself; but because of its abbreviated treatment, it is unlikely to appeal to the gas analyst.

D. AMBROSE

Parva Naturalia

By Aristotle. A Revised Text with Introduction and Commentary by Sir David Ross. Pp. xi+354. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 40*s.* net.

THIS book will be valued by all Aristotelian scholars, and by naturalists interested in the early formulation of their science. Present-day psychologists, too, if they consult it, may find a few surprises. For example, the work contains the oldest general formulation of the laws of association. It is well known that some examples of these laws occur in Plato's "Phædo", but the originality of Aristotle's concept is the introduction of contrast. A reference of great historical significance is that to 'Aristotle's experiment' (frequently mentioned by philosophers) in which a marble, if held between the crossed first and second finger of either hand, is 'felt' as two objects. The explanation of the effect is commonly ascribed to our involuntary separation of the contacts as distinct in space.

These are only two of the numerous problems contained in the collection; much else deserves careful thought at the current level of observational technique. It is scarcely necessary to add what a delight the whole volume is—the result of the hand of Sir David Ross upon it.

F. I. G. RAWLINS

POLAR WANDERING: A MARATHON OF ERRORS

By DR. W. H. MUNK*

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"THE subject of the fixity or mobility of the earth's axis of rotation in that body . . . [has] from time to time attracted the notice of mathematicians and geologists. The latter look anxiously for some grand cause capable of producing such an enormous effect as the glacial period. Impressed by the magnitude of the phenomenon, several geologists have postulated . . . a wide variability in the position of the poles on the earth; and this, again, they have sought to refer back to the upheaval and subsidence of continents." With these words George Darwin introduced his paper[1], "On the Influence of Geological Changes on the Earth's Axis of Rotation"; it occupies forty-two pages in the *Philosophical Transactions*, and its mathematical complexity is in proportion to the length. The paper was published in 1877 when Darwin was thirty-two years old; it is the first of his seventy-two papers on cosmology. Yet this was to remain the only serious study of the dynamics of polar wandering until Gold[2] reopened the problem in a succinct article in *Nature* in 1955. Gold's conclusion differs from Darwin's, but this is only the latest chapter in an extensive, and sometimes heated, controversy that has been going on for seventy years.

Darwin set himself the following problem: at time 0 some continents suddenly commence to rise, others to fall, and the movements continue at a uniform rate thereafter. What would be the position of the axis of rotation if the Earth is (*a*) a rigid solid, (*b*) a viscous fluid? We now consider that the Earth is better described as an elastic solid. Darwin did not consider this case; neither the evidence nor the elastic theory had been developed. We are here concerned only with the orientation of the axis in the body of the Earth; the orientation in space is scarcely altered. It is therefore convenient to refer to the geographical location of the poles of rotation, where the axis pierces the crust.

Darwin's solution (ref. 1, pp. 282–83) consists of oscillatory terms like

$$\exp(-\alpha t)\cos\omega t \qquad (1)$$

plus others that remain after the initial oscillation has become damped out. These have the components (disregarding for the moment a slight separation between axes of figure and rotation):

$$\begin{aligned} x &= \frac{\alpha(\omega^2-\alpha^2)}{\omega^2+\alpha^2}u - \frac{\omega^2}{\omega^2+\alpha^2}ut \\ y &= -\frac{2\omega\alpha^2}{\omega^2+\alpha^2}u + \frac{\omega\alpha}{\omega^2+\alpha^2}ut \end{aligned} \qquad (2)$$

u is a measure of the rate of upheaval, x is the polar displacement toward the centre of upheaval and y at right angles to it.

For undamped oscillations of a rigid Earth, $\alpha = 0$, and

$$x = -ut,\ y = 0 \qquad (3)$$

For reasonable continental upheavals, these solutions must be limited to such times that ut is of the order of a degree of latitude at most, according to Darwin; actually one mile might be a better upper limit. In any event, there can be no appreciable polar wandering on a rigid Earth. The opposite extreme, that of great fluidity, corresponds to large α, and to

$$x = -\alpha u,\ y = -2\omega u \qquad (4)$$

so that x can be made arbitrarily large by taking α arbitrarily large.

Darwin is explicit in the interpretation of his solution: "If the earth be sensibly rigid . . . the geographical path of the axis is very nearly the same as is due merely to the geological deformations of the earth's shape; but if the earth be more or less plastic, . . . the dynamical reactions introduced are such as more or less to modify the geographical path of the axis. In the case of great plasticity these reactions would suffice to alter entirely the character of the path". We have therefore clearly a state of things in which the pole may wander indefinitely from its primitive position. "On this hypothesis, as in successive periods the continents have risen and fallen, the pole may have worked its way, in a devious course, some 10° or 15° away from its geographical position at consolidation, or may have made an excursion of a smaller amount and have returned to near its old position."

Whether or not there had been polar wandering was therefore not a question of dynamics, but depended on whether the Earth was taken as plastic or rigid. The decision was outside the scope of Darwin's analysis, though he favoured the latter alternative: "But Sir William Thomson has shown that the earth is sensibly rigid; and in any case the earth is not a viscous fluid, properly so-called, although it may be slightly plastic".

What was Kelvin's evidence for a rigid Earth? His original argument[3] was by way of reference to Hopkins, "who first adduced the phenomena of precession and nutation to disprove the hypothesis that the solid part of the Earth's mass is merely a thin shell". But this argument is wrong, because precession is caused by the pull of the Sun on the equatorial protuberance regardless of whether it is fluid, elastic or frozen. Kelvin was questioned on this point by Newcomb, and in a presidential address to the British Association[4] Kelvin asked his audience to cross out what he had written on this subject in "Natural Philosophy". (I found the copy in the University Library, Cambridge, to have been defaced accordingly.) Unknown to Kelvin and Newcomb, the error had already been pointed out by General Barnard[5].

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Darwin[1] refers to Kelvin's retraction of precession as an argument for rigidity, but adds that Kelvin ". . . adduces, however, a number of cogent arguments on this point". Curiously enough, Kelvin refers here to a paper by George Darwin's great father[6] entitled "Observations on the Parallel Roads of Glen Roy and other parts of Lochaber in Scotland, with an attempt to prove that they are of Marine Origin", in which it is said that the Earth as a whole takes approximately the figure due to gravity and centrifugal forces, because of the fluidity of the interior and the flexibility of the crust. To this statement Kelvin raises the following two objections in his British Association presidential address[4]: (1) "But alas, for this 'attractive sensational idea' . . . that a molten interior to the globe underlies a superficial crust, its surface agitated by tidal waves, . . . the solid crust would yield so freely to the deforming influence of sun and moon that it would simply carry the waters of the ocean up and down with it, and there would be no sensible tidal rise and fall of water relatively to land . . ."; that is, unless the crust consisted of "preternaturally rigid matter", far more rigid than steel; (2) that the "solar semiannual nutation must be largely, and the lunar fortnightly nutation enormously, affected by interior liquidity. . . . This conclusion is absolutely decisive against the geological hypothesis of a thin rigid shell full of liquid". But the argument is not decisive if we ascribe to the mantle a behaviour characteristic of many materials, whereby it responds almost as an elastic solid to disturbances of short period, but flows in response to stress of long duration. I think Darwin's suggestion was well taken[1]: "it seems quite possible that the earth may be sensibly rigid to the tidal deforming influences of the sun and moon, and yet may bring itself back from any considerable departure from a form of equilibrium to approximately that form". Kelvin's foregoing arguments may have had something to do with a letter George Darwin was to receive from his father two years later[7]: "Hurrah for the bowels of the earth and their viscosity and for the moon and for the Heavenly bodies . . . and for my son George (F.R.S. very soon) . . .".

But Kelvin[4] was not yet contented with the two preceding arguments: "But now thrice to slay the slain: suppose the earth this moment to be a thin crust of rock or metal resting on liquid matter; its equilibrium would be unstable! And what of the upheavals and subsidences? They would be strikingly analogous to those of a ship which has been rammed —one portion of crust up and another down, and then all down. Now whatever may be the relative densities of rock, solid and melted, at, or about, the temperature of liquefaction, it is, I think, quite certain that cold solid rock is denser than hot melted rock; and no possible degree of rigidity in the crust could prevent it from breaking to pieces and sinking wholly below the liquid lava".

"And thrice he slew the slain"? The quotation may have been more apt than Lord Kelvin intended. For later during the feast the slain come back to plague the king, and Timotheus cries: "Those are Grecian ghosts, that in battle were slain, . . . behold how they toss their torches on high . . .".

Darwin himself seems to have been well enough convinced by Kelvin's persuasiveness[8]: "A third opinion, contended for by Sir William Thomson [Lord Kelvin], and of which I am myself an adherent, is that the earth is throughout a solid of great rigidity . . .". Thirty-one years later, when his paper was reprinted among his collected works, he wrote[9]: "The conclusions arrived at in my paper are absolutely inconsistent with the sensational speculations as to the causes and effects of the glacial periods which some geologists have permitted themselves to make". Darwin remained on close terms with Kelvin, a friendship that had, in fact, begun with the selection of Kelvin by the Royal Society as referee for the paper here under discussion. An alternative derivation due to Kelvin is included as Appendix *C* to Darwin's paper. Kelvin, according to Darwin, "seemed to find that on these occasions the quickest way of coming to a decision was to talk over the subject with the author himself". Darwin considered that all his work on cosmogony "may be regarded as the scientific outcome of our conversations of the year 1877; but for me at least science in this case takes the second place".

I must refer to one more aspect of the Kelvin–Darwin discussion of polar wandering. Kelvin's arguments for a rigid Earth denied the possibility of polar wandering within the framework of Darwin's analysis. But this should not imply that Kelvin was opposed to shifting the pole over large distances. Far from it. In a passage often quoted by those who favour large polar displacements, Kelvin said[4]: "Considering, then, the great facts of the Himalayas and the Andes, and Africa and the depths of the Atlantic, and America and the depths of the Pacific, and Australia, and considering further the ellipticity of the equatorial section of the sea-level, estimated by Capt. Clarke at about 1/10 of the mean ellipticity of meridional sections of the sea level, we need no brush from the comet's tail (a wholly chimærical cause which can never have been put forward seriously except in ignorance of elementary dynamical principles) to account for a change in the earth's axis; and we may not merely admit, but assert as highly probable, that the axis of maximum moment of inertia and the instantaneous axis of rotation, always very near one another, may have been in ancient times very far from their present geographical position, and may have gradually shifted through 10, 20, 30, 40, or more degrees without at any time any perceptible sudden disturbance of either land or water". These views were reprinted in Kelvin's "Collected Works"[10] in substantially their original form.

So far as I can see, Kelvin reasoned as follows: the surface of the Earth is divided into quadrants; in the northern hemisphere a rise is centred at 0° longitude (say) and a fall at 180°, in the southern hemisphere a fall at 0° and a rise at 180°. For a maximum crustal displacement of 10 cm. the pole of a rigid earth is shifted by 0·1″. Then by what Kelvin calls a "simple effort of geological calculus" he finds that for a corresponding surface displacement by 10 km. the pole is moved through nearly 40° latitude. Kelvin had assumed the Earth to be sufficiently rigid to sustain a distortion commensurate with the dimensions of the equatorial bulge. Of course, this must lead to appreciable polar wandering, but it would seem to be the hard way of doing it.

We return to Darwin's solution (equation 2). It may have been noticed that the first terms in x and y have the dimensions length/(time)^2 instead of length. This is the result of a simple algebraic error made earlier in the derivation. The mistake was discovered by Lambert[11]; the corrected equations are given by Jeffreys[12]:

$$x = \frac{\alpha(\omega^2 - \alpha^2)}{(\omega^2 + \alpha^2)^2} u - \frac{\omega^2}{\omega^2 + \alpha^2} ut$$
$$y = -\frac{2\omega\alpha^2}{(\omega^2 + \alpha^2)^2} u + \frac{\omega\alpha}{\omega^2 + \alpha^2} ut \qquad (5)$$

All terms now tend to zero as α becomes infinite. There can be no polar wandering no matter how fluid the Earth is. This conclusion contradicts the previous result (equation 4).

For simplicity we now restrict ourselves to the case $\alpha \ll \omega$. Equation (5) can then be written

$$x = (\alpha/\omega)(u/\omega) - ut, \qquad y = 0 \qquad (6)$$

The approximation $\alpha \ll \omega$ is amply justified by the observation that the damping of the free nutation requires many periods. Subject to the same assumptions and restrictions, I find, in an independent derivation,

$$x = (\alpha/\omega)(u/\omega) - ut - \tfrac{1}{2}\alpha ut^2, \qquad y = 0 \qquad (7)$$

The solutions differ by the term in t^2, and this term yields substantial polar wandering as a consequence of surprisingly small continental upheavals. Equation (7) has the pole move at a constant *acceleration* in response to a constant *velocity* of upheaval. Had Darwin chosen the simpler (and sufficient) example of a sudden vertical displacement, the result would have been a polar wandering at constant velocity. My solution agrees on all essential points with Gold's conclusions arrived at by non-analytical reasoning.

To point out the difference between Darwin's (corrected) solution, and Gold's conclusion, we must return to the basic considerations that underlie Gold's hypothesis. The pole of figure is a position where the axis of figure (about which the moment of inertia is a maximum) pierces the crust. For a rigid Earth the displacement of the pole of figure by $x = -ut$, $y = 0$ is entirely determined by the prescribed upheaval. The pole of rotation circles the pole of figure once every ten months. In the case of a yielding Earth, there is an additional displacement of matter as the geoidal protuberance attempts to adjust to the disturbed position of the rotation axis. The total displacement of the pole of figure is then the sum of displacement of the geoidal pole and that determined by the prescribed upheaval. From dynamic considerations one finds that the velocity of the rotation pole is proportional to its separation from the pole of figure, and from elastic (or plastic) considerations that the velocity of the geoidal pole is proportional to its separation from the pole of rotation. It is, according to Gold[2], "as with the ass and the carrot hanging from a stick held by the rider". The geoidal pole pursues the rotation pole, the rotation pole pursues the pole of figure, which in turn is continuously being displaced by the geoidal pole.

Darwin's reasoning is implicit in his equations 1–4 (ref. 1, p. 282). The sum of the four equations is equivalent to the above-mentioned dynamic considerations. But equations (3) and (4) state that the geoidal pole moves at a rate proportional, not to its separation from the rotation pole, but to the separation of the rotation pole from the pole of figure. I cannot think of any reason for this type of behaviour; it would be consistent, for example, with a stationary solution for a liquid, rotating Earth where the poles of figure and rotation are united, with the geoidal pole being elsewhere.

Darwin obtained his four equations from what he calls geometrical, rather than dynamical, considerations. The important thing is that they do not follow from a deductive argument, and he seems to have gone astray in the formulation of the last two equations. When these are modified in the above sense, then equations (7) follow once more. On the basis of the present development of the theory of elasticity, which was not available to Darwin, it is possible to proceed from fundamental principles to a solution without any break in the deductive argument, and this is, in fact, the method whereby equation (7) was derived.

We are left with three solutions: Darwin's original solution (2) made polar wandering possible; the corrected solution (5) made it impossible; and the modified solution (7) makes it easy. That the final outcome is not in contradiction to the original conclusion is a result of having made an even number of errors. But there is an important difference; equation (2) requires a large value of α for polar wandering, (7) does not, and is in fact based on the assumption that $\alpha \ll \omega$.

In the light of these developments, the many papers that have centred on Darwin's work assume grotesque proportions. Long before Darwin wrote, Comte de Buffon had founded the 'Catastrophic School' of polar wandering to account for palæoclimatic evidence. Darwin clearly hoped his paper would put certain restraints on contemporary arguments for polar wandering by Lubbock, Delabeck, Evans and others. In fact, it was followed by a renewed wave of enthusiasm for large polar displacements, which reached its peak in "Die Pendulations Theorie" of Reibisch and Simroth. Darwin's student, the astronomer Brown, countered these claims with apparent exasperation[13]: "[Darwin's] conclusion, now well known to astronomers, but frequently forgotten by geologists even at the present time is against any extensive wanderings of the pole during geological times". In 1914, Barrell[14] reviewed "The Status of Hypotheses of Polar Wanderings" as follows: "Geologists and biologists may array facts which suggest such hypotheses, but the testing of their possibility is really a problem of mathematics. . . . Notwithstanding this, a number of hypotheses concerning polar migration have been ingeniously elaborated and widely promulgated without their authors submitting them to these final tests. . . . Others, of more logical mind, recognizing the need of mathematical justification, have thought to find a qualified support in the work of Kelvin and G. H. Darwin. . . . The work of Darwin, instead of permitting hypotheses of polar wanderings, offers the most convincing proof which is available that migrations of the axis of the earth sufficiently extensive to be of geological importance have not occurred [*sic*]. . . . His [Darwin's] papers seem to have checked further speculation upon this subject in England, but, apparently unaware of its strictures, a number of continental geologists and biologists have carried forward these ideas of polar wandering to the present day. . . . Does not the history of the subject show the dangers of over-specialization within one division of science with the consequent putting forth of hypotheses regardless of the verdict of related Sciences?".

In this controversy between physicists and geologists, the physicists, it would seem, have come out second best. They gave decisive reasons why polar wandering could not be true when it was weakly supported by palæoclimatic evidence; and now that rather convincing palæomagnetic evidence has been discovered[15], they find equally decisive reasons why it could not be otherwise.

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BOOLE'S "THE LAWS OF THOUGHT"

By F. I. G. RAWLINS

THE Royal Irish Academy has done well to collect and issue a series of papers* commemorating the appearance of "The Laws of Thought" by George Boole in 1854. The occasion was a centenary celebration in Dublin, and here is a permanent record, bearing witness both to the unique character of the book itself, and in parallel, so to say, to the remarkable personality of its author. If ever a publication reflected the innermost being of its originator, this volume assuredly did. Its production, moreover, stands as a monument to the foresight of the electors to the chair of mathematics at Queen's College, Cork, who appointed a candidate without a university degree, and devoid of formal academic training. It is rather as if a similar choice had been made of Ramanujan many decades later, before he went to Trinity College, Cambridge, to carry all before him.

Most appropriately, Sir Geoffrey Taylor opens the series with a graphic account of his grandfather's life. And what a life it must have been; serene, highly disciplined, creative at every stage, both in research and in the task of imparting knowledge. For even when Boole was school-mastering in Lincoln as little more than a youth he was experiencing the joy of discovery, as he read and mastered the works of the French mathematicians. Alongside all this, he taught himself several languages, as if to foreshadow the development of semantics as the century wore on.

Boole had a great appreciation of the place of tranquillity in the intellectual life. We read of him taking a "solitude à deux" with a friend to the Alkborough Hills near his peaceful Trent, and sitting down alone under a bush in the evening. From this excursion arose the precursor of his analytical studies which he later improved and expanded in "The Laws of Thought". At times his inclination seems to have been towards algebraic methods rather than in the direction of geometry, believing the former to be the more powerful instrument. But as we shall see later, this was no lopsided view. His grasp was so sure that, analyst as he sometimes was, history will credit him as a great architect in synthesis.

How exactly did this come about? The answer is to be found in Boole's attitude to Nature. He believed profoundly that there was such a thing as unity *of* Nature, and unity *in* Nature. In these two concepts, which went far to mould the entire pattern of his life, he approximated to Leonardo da Vinci, with his deep veneration for natural law. The method of Boole is based upon this one-ness, and enmeshed in it are the seeds from which has flowered much of the propositional calculus as we now have it, and a great part of the powerful machinery of modern logistics. It must not be too readily deduced from this, however, that the meta-sciences of to-day spring directly from "The Laws of Thought"; what has in fact happened is that out of traditional logic has appeared a means whereby it has become possible to raise such a majestic structure that the elements of Aristotelian thought still embedded in it comprise but a minute fraction of the whole. It is an example on the grand scale of the eternal verity that nothing can be quickened except it die. The sower of that particular harvest was George Boole.

We can now, with this in mind, attempt some appraisal of the method of this remarkable man, and we shall not get far without observing certain features in common with the outlook of Alfred North Whitehead. It is probably no accident that much the same logical pressure acted upon the mind of Boole as it did much later upon the authors of "Principia Mathematica". The essence of his method is to begin with things rather than words; with objects before concepts. Then follows the paramount need to train the mind by rigorous exercise, including the working out of numerous examples. One may compare this with Whitehead's belief in the use of the simplest possible apparatus, to squeeze the last drop of juice out of any problem amenable to experiment. Just as Leonardo da Vinci took infinite pains (somewhat against the grain) to study the works of Archimedes, so we find Boole ever ready to relate his abstractions to things as we find them. His insistence upon the acquisition of a beautiful and legible handwriting gives us a clue to the importance which he attached to means as well as ends. He was human enough to seek relief from pure speculation by resorting sometimes to "mechanical employments", while conversation he regarded as an entertainment, not as an occasion for strife.

Strong traditionalist as he was—as we have already seen—Boole's concept of the construction of a physical science has a present-day familiar look. In "The Laws of Thought" he finds four stages: namely, observation, presumption (that a law exists), experimental tests, and the investigation of causes. In addition, his emphasis upon increasing probability towards the limit of certainty as confirmatory data increased shows how sure an insight he had of a methodology well ahead of his time. This is noteworthy when one recollects that Boole was working at a period when laboratory techniques were very limited and—supposedly—his own contacts with them of the most slender kind.

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* Proceedings of the Royal Irish Academy. Vol. 57, Section A, No. 6: Celebration of the Centenary of "The Laws of Thought" by George Boole Pp. 63–130. (Dublin: Hodges, Figgis and Co., Ltd., 1955.) 6s.

In passing from here to some evaluation of Boole's place in logic, the elementary fact of history—that the subject had been static "at the same level of very elementary deduction" for some two thousand years—throws into relief the achievement of infusing new life in the form of a conscious mathematical logic into something which had eluded Leibniz and Lambert many years before. All this was propounded in the "Mathematical Analysis of Logic" (1847), and elaborated in "The Laws of Thought". In essence, Boole set about calculating as an algebraist would, afterwards eliminating such terms as were incapable of a logical interpretation. According to him, however, the equality $xx = x$ is unique. In ordinary algebra this is only true for $x = 1$ and $x = 0$, whereas in logic it holds for all values of x. From this he goes on to assume that the laws of his algebra only exceed those of ordinary algebra in this one particular. A number of criticisms have been made of Boole's system both in regard to mathematical rigour, and touching the æsthetic point that in some degree it lacked elegance. No doubt, as one commentator observes, there were some tares among the wheat, and they grew together until the harvest. Time has exterminated the chaff.

A trio of papers in the collection under notice brings the story of Boole's genius up to date by a discussion of the relation of his methods to contemporary many-valued logics, his concept of a function, and the influence of institutionalism upon the classical algebra of logic. Finally, comes a contribution dealing with an engineering application of Boolean algebra, which turns out to be an extremely powerful calculus for the determination of electrical circuits comprising two-state switches, that is, those that can be only 'on' or 'off'. In the case of complex problems in telephony, it can make possible major advances in communication theory, by simplifying equations otherwise almost unmanageable in practice.

In brief, the life and work of George Boole as reflected in "The Laws of Thought" are the perfect illustration of the truth of Whitehead's dictum: "You may not divide the seamless coat of learning".

THE COLE MUSEUM OF ZOOLOGY

UNIVERSITY OF READING

It is fifty years since the appointment of Prof. F. J. Cole to the Department of Zoology in University College, Reading (now the University of Reading). One of the factors that contributed to Reading's rise to the status of a university was the fact that several men and women of high quality identified their careers with her, and Prof. Cole was one of them. Soon after his arrival he started to build up a museum of zoology, and when he retired in 1939 he had the satisfaction of seeing his Department endowed with one of the finest teaching museums in Great Britain. An appreciative Council decreed that it should remain as a permanent memorial to him with the name of 'The Cole Museum of Zoology'.

Small though the Department was, it was from the beginning the special duty of one of the members of the staff to care for the growth and maintenance of the Museum. From 1912 until 1919 this was Miss (now Dr.) Nellie B. Eales, and from 1921 to the present time Mr. W. E. Stoneman has held the curatorship.

The exhibits now number more than three thousand, and each is described in the manuscript catalogue, where references to original publications are found and drawings help to interpret intricate parts. This is the source-book for the Museum's history, and it is appropriate to celebrate its jubilee by recalling some of the highlights.

Prof. Cole appealed to zoological friends all over the world, asking for particular animals in accordance with a careful plan. Prof. Ijima of the University of Tokyo, a world authority on the Porifera, collected and prepared in his own laboratory the magnificent series of Hexactinellid sponges. He, moreover, went to sea six times before he succeeded in dredging from the depths of the ocean the fine sea-lily (*Metacrinus*) which now adorns the Echinoderm case. Skeletons of a record python and an orang were contributed by Dr. Hanitsch, formerly director of the Raffles Museum, Singapore. Mr. Alfred Palmer, by a generous donation, made possible the purchase of a fine gorilla skeleton to complete the Huxleyan series—gibbon, orang, chimpanzee, gorilla, man. Captain C. R. S. Pitman, when game-ranger of Uganda, sent such animals as the tree pangolin and the lung-fish, *Protopterus*. The Australian Government presented specimens of the echidna and the platypus, from which dissections, skeletons and stuffed skins were prepared. Dr. Johannes Schmidt provided a set of stages of the *Leptocephalus* larva (eel) up to its metamorphosis. An officer of an Antarctic whaling ship prepared a group of specimens to illustrate the auditory organ of the whale, and a beautiful and perfect exhibit is the result. From the *Discovery* collections also many gifts were received. Old students going abroad were briefed to obtain specimens, and to them the Museum owes its Java pangolin, West African manatee, bats and monkeys, Central African hyrax, giant millipedes and scorpions and Mauritian lemurs and tenrecs.

The fullest use was made of all this valuable material. A single *Cryptobranchus* from Japan yielded a complete skeleton and preparations of the heart, arterial arches, gut, renal and reproductive organs, as well as a stuffed skin.

Dissections form a major part of the collection, and they include numerous injections of blood vessels, lymphatics and air-sacs. A former student, Dr. D. H. Tompsett, prosector at the Museum of the Royal College of Surgeons, prepared an exquisite Marco resin cast of the pulmonary vessels and bronchi of a sheep, and another of the cavities of the human brain, both of which were presented by the College.

Transparencies, in which the bones and cartilages are stained to show the skeletal parts *in situ*, have been made by Mr. Stoneman. There are wax models of invertebrate larvæ, mostly prepared by Mr. W. Rogers, laboratory steward, from the fine collection of microscope slides of marine larvæ made at Port Erin by the late Mr. H. C. Chadwick and purchased from him. Gastropod development is illustrated by copies of Dr. Doris Crofts's models of *Haliotis* larvæ.

Among the Museum's treasures are numerous delicate preparations of medusæ, corals and sea-pens with polyps expanded, from Naples Marine Biological Laboratory, preserved especially for the Museum by Cavaliere Salvatore Lo Bianco. They were probably the last specimens preserved by that greatest of preparators of marine material.

At one time the Museum of the Royal College of Surgeons, with its long history from Hunter to R. H. Burne, was Reading's nearest parallel and exemplar; but this was destroyed by bombs in the Second World War. The Cole Museum was built up probably in the last years when such things were possible. Thirty years ago it was adequately housed in the room which it still occupies, and now congests. It is greatly to be hoped that on the new University site a worthy building will be planned for the Cole Museum and that provision will be made to maintain what is a unique asset, not only for the University of Reading, but also for the entire country. Since this project may be many years ahead, we look to the University authorities to preserve the Museum intact, perhaps, if necessary, in a temporary building big enough for the whole collection to be adequately displayed and used.

OBITUARIES

Prof. Kurt G. Stern

Kurt G. Stern died on February 3 of a heart attack in St. Mary's Hospital, London, in his fifty-first year. Born in Tilsit, he attended elementary and grammar school there and moved to Berlin for his higher education, where he received his Ph.D. in 1930 at the University. In the following year he won a Rockefeller fellowship, worked for one year at the Rockefeller Institute in New York, and for two more years at the Courtauld Biochemical Institute in London. When he was to return to Germany in 1935, the Nazis had taken over and Dr. Stern decided to accept a research fellowship at Yale University in New Haven, where he became a research associate in 1938 and joined the Overly Research Foundation in 1942. Two years later he was offered a post as research associate and adjunct professor at the Polytechnic Institute of Brooklyn, in which position he remained until his death.

Stern's influence on the development of biochemistry rested on the combination of several distinguished qualities: he was an excellent lecturer and an inspiring teacher; he was a meticulous experimentalist with an innate urge for precision and accuracy, and on top of it all he had a never-failing flair for selecting problems of general importance and far-reaching significance. He was strongly attracted by questions connected with the fundamental aspects of life, and hence biochemistry, biology and physiology were the sources from which he selected his problems; but with equal firmness he adhered to the exact quantitative and reproducible methods of physical chemistry and physics. As a consequence, for many years, his activities developed in the borderland between different sciences, taking problems from one and solving them with methods taken from another. In this difficult, self-assigned task, Stern succeeded not only in introducing precise methods in fields where they were unknown, but also in inventing and constructing many new instruments for the purification and characterization of biological objects, particularly enzymes, virus, proteins and nucleic acids.

While he worked and taught at the Polytechnic Institute of Brooklyn, he also acted as chemical consultant at the Montefiore Hospital in the Bronx; and it was a fitting expression of his constant tendency to bridge gaps between different sciences that each day he moved in the morning through the corridors of a busy hospital at one end of New York's metropolitan area, and in the afternoon lectured and supervized fundamental research in the laboratories of the Polytechnic Institute of Brooklyn at the other end. This type of work he liked; thus he contributed innumerable important results, and in both fields he was highly esteemed and liked by his colleagues and collaborators.

Dr. Stern's activities and efforts won him many recognitions and honours. He served as chairman of the Protein and Nucleic Acid Week of the Gordon Research Conferences; he was the secretary of the Planning Committee of the Chaim Weizmann Institute in Rehovoth; he was president of the American Society of European Chemists and Pharmacists and he served on many occasions as chairman of special symposia arranged by the American Chemical Society, the New York Academy of Sciences and in other scientific and technical organizations. He was awarded in 1953 the Pasteur Medal of the French Society of Chemistry and Biology.

His great scientific achievements and professional success were equalled by his warm, friendly and helpful personality. Everybody who came into contact with Dr. Stern was impressed by his high ideals, his devotion to the cause of science and his unfailingly deep interest in social and human relationships.

H. Mark

Mr. Horatio Ballantyne

Horatio Ballantyne, who died on January 25 at his home at Tadworth, Surrey, in his eighty-fifth year, was a consulting chemist and expert witness in patent cases whose theoretical knowledge was firmly buttressed by wide practical experience. His transfer from this field of activity to the Board of Lever Bros. in 1928, while at the height of his powers, though doubtless of benefit to commerce and industry generally and to that great Company in particular, left a gap in the ranks of scientific witnesses, and when, a few years later, his boyhood friend, Sir Dugald Clerk, the patent agent and expert on internal combustion engines and gaseous fuels, passed away, the fundamental contribution which they had made to the administration of the patent law was demonstrably evident. In engineering matters, Sir James Swinburne, the late Mr. H. A. Gill and Horatio's younger brother, the late Mr. W. H. Ballantyne, provided an adequate complement; but their gallant efforts to assist in cases arising in other scientific fields only made it more manifest that the day of the comprehensive scientific expert witness had come to an end.

The Reports of Patent Cases bears witness to Ballantyne's amazing versatility. From his début in the famous Welsbach gas mantle litigation, he assumed the burden of scientific exposition in patent cases for more than thirty years, dealing with topics as diverse as gramophones, electric lamps and filaments, steel ball grinders, coal-cutting machines, typewriters, confectionery, the drying of milk and a host of others. The first encomium he received was in his first case and came from Mr. Justice Wills, who said in his judgment: "I wish to add that Mr. Ballantyne has given me reason to rely on him. He is one of the most truthful and fairest minded men I have seen in the witness box". The last to my knowledge appears in an appreciation by Sir Kenneth Swan, a distinguished leader of the Patent Bar and himself a son of a great inventor. He wrote: "His evidence, invariably characterized by scrupulous candour and fairness, was not only backed by profound technical knowledge, but was always based on a careful and crucial experiment; moreover it was given with that degree of precision and tenacity that rendered it proof against the most penetrating cross-examination. In short, he was a pattern of what an expert witness should be". Both, it will be noted, remarked Ballantyne's candour and fair-mindedness, two attributes which the experienced judge will thankfully recognize, and without which the most profound scientific knowledge will fail to impress. The value of an expert witness resides in the weight attached to the expression of his opinions. He must, of course, be technically competent and preferably free from addiction to technical jargon. But in the ultimate result, his assistance in the administration of justice will depend not only upon his perception and expression of truth, but upon the manner in which he completes and isolates it. In this Ballantyne was pre-eminent, and that explains why it was that, in cases involving scientific questions with which he was only generally familiar, his assistance was often more valuable than the evidence of more specialized experts.

Horatio Ballantyne was born at Glasgow in 1871. His father, Thomas Ballantyne, who was a pioneer of unitarianism in Glasgow, was married twice, and had thirteen children, Horatio being the eldest son and first child of the second marriage. His father died when Ballantyne was fifteen years old.

At fourteen he left school to begin work in the laboratory of Robert Tatlock, city analyst for Glasgow. It had been planned that he should go to the University, having gained a bursary that would have enabled him to do so, but the young Ballantyne resigned the bursary and went to Tatlock's, starting at a wage of 2*s*. per week.

It was a very busy commercial laboratory, with a large Students' Department attached, and gave a really extensive training in industrial chemical analysis. After some time Ballantyne became chief assistant, and Tatlock and his partner Thompson invited him to become, in 1898, a member of the firm when Dr. J. B. Readman was due to retire; but brighter prospects came his way.

During the years with Tatlock, he had opportunities for carrying on research, especially into the little-understood chemistry of the oils and fats. Some accounts of these investigations were published in the *Journal of the Society of Chemical Industry*. In the evenings he attended classes in chemistry, mineralogy, German, etc. He took first place in Great Britain in the 'South Kensington' examination in honours chemistry, and the first place also (with medal) in the Society of Arts examination in German.

In March 1896 occurred an event which determined the course of his professional life. A few years before that date, Tatlock had received from Norway some samples of minerals which were to be tested for what was then known as the "rare earths", especially yttrium, cerium, lanthanum and thorium oxides. The invention of the incandescent gas mantle by Auer von Welsbach had given a special value to such earths, the chemistry of which was quite unknown to chemists in general. Tatlock had passed on to Ballantyne the problem of working out methods of analysis, etc., and he became in a small way a specialist in this recondite subject.

The Welsbach Incandescent Gas Light Co. of London acquired the rights to the British Welsbach patents, and by the year 1895 had become so successful that many infringing manufacturers appeared. An action for infringement of patent was brought against one of them. Towards the end of October 1895 a specimen of the infringing article was sent to Tatlock for analysis, and as it was said to be made of the rare earths he handed over the problem to Ballantyne. In March 1896 Ballantyne was asked unexpectedly to proceed immediately to London to be present at the trial of the action. The case began before Mr. Justice Wills. Fortunately for Ballantyne, it turned out to be the most important case of the time. The principal leaders of the Patent Bar were engaged in it, as were the leading expert witnesses (Sir Henry Roscoe, Prof. (Sir) James Dewar, Dr. Otto Hehner, (Sir) James Swinburne, Dr. Dupre, (Sir) Dugald Clerk, John Murrey, Prof. Vivian B. Lewes, Prof. Lambert, etc.). Leading counsel for the patentee was J. Fletcher Moulton (afterwards Lord Moulton), at that time the most distinguished counsel at the Patent Bar. The trial of the action was very protracted. Most of the work on the controversial matters fell upon Ballantyne's shoulders and he worked feverishly, night and day. Three times he was called to the witness-box. Such was the event which began Ballantyne's career as an expert witness and led him to specialize in patents and cognate matters.

Ballantyne was elected vice-president of the Institute of Chemistry in 1918, and again for the years 1920–22. He served on a number of Board of Trade departmental committees dealing with patent law and practice and with inventions made in government service. He married in 1899 Miss K. Russell, who survives him with the three daughters of the marriage.

G. H. LLOYD-JACOB

Mr. D. B. Waters

DAVID BOWE WATERS, whose death occurred on February 7 at Glasgow at the age of forty-three, was a civil engineer and was responsible during the Second World War for much of the detailed technical development at the Road Research Laboratory (Department of Scientific and Industrial Research) of the devices known as 'plastic armour' and 'plastic protective plating': these materials were used on most of the Allied merchant ships for the protection of vital parts from aircraft cannon fire. 'Plastic armour' consisted of a tightly packed mass of stone particles held together by a bituminous mortar and backed by a steel plate; 'plastic protective plating' was an even denser material with a higher stone content compacted by vibration and encased in thin sheet steel. In essence, these devices provided a protective layer, the resistance of which to penetration was highly irregular, thus causing projectiles to yaw away from a straight path.

Mr. Waters joined the Bituminous Section of the Road Research Laboratory in 1936: at the time of his death he was in charge of the Laboratory's Scottish branch at East Kilbride. His colleagues will long remember his originality of mind, enlivened always by gaiety and wit.

Dr. Ernst Wanner

Dr. Ernst Wanner was born in Zurich on July 22, 1900. In 1925, he was awarded the degree of doctor of mathematics at Zurich for work on groups of linear transformations, and in 1928 was appointed to the Swiss Meteorological Service, where he remained until his death from a heart attack on November 4, 1955. He worked on magnetic variations at Regensberg and on seismology at Zurich. Latterly he was vice-director of the Swiss Meteorological Service and responsible for personnel. That he was successful in both these fields is a tribute to him both as a scientist and as a man. He was basically good-natured, modest and very straightforward.

With A. Kreis, Wanner constructed a 1,000-kgm. vertical seismograph, which assisted him in obtaining data for the study of Swiss earthquakes and their impact on Alpine structure. He also studied Swiss earthquakes historically, compiling a catalogue of shocks between the dates 1856 and 1879. With all this material he was able to work out the correlation between earthquake epicentres in Switzerland and Swiss Tertiary volcanics and thermal springs. He used a method due to G. Polya and F. Eggenberger on the coupling of earthquake aftershocks. Finally, with P. L. Mercanton, Wanner studied the magnetic anomaly in Jorat, near Lausanne.

Wanner was president of the Swiss Committee of the International Union of Geodesy and Geophysics, vice-president of the International Association of Seismology and the Physics of the Earth's Interior, and the Swiss representative on the European Seismological Commission. He was unmarried.

Ernest Tillotson

NEW FELLOWS OF THE ROYAL SOCIETY

At the meeting of the Royal Society on March 15, the following were elected to fellowship:

Dr. N. P. Allen, superintendent, Metallurgy Division, National Physical Laboratory, Teddington, Middlesex, distinguished for his work on alloy steels, their transformations, and their engineering properties

Prof. J. F. Baker, professor of mechanical sciences, University of Cambridge, distinguished both for his experimental and theoretical investigations of steel structures and for services to education in engineering.

Prof. R. M. Barrer, professor of chemistry, Imperial College of Science and Technology, London, distinguished for his work on the mechanism of adsorption and diffusion of gases in solids and the problem of molecular sieves in zeolite minerals.

Dr. R. Brown, head of the Agricultural Research Council Unit of Plant Cell Physiology, Oxford, distinguished for his work on germination of parasitic seeds and isolation of germination hormones, also for studies of factors involved in cell division and development.

Prof. J. A. V. Butler, professor of physical chemistry, University of London, distinguished for his work on thermodynamics, and the application of physical techniques for the solution of problems of molecular structure of deoxyribonucleic acids.

Dr. D. Gabor, Mullard reader in electronics, Imperial College of Science and Technology, London, distinguished for his work on transient electric phenomena, electron microscopy, the theory of communication and the electric arc plasma.

Dr. H. Gruneberg, reader in genetics, University of London, distinguished for his investigations into the expression of genes during development in mammals.

Dr. C. S. Hallpike, director, Otological Research Unit of the Medical Research Council, London, distinguished for his investigations of the physiology and pathology of the internal ear and the mechanisms of hearing and equilibration.

Prof. J. E. Harris, professor of zoology, University of Bristol, distinguished for his researches in several branches of experimental zoology.

W. K. Hayman, reader in analysis, University of Exeter, distinguished for his contributions to the theory of functions of a complex variable.

Prof. N. Kemmer, Tait professor of natural philosophy, University of Edinburgh, distinguished for his pioneering work on the fundamental particles of physics, particularly on the meson and its role in determining forces within the atomic nucleus.

Dr. N. Kurti, lecturer and demonstrator in physics, University of Oxford, and Senior Research Fellow, Brasenose College, distinguished for his work on phenomena at very low temperatures, particularly in paramagnetism and nuclear alignment.

Dr. R. G. MacFarlane, Radcliffe lecturer in hæmatology, University of Oxford, distinguished for his studies on blood coagulation and their application for the treatment of hæmophilia.

Dr. R. Markham, principal scientific officer, Plant Virus Research Unit (Agricultural Research Council), Cambridge, distinguished for his studies on plant viruses and for his contributions to knowledge of nucleic acids.

Dr. J. W. Mitchell, reader in physics, University of Bristol, distinguished for his work on the action of light on crystals, particularly in photographic emulsions, and on the nature of the photographic latent image.

Prof. W. D. M. Paton, professor of pharmacology, Royal College of Surgeons, London, distinguished for his work on the relation between chemical structure and pharmacological action, and for the discovery of several important new drugs.

Dr. A. B. Pippard, lecturer in physics, University of Cambridge, distinguished for his work on the electrical properties of metals at radio-frequencies, and for his studies of the superconducting state.

Dr. Helen K. Porter, principal scientific officer, Research Institute of Plant Physiology, Imperial College of Science and Technology, London, distinguished for her work on fructosans of leaves, on carbohydrate metabolism of fruits and cereals and for enzymological studies on polysaccharide syntheses in plants.

Dr. G. Salt, lecturer in zoology, University of Cambridge, distinguished for his experimental and ecological researches on insects, especially on parasitic Hymenoptera.

Prof. C. W. Shoppee, professor of chemistry, University College, Swansea, distinguished for his contributions to organic chemistry with special reference to the elucidation of problems of stereochemical relationships in the steroid field.

Prof. F. W. Shotton, professor of geology, University of Birmingham, distinguished for his contributions in stratigraphy and particularly for his work on the Pleistocene deposits of the Midlands.

Dr. E. I. White, keeper of geology, British Museum (Natural History), London, distinguished for his research on the earliest vertebrates and fossil fishes, particularly those from the Old Red Sandstone.

Dr. M. V. Wilkes, director, University Mathematical Laboratory, Cambridge, distinguished for his contribution to the design and construction of automatic calculating machines, and their application to the solution of a wide variety of scientific problems.

Dr. D. H. Wilkinson, lecturer in physics, University of Cambridge, distinguished for his researches in nuclear physics, especially his investigation of the properties of the energy levels of light nuclei.

Prof. A. Wormall, professor of chemistry and biochemistry, St. Bartholomew's Hospital Medical College, London, distinguished for his researches in biochemistry and for his 'pioneer work in the development of the use of isotopes in immunochemistry.

NEWS and VIEWS

Physical Metallurgy at the Imperial College, London: Mr. J. G. Ball

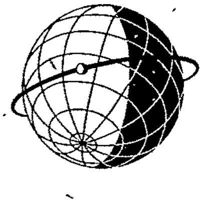
Mr. J. G. Ball, of the Atomic Energy Research Establishment, has been appointed to the chair of physical metallurgy in the Imperial College of Science and Technology, University of London. After leaving the University of Birmingham, Mr. Ball joined the Welding Research Council in 1941. When this became the British Welding Research Association in 1945, he was appointed senior metallurgist with responsibility for establishing and directing the metallurgical laboratories; there he initiated a programme of basic work on light alloy and structural steel welding. Mr. Ball led a strong team on steel welding which has made fundamental contributions to the understanding of welding behaviour and the development of new alloy steels of good weldability. He was particularly associated with developments in the fabrication of Bailey bridges and is a member of a Ministry of Supply Committee on this subject. He joined the Atomic Energy Research Establishment, Harwell, in 1949, to take charge of investigations on the metallurgy of plutonium, and he pioneered the special techniques for handling plutonium and for micro-scale investigations. He was jointly responsible with Dr. R. Hurst for the design of the new plutonium laboratory at Harwell, which is based on new principles and incorporates novel techniques. The plutonium core for the fast reactor Zephyr was fabricated under his direction. For the past three years he has been head of the Reactor Metallurgy Group in the Metallurgy Division, and has given much attention to the problems of irradiation behaviour of fissile materials and the design and behaviour of fuel elements. Mr. Ball is a member of the Council of the Institution of Metallurgists. With Mr. Ball's appointment, it is intended that the development of the research and postgraduate activities in metallurgy at the Imperial College will have a bias towards the metallurgy of nuclear energy.

Chemistry at Rothamsted Experimental Station: Dr. G. W. Cooke

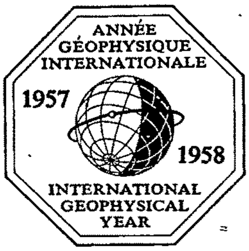
Dr. G. W. Cooke has been appointed head of the Chemistry Department of Rothamsted Experimental Station, in succession to Dr. R. K. Schofield, who has gone to the Department of Agriculture, University of Oxford (*Nature*, 176, 910; 1955). Dr. Cooke was educated at Loughborough Grammar School and (the then) University College, Nottingham, graduating with first-class honours in chemistry in 1937. After postgraduate research in biochemistry with the late Prof. J. M. Gulland, he joined the Chemistry Department at Rothamsted as a Ministry of Agriculture research scholar. In 1940 Dr. Cooke obtained his Ph.D. for a thesis on soil phosphate chemistry. During the Second World War he was concerned with testing new phosphate fertilizers which were made as alternatives to superphosphate. Afterwards he turned his attention to improving the efficiency of fertilizers by developing special methods of application. This work, which proved the value of fertilizer placement practices for certain crops, is already being applied by farmers His experience in fertilizers has led to Dr. Cooke being invited to carry out short-term work for both the Food and Agriculture Organization and the Organization for European Economic Co-operation. He has been honorary secretary of the Agriculture Group of the Society of Chemical Industry, of which he is at present vice-chairman. He has also served on the Council of the Fertilizer Society.

Symbol for the International Geophysical Year

It has been decided to use the following symbols in connexion with the International Geophysical Year:



(1)



(2)

Symbol 1 is a representation of the Earth with meridians and circles of latitude, showing the south pole, to signify the special antarctic features of the International Geophysical Year; part of the Earth is shown in darkness, implying the influence of the Sun; a satellite orbit is shown encircling the Earth at an inclination to the equator, with the satellite, of course exaggerated in size, shown partly sunlit. Symbol 1 is to be used without change on publications issued by the Comité Spécial de l'Année Géophysique Internationale (CSAGI) and other International Geophysical Year publications under rules issued by the General Secretary of the Comité Spécial. This symbol does not include an inscription because the relevant information will normally be printed on the title page and cover of each publication. Symbol 2 is to be used on instruments, equipment or uniforms of personnel associated with the International Geophysical Year national committees, where the French or English language is appropriate; other national committees will substitute a translation of the inscription in the relevant language. If commemorative postage stamps are to be issued by any nation, the inscription may be used with the central symbol but otherwise disposed and with a border other than the octagonal one.

Man-power in the Royal Air Force

In submitting the Air Estimates to the House of Commons on March 5, the Secretary of State for Air, Mr. Nigel Birch, referred at some length to the problem of saving man-power. Apart from limited inquiries into specific aspects of the subject, in which the Royal Air Force has had the assistance of business men, trade union officials and others, imaginative and effective work is going on all the time in the Royal Air Force itself, which has, he claimed, pioneered the application of scientific methods to the man-power question. This work has aimed not only at saving man-power but also at adjusting establishments in a highly technical and rapidly changing Service; further, the Air Ministry Man-power Research Unit has been in existence for many years and has done much good work. Inquiries are now being extended into the whole life and work of a station, and not only into specific aspects. For example, it has been found that in servicing operational aircraft, with a slightly larger supervising staff and tradesmen with the correct skills, considerable savings in man-power can be effected. Arising out of the discovery of a desire to have the technical and administrative wings on the airfield broken down into squadrons, experiments are being made with technical squadrons, signal squadrons, engineering squadrons, and so on, which have indicated that morale as well as efficiency are thereby improved. The application of these conclusions in a much bigger way on operational airfields is now being investigated by the Man-power Utilization Committee. Senior staff are also being sent to make special studies of work methods, not only in the Royal Air Force, but also in industry, and in this work they are having the help of young national service officers with honours degrees in scientific subjects, who were helping to work out the techniques.

Mr. Birch believes that the experience drawn from industry can have solid and substantial results in saving man-power and increasing efficiency, and that as a result of all these experiments it should be possible during the next two or three years to save some thousands of posts. He referred also to the need for very highly trained technical officers which is being met by the Technical Cadet Scheme, and by the postgraduate training of serving officers, for example, in the postgraduate course in guided weapons. The real background of the Royal Air Force was, and will remain, however, the general duties officer, and the period of training at Cranwell has been extended to three years, first to enable the cadets to finish their training in jet aircraft, and second, to ensure that they have a good general education as well as a technical one.

Mr. G. S. de Freitas, while welcoming this reference to scientific research into man-power, and referring to the need for increasing the supply of scientists and technologists, as well as reducing unnecessary demands on the limited resources in Britain of skill and materials, suggested that more attention to human relations in the Royal Air Force is also required. There was little other reference in the debate to what is already being done in the Royal Air Force to save man-power, although there was general recognition of the importance of deploying wisely scientific and technological man-power and increasing its supply so far as possible. Dr. A. D. D. Broughton, in supporting the idea of an exchange of technicians between the Service and industry, stressed the importance of keeping a careful watch on the competition for technical man-power between the Services and industry.

Recent Earthquakes in Lebanon

A swarm of earthquake shocks, of which four were strong, occurred on the night of March 16, and the following day. The epicentres were in the south of Lebanon, where considerable damage was done in some forty villages. Reports so far received state that 112 people are known to have been killed and more than a hundred injured. Considerable apprehension was caused, and thousands of people gathered on the shore, away from buildings. Minor earth tremors have been known to occur in Lebanon, but large shocks are infrequent there. The larger earthquakes are more frequent in southern Turkey.

Preparation of Illustrations for Publication

Illustrations in the form of drawings or graphs are often the most important feature of a scientific paper, and many research workers with little or no previous experience in the matter sometimes unwittingly cause considerable extra trouble and expense in editorial offices by submitting illustrations which require a great deal of alteration before they are suitable for reproduction. Most journals have their own peculiarities, and before submission of a paper intending authors should examine the particular journal they have in mind to see, for example, if any particular form and size of lettering is favoured (many journals prefer to set up letters and numbers in actual type when these occur outside the block).

However, as a general guide, intending authors (even senior ones) could not do better than consult "Notes on Preparation of Illustrations", prepared by the editorial office of the *Biochemical Journal* (price 1*s*., from the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1). This gives simple instructions, and goes on to consider a typical graph. It shows the graph drawn incorrectly, then as it should have been drawn, and finally as it would appear when published. The points discussed are really based on common sense alone; but the pamphlet does emphasize in a particularly direct way the essentials of the matter, and its acquisition by departments and/or individuals for the modest outlay of a shilling is a worth-while investment.

Stress Analysis Group of the Institute of Physics: Annual Conference

THE summarized proceedings of the ninth annual conference of the Stress Analysis Group of the Institute of Physics, which was held in the University of Sheffield during September 28–30, are printed in the January issue of the *British Journal of Applied Physics* (7, 1; 1956). The opening lecture was delivered by D. G. Sopwith (Mechanical Engineering Research Laboratory, East Kilbride), who spoke on the application of stress analysis to the design of some engineering components. Dr. Sopwith outlined the pattern that any design investigation should follow and emphasized that the stress analyst's task is not finished until the results are presented in a form such that the designer can apply them directly to the particular problem under consideration. Four papers by members of the Engineering Department of the University of Sheffield dealt with the measurement of residual stresses in cold-drawn tubes; the effect of tensile overstrain on the yield criterion for mild steel, brass and copper; extrusion under drop-hammer impact; and stress-strain characteristics of metal at high rates of strain, respectively. D. A. Drew (Rolls-Royce, Ltd., Derby) discussed the measurement of aircraft engine vibration in flight and pointed out that, though great accuracy is not vital, the measuring system has to be capable of dealing with frequencies up to 15 kc./s. Other papers dealt with strain gauges; the use of the resistance-network analogue for solving plane stress problems; machining stresses in turbine blades; and the application of the frozen stress method of photo-elastic analysis using 'Araldite' resin models to the study of the stresses in the T-junction of a branched pipe. In addition, a series of short papers presented by R. G. Boiten (Institut T.N.O. voor Werktuigkundige Constructies, Delft), describing the work of his organization, are of particular interest; they included descriptions of the photoelastic bench at Delft, work on prefabricated strain gauges, and a new type of brittle lacquer the raw material of which consists of plumber's resin.

Refugia Indicated by Pollen Profiles

C. H. HEUSSER has given an account of some interesting pollen profiles in the Queen Charlotte Islands, British Columbia (*Canadian J. Bot.*, 33, 5, 429; 1955). In all, five peat sections were examined from muskegs in different islands of the group with the primary purpose of reconstructing the post-glacial plant succession and associated climatic and physiographical alterations. A secondary purpose was to support or disprove the geological and zoölogical data favouring the existence of refugia in which biota survived from pre-glacial or inter-glacial times. The oldest pollen record tends to support this contention. The record is older than any derived from sections heretofore studied on the north-west coast. Twenty-three plant entities are represented in the bottom sediments below the lodgepole pine maximum which in these other sections marks the oldest peat. In addition, 27 per cent of the coniferous pollen at the base of the section is constituted of climax forest trees, thus implying the presence of long-established forest when pollen sedimentation began. The number and kinds of pollen in the basal peat favour the interpretation that vegetation persisted in refugia through at least the last glaciation. The pollen profiles further corroborate earlier findings for changes in land–sea level relations and for the following post-glacial climatic sequence: early cool-moist, warmer and drier (thermal maximum), and late cooler and wetter.

The Neurohypophysis: Symposium in Bristol

THE Colston Research Society, Bristol, has arranged since 1948 annual symposia on subjects appropriate to each of the Faculties in turn of the University of Bristol, and this year the symposium, to be held during April 9–12, will be on "The Neurohypophysis". The subject is one which appeals to a diversity of scientific interests, and the list of invited speakers includes anatomists, biochemists, pharmacologists, physiologists and zoologists. Besides eight speakers from Great Britain, there are three speakers from the United States, two from Sweden and one each from Canada, Chile, France, Germany and Switzerland. The symposium will be under the direction of Prof. H. Heller (Department of Pharmacology, University of Bristol), and Sir Henry Dale will open the proceedings. On April 10 the Society will hold its annual reception, at which the principal speaker will be Sir Lionel Whitby. Further information can be obtained from Dr. R. J. Fitzpatrick, Department of Pharmacology, University of Bristol.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: E. W. Momber (assistant director of agriculture, Northern Region, Nigeria), deputy director of agriculture, Northern Region, Nigeria; T. A. Phillips (principal of the School of Agriculture, Northern Region, Nigeria), deputy director of agriculture, Eastern Region, Nigeria; S. T. Hoyle (principal scientific officer, Nyasaland), senior principal scientific officer, Nyasaland; Miss F. M. Roberts (principal scientific officer, Jamaica), principal scientific officer, plant pathologist, Kenya; W. H. Foster, senior scientific officer (botanist and plant breeder), Northern Region, Nigeria; A. M. M. McFarquar, agricultural economist, Western Region, Nigeria; P. Thomas, cocoa soil survey officer, Gold Coast; D. R. Younger, manager, Yumdum Experimental Farm, Gambia; C. F. Hutchison, assistant bacteriologist, Jamaica; J. E. Clarke, entomologist, Game and Tsetse Control, Northern Rhodesia; D. G. Coursey, scientific officer (chemist), Federation of Nigeria; M. G. R. Hart, scientific officer, Sierra Leone; D. W. Brocklesby, veterinary research officer (protozoologist), East Africa High Commission; R. I. C. Hyam, veterinary officer, Northern Rhodesia; W. R. Nunn and L. D. Tennant, veterinary officers, Uganda; D. J. Skinner, veterinary officer, Kenya; Miss M. de Vere Allen, laboratory technologist, Kenya.

Announcements

BRIGADIER J. A. SINTON, V.C., F.R.S., has been awarded the Manson Medal for 1956 of the Royal Society of Tropical Medicine and Hygiene. This Medal is awarded triennially to the living author of such original work in any branch of tropical medicine or tropical hygiene as the Council may consider to be deserving of the honour.

MR. P. R. OWEN, reader and director of the Laboratory of Fluid Motion in the University of Manchester, has been appointed professor of the mechanics of fluid motion in the University.

MR. R. W. MARSH, head of the Plant Pathology Section at Long Ashton Research Station, is being seconded to the Food and Agriculture Organization for the period April–June to report on crop protection methods and organization in Yugoslavia.

A CONFERENCE on starch will be held in Detmold, Germany, during May 2–4, and will consist of three sessions as follows: fundamental research and research methods; starch production and techniques; and starch fractions and derivatives. The conference is organized by the Arbeitsgemeinschaft Getreidesforschung e.V., Detmold, from which further information can be obtained.

FOLLOWING the extremely successful Summer School in Theoretical Chemistry held last year at Oxford, another similar School is to take place during July 7–21, under the direction of Prof. C. A. Coulson. Further particulars can be obtained from the Assistant Secretary, Delegacy for Extra-Mural Studies, Rewley House, Wellington Square, Oxford. Applications should be made before April 30.

THE Chemical Society is organizing a symposium on "Antibiotics and Mould Metabolites", to be held on March 26 in the Great Hall, University of Nottingham. Seven papers will be read and these will be published later as No. 5 in the Society's series of "Special Publications" (8*s*. 6*d*. to Fellows of the Society; 15*s*. to others). Further information can be obtained from the Society at Burlington House, Piccadilly, London, W.1.

THE Society of Chemical Industry is organizing a three-day conference on the "Disposal of Industrial Waste Materials", to be held in the University of Sheffield during April 17–19. The conference will cover a very wide range of materials, including fine chemicals, industrial effluents, slag and ash, and atomic-energy products. The conference is open to all on payment of a registration fee of 2 guineas (10*s*. 6*d*. for members of the Society). Application forms and further information can be obtained from the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

A SYMPOSIUM on "Vegetable Tannins", organized by the Society of Leather Trades' Chemists, will be held in the Chemistry School, Pembroke Street, Cambridge, during April 12–13. The chairmen during the two days will be Prof. R. D. Haworth and Dr. F. E. King, respectively. The conference is open to all, on payment of a fee of £1. Registration forms, to be returned by March 31, and further information can be obtained from G. H. W. Humphreys, Forestal Land, Timber and Railways Co., Ltd., Forestal Central Laboratories, Harpenden, Herts.

AN international symposium on "Macromolecular Chemistry", under the auspices of the Commission on Macromolecules of the International Union of Pure and Applied Science, will be held in the Weizmann Institute of Science, Rehovot, Israel, during April 3–9. The first half of the symposium will consist of sessions of papers on the following three topics: general behaviour of polymers in solution; general behaviour of biocolloids and polyelectrolytes in aqueous solution; and special polymeric systems in solution. The rest of the meeting will be devoted to tours around Tel Aviv, Haifa and Jerusalem. Further information can be obtained from the Weizmann Institute of Science, Rehovot.

THE fourth and final meeting of the series of meetings on "Nutritional Requirements and Food Fortification", organized by the Nutrition Panel of the Food Group, Society of Chemical Industry, will be held at the Royal Society of Medicine (Barnes Hall), 1 Wimpole Street, London, W.1, on April 11, at 6 p.m., when the subject of iodine and fluorine will be discussed. Iodine metabolism and the iodization of food will first be considered, and the meeting will then turn to physiological and medical aspects of fluorine, including the dental problem and the fluoridation of water supplies. Further information can be obtained from the honorary secretary of the Panel, L. C. Dutton, Virol, Ltd., Hanger Lane, Ealing, London, W.5.

A DEBATE on the motion "That Science can Provide as Good an Education as the Humanities", organized by the Fine Chemicals Group of the Society of Chemical Industry, will be held in the William Beveridge Hall, Senate House, University of London, at 7 p.m., on April 20. The principal speakers will be as follows. *For the Motion:* Dr. R. P. Linstead (rector of the Imperial College of Science and Technology, London) and Prof. A. R. Ubbelohde (professor of thermodynamics in the Imperial College). *Against the Motion:* Mr. B. L. Hallward (vice-chancellor of the University of Nottingham) and Mr. H. D. P. Lee (headmaster of Winchester College). The chair will be taken by Sir William Ogg (director of the Rothamsted Experimental Station and immediate past-president of the Society of Chemical Industry). Admission will be by ticket, obtainable from the honorary secretary of the Group, Dr. J. D. Kendall, Ilford, Ltd., Ilford, Essex.

THE essay subjects for this year's *Endeavour* Prizes of the British Association for the Advancement of Science will be as follows: research in polar regions; scientific aids to archæology; the story of steel-making; the chemistry of big molecules; new elementary particles; the control of plant diseases. The essays must be sent in by June 1 and should not exceed four thousand words. Competitors must be less than twenty-five years old, and the Prizes will be 50, 25 and 15 guineas, respectively, with two special awards of 5 guineas to those less than eighteen. Further information can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

ERRATUM.—In the biographical note on Edward Goodrich Acheson in the issue of March 3, p. 412, the United States Patent Office was incorrectly referred to as the United States Post Office; the Patent Office exhibited one of E. G. Acheson's patents, among seventeen which were considered to have most benefited mankind, and not seventeen of Acheson's patents, as stated.

SNOW ACCUMULATION AND ABLATION

THE mass of snow and ice stored at high elevations on the Earth is a large reservoir of the hydrological cycle. Any reduction in its mass by melting releases potential energy, and the debts of past climates become discharged. We have neither made much use of this energy nor made a serious attempt to measure its size or its fluctuations. Even the mass of water accumulated in annual snowfields is measured only in a few places, and yet its sudden release in a thaw is often the source of a disastrous flood; for example, the 1950 Red River flood at Winnipeg. If the snow stored in the upper catchment area of the River Severn were known and the relation between its ablation and the weather were established, it would be possible to predict the likelihood and the size of the flood lower down the river. Unfortunately, however, snow accumulation and ablation are not easy to measure, and we have almost no knowledge of the quantity of water lying as snow in any catchment area in Britain.

The discussion meeting on "Snow Accumulation and Ablation", organized jointly by the Royal Meteorological Society and the British Glaciological Society and held in London on January 18, was concerned mainly with the problem as it affects the budget of glaciers. Even in Britain, glaciers are of interest; for as one speaker (L. C. W. Bonacina) remarked, there would be glaciers in Scotland after fifty summers—not winters—like that of 1951.

It is well known that European glaciers are retreating in association with the warming of the climate. Their retreat is measured in the simplest way by recording the annual change in the position of the glacier tongue. This measurement merely indicates that the glacier is striving to balance its income, the total accumulation, against its expenditure, the net ablation; but it reveals neither the sizes of its budgetary items, nor which climatic variable dominates its retreat. For that purpose it is necessary to measure the annual changes in the glacier mass both in the higher parts where there is a surplus (the net accumulation) and at the lower levels where there is a deficiency (the net ablation). This will show whether the retreat is associated with decreased precipitation or with increased atmospheric heat causing greater ablation. Then it is necessary to investigate the heat balance at the glacier surface to discover the importance of the various meteorological factors causing the ablation. All the heat sources and sinks at the glacier surface have to be measured: the net radiation, the convection from the air, the conduction from the glacier, the evaporation and the condensation. This task is similar to estimating the heat balance at the ground surface, with the one simplification that the snow surface remains at 0° C. whenever melting occurs.

Such investigations of the mass and heat budget of a glacier are difficult undertakings, and it is not surprising that only a few studies have been made. The observations of Ahlmann and Eriksson in North East Land in 1931 were analysed by Ångström[1]. An intensive study of the heat balance over a glacier surface was made by Sverdrup[2-4], Ahlmann and Olsson on Isachsen's Plateau in Spitsbergen in 1934. Sverdrup's findings were used to obtain some idea of the relation between ablation and climate on the Vatnajökull in Iceland by Ahlmann and Thorarinsson[5], and these findings were also applied to observations on the Fröya Glacier in East Greenland by Eriksson[6]. The most exhaustive study has been made by Wallén[7] on the small, but accessible, Kårsa Glacier in Swedish Lapland. This is the only study that has covered a number of consecutive years (1942–48), and it was concluded that the principal cause of the recession of the glacier was increased ablation associated with increased summer temperature and humidity, and a longer ablation season. More recently, Baird[8], Ward[9] and Orvig[10] have made the first studies in the Canadian Arctic on two ice caps in Baffin Island, and observations have been made on the ice shelf of Queen Maud Land in the Antarctic[11]. (An ice shelf is a coastwise glacier composed of land ice, sea ice and local snow, generally floating on the sea.)

The discussion at the meeting was opened by R. A. Hamilton, of the British North Greenland Expedition, who gave a brief description of the geography and glaciology of the Greenland ice cap and of its dominant weather systems.

H. Lister, another member of the Expedition, followed with a detailed account of his measurements of the ablation and of the heat balance during the melting season made on one of the glaciers flowing from the Greenland ice cap. The practical difficulties of using normal meteorological instruments to measure the gradients of temperature, vapour pressure and wind speed over a polar glacier surface were well illustrated. The many meteorologists present must have been convinced of the need for the development of more suitable instruments for reliable work in cold climates. The subject of heat transport through the air has been one of much controversy during recent years in the light of current ideas on turbulence and there is a feeling that the Greenland ice cap is not a convenient place to delve into detailed research on this problem; it can be pursued more profitably on the snowfields of the Cairngorms, for example. Such a site would be suitable also for development trials of instruments and for determining the optimum observations required for a study of heat balance. It is gratifying to record that P. D. Baird, of the University of Aberdeen, has made a start in this direction, with the help of the Meteorological Office, by establishing a weather station on the Cairngorm plateau this winter.

W. H. Ward spoke generally of the problems of the direct measurement of snow accumulation and ablation in the light of his experiences on two ice caps in Baffin Island, Canada. The long-term seasonal measurement of accumulation and ablation was not too difficult and was easiest in the ablation zone of a glacier. It was a question of measuring the change in the mass of water relative to a suitable reference horizon, and the dense ice surface in the ablation zone was a convenient reference. But in the thick permeable accumulation zone it was sometimes impracticable to reach a reference level through which some melt water did not seep and re-freeze at a lower level. When accumulation and ablation occurred intermittently, it was difficult to define the duration of the ablation season.

Daily measurements of ablation and accumulation are of greater interest to the meteorologist, and the usual methods of measurement are subject to many errors. The ablation is frequently measured by the lowering of the surface relative to a stake sunk in the snow, and the change in level is multiplied by a density to give the ablation in, say, inches of water. But the surface can settle for a variety of reasons. Compaction can occur without ablation, melt water descending through subsurface snow can cause compaction beneath a frozen snow surface and radiation can cause melting below the surface. Furthermore, the snow density varies irregularly with depth. Constant watching of the snow and the weather cannot eliminate all sources of error. In the accumulation area of a glacier during the melting season, the total mass of ice and water can be measured by sampling every snow layer from a pit dug to a suitable reference level. The density of each sample and the thickness of each layer are measured and their products summed up. That task may easily take a full day's work. The water content of all the samples can be measured by calorimetry, but it is an impossible task in a deep profile.

These are the methods of measurement available at present, and there is a pressing need to develop a simple field-method of recording separately the total masses of water and ice in a melting snow profile.

W. H. WARD

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[1] *Geog. Ann.*, **16**, 264 (1933).

[2] *Geog. Ann.*, **17**, 145 (1935).

[3] Chr. Michelsens Inst. for Videnskap og Åndsfrihet. Beretninger, **5**, 3 (1935).

[4] *Geofis. Pub.*, **11**, No. 7 (1936).

[5] *Geog. Ann.*, **20**, No. 3–4 (1938).

[6] *Geog. Ann.*, **24**, 23 (1942).

[7] *Geog Ann.*, **30**, 451 (1948).

[8] *J. Glaciol.*, **2**, 2 (1952).

[9] *J. Glaciol.*, **2**, 158 (1953).

[10] *Geog. Ann.*, **36**, 193 (1954).

[11] *Weather*, **7**, 314 and 327 (1952).

TESTING OF METALS BY OPTICAL METHODS

On January 13 a symposium, at which there were some sixty participants, was held at the Institute of Physics, London, on "The Possible Uses of Surface Methods as a Means of Testing Metals (with Special Reference to Optical Methods)". This was sponsored by the Non-Destructive Testing Group of the Institute of Physics, and it was to be understood that only non-destructive methods were to be discussed. The symposium was opened by Prof. S. Tolansky, of the Royal Holloway College, University of London, Dr. O. S. Heavens, of the University of Reading, and Dr. R. W. B. Stephens, of the Imperial College of Science and Technology, University of London, who each in turn gave a half-hour discourse on selected topics, after which the meeting was thrown open to general discussion. The chair was occupied by Dr. J. Thewlis.

In an introductory survey, illustrated by some forty slides, Prof. Tolansky selected as typical subjects for examination some of his own studies on the optical testing of surface finish, of microtopography in general, the examination of micro-hardness and directional hardness, the character of electrodeposits and the examination of machined metal surfaces. Attention was devoted to five different methods of approach which he uses for the study of surface structure. There is first two-beam interferometry, which is capable of extensive application; then, for increased precision, indeed reaching down to structural features the heights of which approach crystal lattice dimensions, there is multiple-beam interferometry in a variety of forms, examples of which were shown. It was stressed that the great resolutions attainable are only in the height–depth dimension and not in extension across the surface. Experiments revealing the perfection of contour of the silver layers used in multiple-beam interferometry were described. The light-profile microscope was then illustrated, and it was emphasized that this has very obvious metallurgical applications, some of which were shown. The advantage of this system is that it is capable of resolving an elementary cube of side (roughly) half a light-wave. Thus in effect a useful magnification of about a thousand is available in three dimensions, and this is of much value in many problems. A simple optical shadow-casting technique was then described and possible applications discussed.

Finally, a review was included of a critical experimental examination intended to test the validity of the method of total reflexion advocated for the exploration of engineering bearing surfaces. In this, a hypotenuse of a right-angled prism is pressed on to the surface and at the points of contact total reflexion is interfered with, revealing thus a dark pattern. Some difficulties in interpretation were discussed.

Dr. Heavens then reviewed the development of recent studies of surface reflectivity and of the assessment of surface films and oxide films on metals. He pointed out that electromagnetic theory enables the optical constants of a material to be deduced from observations on light reflected from a surface. The theory is simple for the ideal theoretical case of a plane boundary separating homogeneous, isotropic regions. Thus accurate experiments can yield information on the nature of a real surface from the difference between such observations and the computations of the theory for the ideal case. In the case of transparent materials, the presence of a transition layer at the surface is revealed by a gradual, rather than abrupt, differential phase-change in the light reflected from the surface. For heavily absorbing materials, the optical constants are easily deduced from polarimetric observations. Since the depth of penetration in these cases is a small fraction of a light-wave, then these observations yield information about the surface layers only and cannot easily be adapted to the problem of examining the bulk properties. Simple criteria exist, however, enabling the homogeneity of the surface layers to be checked.

The problem of examining surface roughness was then discussed by Dr. Heavens. He indicated that this may be tackled by a number of different reflexion methods, according to the scale of the roughness involved. For very rough surfaces (irregularities of many wave-lengths) he described scattering methods as useful. By judicious selection of the wave-length a wide range of roughnesses may be covered. Irregularities of the order of a wave-length may be examined by two-beam interference methods, such as are widely used in the optical industry. Under this heading, the interference microscope, coupled with replica techniques, was mentioned. It was then stressed that for surface roughnesses much smaller than a wave-length there are two notable methods, namely, multiple-beam interferometry which can be applied to a wide range of surfaces, both transparent and absorbing, and, for specialized applications, phase-contrast methods. Both these methods enable a very high resolution normal to the surface to be attained.

Although much information may be obtained by a detailed analysis of the state of light reflected from a surface, methods suitable for non-destructive testing tend to be restricted to those which are reasonably simple to make and to interpret.

The third formal contribution, by Dr. Stephens, was devoted mainly to suggesting future possible extensions of techniques. It was pointed out that, as a general assessment, the application of optical reflexion methods is mainly dependent on the provision of good reflecting surfaces. Since for opaque materials the light-wave penetrates only to depths of the order of a few hundred angstroms, considerable care is necessary to avoid any treatment of the surface which might alter appreciably its physical characteristics as compared with the bulk material. The use of obliquely incident light minimizes the effect of small surface blemishes, and radiation wavelength is another factor at our choice. In testing for a high surface polish, it would be desirable to use the shorter ultra-violet wave-lengths; but when the object is to standardize the material itself, then longer wave-lengths are to be preferred. Dr. Stephens then directed attention to the recent advances in infra-red detectors—the photoconductive cells with their very small time-constants which provide new possibilities in non-destructive testing. Moving farther along the electromagnetic spectrum to the microwave region, the use of these centimetre waves offers an advantage in reflectivity measurements from the aspect of less exacting requirements in surface smoothness, and furthermore, by changing the frequency, the effective depth of penetration can be conveniently varied. Dr. Stephens here emphasized the advantage of such studies over methods using visible light, which are confined effectively to surface layers.

Recent work on the fundamental properties of surface electromagnetic waves has indicated another possible line of approach to the investigation of surface properties. These, Sommerfeld or Zeeneck waves, are attenuated both in the direction of propagation and normally to the surface to an extent dependent on the reactance of the surface, and are thus sensitive to geometrical irregularities and surface composition. Another approach in surface testing which Dr. Stephens thinks may merit attention is to investigate optically the effect of applying a second physical agency to the specimen, for example, a magnetic field, as in the Kerr magneto-optic rotation effect.

The three formal surveys were succeeded by a lively discussion to which many of the audience contributed. An appreciable fraction of the available time was taken up with a discussion of the reliability of replication methods, contributions being made by Dr. J. Thewlis, Miss K. B. Day and also Prof. Tolansky, who expressed the view that he has experimentally established that some materials can be used for making replicates with very high fidelity in extension, but yet simultaneously with appreciable uncertainty in depth. Mr. J. C. Kelly raised the issue of the relative perfection of contour of vacuum-deposited silver and vacuum-deposited dielectric multilayers. This matter received appreciable discussion.

The novel surface-penetrating methods proposed by Dr. Stephens aroused much interest and several queries about such procedures were posed.

Several members present were surprised at the extreme sensitivity of the polarization methods advocated by Dr. Heavens.

It was clear from the vigour of the discussion that the symposium had justified itself and focused attention in a practical way on a wide variety of techniques available to those who must needs examine metals in a non-destructive fashion.

PHOSPHOLIPIDS IN FOODS

A CONFERENCE on recent advances in the knowledge and uses of phospholipids in foods, arranged jointly by the Food Group and the Oils and Fats Group of the Society of Chemical Industry, was held in London during February 9–10 at the Wellcome Research Institution. The opening session, under the chairmanship of Prof. T. P. Hilditch, was concerned with the chemistry and physical chemistry of phospholipids. Papers were presented by Prof. T. Malkin and Dr. B. A. Pethica. The afternoon session, at which Dr. K. A. Williams took the chair, was devoted to consideration of methods of separation. Dr. June Olley described methods of counter-current distribution, and Mr. D. N. Rhodes' chromatography. A third paper, on deteriorative changes in food phospholipids, was presented by Dr. C. H. Lea. During the first half of the second day, two papers were presented: one by Dr. J. A. Lovern on phospholipids in fish, and the other by Dr. F. Aylward on plant phospholipids, the chairman being Dr. A. J. Amos. The final session, under the chairmanship of Prof. A. C. Frazer, was also introduced by two papers: Dr. J. N. Hawthorne spoke on animal phospholipids, and Mr. H. H. Hutt on the large-scale production and industrial uses of phospholipids.

The papers were full of interesting information and covered a wide range, from relatively abstruse and detailed chemistry and physical chemistry to technical points concerned with large-scale production. Discussion was lively and varied in each session. It was apparent that things are moving on the chemical side. A wider range of pure synthetic phospholipids is likely to be available in the near future. This should lead to greater and more accurate knowledge of the physical chemical properties of this group of substances. Once this information begins to become available, many fascinating problems in the biological field, especially those associated with the structure and functions of lipoproteins, are likely to open up. The importance of close co-operation between chemists, pharmacologists, biochemists and nutritionalists in this field cannot be over-emphasized.

Work on phospholipids in foods is still in a formative stage, but methods of isolation and identification are rapidly developing. The importance of phospholipids in relation to deteriorative changes in food is well recognized. They may also play an important part in relation to some of the attractive properties of foods that technologists may wish to retain or enhance. This conference concerned itself mainly with the chemical and physical chemical background, with the occurrence of phospholipid in natural materials and the technological uses to which phospholipids may be put. There is clearly considerable scope for the use of phospholipids in food technology. However, the biological effects of separated and prepared phospholipids used in food out of their normal context will require careful examination. With increasing knowledge and improving techniques in this field, it should soon be possible to make a more accurate assessment of the importance of phospholipids in the diet to health and nutrition. We may confidently expect considerable advances in this field during the next ten years, and it is encouraging to see such a wide interest taken in the subject at this early stage.

FULBRIGHT PROGRAMME IN GREAT BRITAIN AND COLONIAL TERRITORIES

FIFTH REPORT

THE fifth annual report on the Fulbright Programme in Britain and Colonial Territories* takes the form of a review and appreciation of the work of the Commission during 1949–54. To this Senator J. W. Fulbright himself contributes a foreword, while there are reviews from the American side and from the British side by Herbert Agar and Dame Lillian Penson, respectively, an article on "Orientation" by Sir Alexander Gray describing what is done to introduce the newly arrived scholars, and a series of articles on special features of the Programme. Sir Raymond Priestley deals with the Colonial programme, Mrs. L. M. Cochrane with the "Special Categories", Dr. S. C. Roberts with the American Studies Conference and Dr. E. A. Ford with the Interchange of Teachers Programme. There are also the usual general appreciations of the work of the British scholars in America and of American scholars in Britain, this year by Dr. F. A. Young and Dr. A. L. Goodhart, respectively, followed by comments from selected lecturers, advanced research scholars, supervisors and graduate students. Besides a summary of awards since 1949, there are appended a directory of Fellows for 1949–54 and an analysis of fields of study and research during 1953–54.

Of the 674 awards in 1953–54, compared with 732 in 1952–53, 329 were to United States and 345 to British citizens, the 1952–53 figures being 349 and 383, respectively. Of those to United States citizens, twelve were to visiting lecturers to British universities, eighteen to advanced research scholars and 163 to graduate students; eleven awards were made in the special categories group; fourteen for visiting lecturers, research scholars, school teachers or graduate students in the British Colonial Territories, and a hundred travel grants were again made to primary and secondary school teachers for exchange under the Anglo-American Teacher Interchange, the remaining eleven awards being to lecturers for the American Studies Conference. The travel grants to British citizens likewise included one hundred to school teachers under the Anglo-American Teacher Interchange, seventy-eight to advanced research workers, visiting lecturers and teachers and 167 to graduate students. The anticipated 350 awards to United States citizens and 384 to British citizens in 1955–56 will bring the cumulative total since 1949 to 4,842. Analysed by fields of study and research, the subjects claiming most awards in 1953–54 were chemistry (26 British and 13 American), education (13 and 3), history (16 and 23), literature (16 and 44), mathematics (11 and 4), physics (12 and 6), medicine (20 and 2), engineering (23 British) and dentistry (12 British).

Originally, the prime concern was to place the scholars in the universities of the United Kingdom; but it was contemplated from the beginning that there should be a counterpart to the reception of American university teachers and students in British universities in the form of travel grants for British lecturers and students to go to the United States, and on both sides applications have always vastly exceeded the number of possible awards. Nevertheless, the Commission has not been prevented from branching out in new directions, and in her review Dame Lillian Penson stresses the particular value of the creation, as a result of Sir Christopher Warner's proposal, of a Special Citizens' section in the Commission's budget which has enabled the Commission to spend a part of its resources in effecting contact between such groups as social workers and extramural tutors. The grant towards the expenses of the teachers in secondary schools exchanging with one another under the scheme for teachers interchange is another development from the original programme, as is the grant made annually for the past three years towards the organization and maintenance of an American Studies Conference at either Oxford or Cambridge in late July or early August to discuss aspects of academic disciplines of interest on both sides of the Atlantic.

Dame Lillian, moreover, lays special stress on the gradual development during recent years of the Colonial programme, in which there is still room for further growth and experiment. The Colonies themselves have welcomed with enthusiasm the seconding to them of the American scholars, and Dame Lillian believes it would be difficult to exaggerate the importance, at this stage of evolution, of the presence of American scholars in these centres of research or teaching. Reviewing this programme in more detail, Sir Raymond Priestley notes that the Commission has now decided to increase to more than 25 per cent the 10–15 per cent of the annual budget expenditure previously devoted to this purpose. Reports made by the American visitors to the Colonies show how significantly these visits are serving the general aims of the Fulbright Programme in promoting international understanding; and although it is too early to assess the contributions to learning which have stemmed from the visits, it is not too early to record the indebtedness of Colonial institutions to the services rendered by their guests. The Royal University of Malta, for example, has profited greatly from the teaching in English literature and in history by a series of Fulbright professors. The administrative problems of the Colonial programme are well on the way to solution in view of the enthusiastic response from the Colonial schools and teacher-training colleges to the initiation in 1952–53 of grants for American school teachers to work in schools and training colleges in the Colonies, and the Commission has decided to use a substantial part of the increase in its Colonial budget for this purpose.

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* Fifth Annual Report of the Fulbright Program in the United Kingdom and Colonial Territories, 1949–1954. Pp. 184. (London: United States Educational Commission in the United Kingdom, 1955.)

Describing the Special Categories programme, Mrs. L. M. Cochrane outlines the reasons which led to the selection and visit of a social work survey team whose five members have covered the fields of delinquency (adult and juvenile offenders); family and child care; organization and administration of public services; group work and community organization; and health and rehabilitation. This visit was the outstanding event of 1954: the personal relationships established wherever the members of the team went were extremely successful, and the full written report was to be presented in 1955. The visit has already led to the suggestion that a similar team should survey adult and workers' education and that the Commission should sponsor research teams to visit British Colonial areas; in commenting generally on the British scholars in the United States, Dr. F. A. Young emphasizes that the special categories, broadly speaking, are an investment in adult education, both as a mean of cultural diffusion and as a form of social service which has generated a cluster of rapidly emerging professions including workers' education, social work, library service, museum technology and educational broadcasting. He points out that the visiting scholars in this section move outside the well-worn academic paths and are continuously discovering much that to them is new and exciting. They seem to be nearer to the everyday life of Britain and come closer to the heart of the United States. Accordingly they are in many ways more effective interpreters, promoting understanding where it is most needed, at the base rather than at the apex of our social structure. The large part they have played in the advancement of scholarship and international understanding, writes Dr. Young, is the basic achievement of the British scholar in America; and elsewhere in the report Prof. Una Ellis-Fermor expresses the view that the Commission has given timely help to young and promising scholars visiting Britain who will in all probability be among the leading university teachers of the future.

CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, HYDERABAD

REPORT FOR 1954

THE annual report for 1954* of the Central Laboratories for Scientific and Industrial Research, Hyderabad, the new buildings of which were formally opened by Pandit Nehru on January 2, 1954, includes the usual lists of papers published during the year and of staff. Two more pilot-plant buildings were due to be constructed in the following year. In the Oils Section, besides investigations on local bleaching earths, samples of triricinolein and sodium ricinoleate were prepared, as well as castor-oil-modified alkyds of 40 per cent, 50 per cent and 60 per cent oil length by the monoglyceride. Work on dehydrated castor oil included its utilization in the preparation of industrial finishes, while studies continued of the antioxidant properties of catechin in fats and oils and of factors affecting the refining of cottonseed oil. In the Entomology Section, work has proceeded on a number of lines: the pharmacological action of the portion of *A. squamosa* seed-oil insoluble in petroleum ether, using the frequency of the isolated heart of the cockroach; the insecticidal properties of chlorinated turpentine against *B. chinensis* and *T. castanium*; the anti-oxidant properties of catechin against pyrethrum; and the insecticidal properties and spreading pressure of various indigenous oils. The Fibre and Paper Section has been occupied chiefly in putting the pilot-plant project for making hand-made paper on a regular production footing, and the report of the Laboratories is printed on hand-made paper produced by the Section. A comparative study of different types of paper led to improvements in the quality of several types produced by the Section.

The Fuel Section continued its work on the briquetting and the low-temperature carbonization of non-caking Indian coals and on the products of low-temperature carbonization, and its systematic survey of the coalfields of Hyderabad State. In the Heavy Chemicals and Fertilizers Section the utilization of felspar and iron pyrites received further attention, as well as the production of sulphur dioxide from gypsum, while preliminary work was carried out on the preparation of hydrazine hydrate; studies continued in phosphate fertilizers and the preparation of active carbon from vegetable waste materials and from a low-temperature coke. The systematic study of Hyderabad clays continued in the Ceramic Section, and in the Organic Chemistry, Pharmaceuticals and Drugs Section, besides work on Indian turpentine, eucalyptus oil and alkaloids from *Strychnos nux-vomica*, investigations proceeded on the preparation of compounds with œstrogenic activity and of insecticides from phenol and its ether. A number of quinazolines have been condensed with magnesium phenyl bromide to give 3 : 1 : 4-benzoxazines, and some of them were being examined further for hypnotic action. The synthesis of the analgesic, methyl dihydromorphinone (metopon), was being continued on a larger scale.

In the Biochemistry Section the yield of citric acid by fermentation of molasses has been increased by supplements of 0·5–2 per cent of methyl or ethyl alcohol, and further work on the itaconic acid fermentation has confirmed that glycolysis is the initial sequence from sucrose and that the presence of arsenite induces the mould to accumulate keto acid. The oxidation of glucose to gluconic and 2-keto-gluconic acids by *Pseudomonas fluorescens* was studied in greater detail, and an exhaustive examination made of the amino-acids of the protein from the seed-cake *Annona squamosa*. X-ray studies of Indian clays were continued, and in the Physical Chemistry Section the conductivity of sulphuric, nitric and hydrochloric acids in binary mixtures of methyl or ethyl alcohol, acetone, and dioxan with water was determined. Pilot-plant work in the Chemical Engineering Section included the pretreatment of cotton seed, the preparation of dehydrated castor oil and the fractionation of fusil oil on the 'Quickfit' all-glass vacuum distillation unit, while the Section also continued to study the solvent extraction of oil cake and the condensation of saturated vapours. The Operational Research Section examined the possibilities of utilizing pectin in the fruit-preserving industry and the utilization of amosite asbestos fibre for asbestos cement sheets.

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* Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1954. Pp. xvii+64. (Hyderabad-Deccan: Central Laboratories for Scientific and Industrial Research, 1955.)

COMPRESSED AIR HYGROMETER FOR MEASURING FROST POINT IN THE STRATOSPHERE

THE most satisfactory method of measuring the water vapour content of air in the stratosphere, where the frost point is −75° C. (−103° F.) or less, is to determine the frost point with the Dobson–Brewer frost-point hygrometer carried in an aircraft. In this apparatus the water vapour in the air is condensed as ice on the outside of a thimble cooled internally by cold petrol (cooled by a mixture of petrol and solid carbon dioxide) or by liquid air. The observer adjusts the rate of flow of the cooling liquid and notes the temperatures at which the ice deposit increases and decreases. The mean of these two temperatures is taken as the frost point; there may be an interval of 5–10 deg. C. between them. As the frost point is reduced, the ice deposit becomes thin and more difficult to see and, finally, at frost points below −85° C. (−121° F.) the ice becomes glassy and cannot be seen at all without special optical aid.

Dr. A. W. Brewer (Clarendon Laboratory, Oxford) suggested that the effective range of the instrument could be effectively increased by compressing the incoming air before it reached the hygrometer. Compression raises the frost point, as can be seen from the fact that the humidity mixing-ratio (grams water vapour per kilogram of dry air) is unchanged by the compression. The mixing ratio at the low vapour pressures concerned is proportional to e/p, where e is the vapour pressure and p the air pressure. The ratio e/p is constant in compression so that a ten-fold increase in pressure increases the vapour pressure in the same ratio. This produces an important increase in frost point. Thus, if air with a frost point of −85° C. at the pressure of 115 mb. prevailing at about 50,000 ft. is compressed to 1,014 mb., the mean air pressure at sea-level, its vapour pressure is increased from $23 \cdot 53 \times 10^{-5}$ mb. to $2 \cdot 0757 \times 10^{-3}$ mb. and its frost point correspondingly increased to −71·5° C. (−96·7° F.). A frost point of about −70° C. is much more easily measurable than one of −85° C.

Mr. P. Goldsmith (Meteorological Research Flight of the Meteorological Office) has proposed (*Quart J. Roy. Met. Soc.*, October 1955, p. 607) the use of the engine compressor of a jet aircraft as the source of compressed air. The system has been used on both Ashton and Canberra aircraft, and satisfactory agreement obtained with frost points measured by the normal method. The compressor provides air compressed to a pressure of six to eight times the external air pressure. Goldsmith's article describes in detail the working of the apparatus.

Using this instrument, thirty-five ascents were made from South Farnborough by the Meteorological Research Flight during 1954 to measure frost point in the stratosphere at heights up to 50,000 ft., and the results are given in a paper by R. J. Murgatroyd, P. Goldsmith and W. E. H. Hollings (*Quart. J. Roy. Met. Soc.*, October 1955, p. 533). The compressed air was used above 30,000 ft.; at lower altitudes there is a danger that the high pressure and temperature of the compressed air would damage the hygrometer. They found the frost point decreased steadily with height through the troposphere and that there was usually no change in the rate of fall at the tropopause. In the stratosphere the rate of decrease of frost point decreased with height, and sometimes there was a discontinuity of the rate of fall a few thousand feet above the tropopause. At heights of 10,000 ft. to 15,000 ft. above the tropopause the frost point became almost constant at a value of −82° C. (−115·6° F.) to −85° C. The value was the same in summer and winter. The air here is very dry, having a relative humidity with respect to an ice surface of only 1 per cent. The humidity of the stratosphere is important in the study of the flux of long-wave radiation and of the large-scale circulation of the atmosphere. It is believed that such low humidities are only explicable on the supposition that the air has come from the equatorial stratosphere, being warmed as it does so.

WELDING OF ALUMINIUM AND ITS ALLOYS

THE welding of many commercial aluminium alloys is rendered difficult as a result of their tendency to crack at temperatures above the solidus, or in other cases at much lower temperatures during the cooling of the weld. In 1944 the light-alloy industry initiated a comprehensive series of researches on this problem at the University of Birmingham, the investigations being started under the supervision of the late Prof. D. Hanson and continued under Prof. L. Aitchison. The Aluminium Development Association, in its Research Report No. 27*, has now published a summary of the work of this research team during 1944–50. This quite admirable publication, prepared by Dr. W. I. Pumphrey, a former leader of the team, summarizes the principal investigations and conclusions of the twenty-six papers which have been published.

It was first necessary to develop a hypothesis to explain the high-temperature cracking, and it was shown that on heating to the solidus temperature the ductility fell to zero and the strength dropped rapidly but did not disappear entirely until some higher temperature, still below the liquidus, had been attained. This latter fact was found to be of prime importance, and the temperature above the solidus at which the strength finally disappears emerged as a major factor in the elucidation of the problem.

The development of tests to reveal the susceptibility to both high- and low-temperature forms of cracking was essential to the continuation of this work, and such tests, applicable not only to welds but also to castings, have been developed and are described. The low-temperature form of the defect is connected with the ductility of the material and, in particular, with the nature and mode of occurrence of the brittle intermetallic compounds. Where the weld is under conditions of severe restraint, the presence of these compounds in an intercrystalline form is clearly a source of great weakness.

The other main objective of the work was the development of alloys with good welding and mechanical properties, and three series—the aluminium–copper–silicon alloys, those of aluminium with zinc and magnesium and those with zinc, magnesium and copper—are specifically considered. The tests devised permit the materials to be given at any rate a quasi-quantitative value, and, from this, cracking diagrams have been drawn up for a number of binary and ternary alloys together with the quaternary aluminium–copper–magnesium–silicon and aluminium–magnesium–silicon–manganese alloys; in one case, aluminium – zinc – magnesium – copper – manganese, a start has been made on a quinary series.

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* Aluminium Development Association. Research Report No. 27: Research into the Welding of Aluminium and its Alloys: a Summary of the Work of the A.D.A. Welding Research Team at the University of Birmingham, 1944 to 1950. Prepared by Dr. W. I. Pumphrey. Pp. 60. (London: Aluminium Development Association, 1955.) *7s. 6d.*

The work has most clearly justified the time and money expended on it, and this publication provides a first-rate summary of the results which have been obtained.

F. C. THOMPSON

A RARE *CRYPTOMERIA*

YAKU-SHIMA, an island about thirty-seven miles off Kyushu, Japan, and covering approximately 190 square miles, is famed for the forests that cover its steep mountain-sides and for its abundant wildlife, especially deer and monkeys. The really unique and outstanding feature of the island, however, is the *Cryptomeria japonica* or 'Yaku-sugi' trees that are found there. These can be compared with the world's most spectacular trees, both because of their size—they grow to 16½ ft. in diameter and 117 ft. high—and their age, which is calculated to be between 1,000 and 3,000 years old. Their classification in systematic botany is not clear, although they are believed to be the ancestors of the Japanese species of *Cryptomeria*, in spite of differing from them both morphologically and ecologically. At one time there seems to have been a mysterious gap in the species' ecology, due either to its requirements or the conditions it was subjected to, as no trees are to be found between four hundred and eight hundred years old; they are all either older or younger. The Yaku-Shima virgin forests are of great interest, for the Yaku-sugi trees grow there along with firs, hemlock and Yamagurumas (*Trochodendron aralioides*, Sieb. et Zuce), and fill the island's valleys with tall trees decorated with intertwining epiphytic and parasitic plants.

At present, negotiations are going on between the Forestry Agency of the Ministry of Agriculture and Forestry and the National Park Division of the Ministry of Welfare to see whether the area should be designated as a national park. It would be a tragedy if the island's beauty were not perpetuated for future generations, and the International Union for the Protection of Nature has offered all possible help to its member, the National Parks Association of Japan, which in its turn is supporting the National Park Division's project (*Bull. Inter. Union Protect. Nature*, **4**, Nos. 5 and 6; December 1955).

WEATHER AND THE LAND

DURING the early years of his period of office the late Sir Nelson Johnson, director of the meteorological Office during 1938–53, realized that much greater assistance could and should be given by the Office to the economic life of Great Britain. One of his major decisions in this respect was the establishment in 1947 of the Agricultural Meteorological Section of the Climatology Branch, the Section becoming in 1948 the Agricultural Branch of the Office under the assistant director for climatology. Since then the Branch has developed its activities very widely. Besides the Branch office at the headquarters of the Meteorological Office, there are now meteorological advisers at the offices in Bristol and Cambridge of the National Advisory Service for Agriculture, and a meteorologist has recently been posted to the Meteorological Office, Edinburgh, for similar duties in Scotland.

A pamphlet written by the staff of the Branch* explains to the farmer the 'why and how' of his meteorological problems, how meteorologists can help to solve the problems, and how best to use the forecasts prepared at the Central Forecast Office and broadcast by the B.B.C.

The first chapter describes the general climate of the British Isles with special reference to plant growth, and the second gives the local variations in climate associated with altitude, aspect, and the nature of the soil and its covering. The third chapter explains the meteorological aspects of methods available for using solar radiation more efficiently by means of glasshouses and cloches, and methods such as shelterbelts and irrigation, of mitigating unfavourable meteorological effects. After this is a chapter describing the structure of depressions and the use of cloud forms and other portents of weather in interpreting the broadcast forecasts and applying them to local conditions. Finally, the fifth chapter gives the times of and areas used in the broadcast forecasts, lists the local meteorological offices from which forecasts can be obtained by telephone and the various special forecast services such as spell warnings which are available, defines terms used in weather forecasts, and states how the farmer can obtain advice (from headquarters, or from the meteorological offices attached to the National Advisory Service or to the Edinburgh Meteorological Office) on making the best use of his land.

The pamphlet gives a general compendium of meteorological knowledge as applied to agriculture in all its aspects and is of very great value to all agriculturists, while the parts on the use of the broadcast forecasts would be of much value to those whose business or pleasure is affected by the weather. Chapter 4 could well be used in schools for teaching the use of weather forecasts.

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* Bulletin No. 165 of the Ministry of Agriculture, Fisheries and Food: Weather and the Land. Pp. iv+35+4 plates. (London: H.M.S.O., 1955.) 3s. net.

EMPLOYMENT STATISTICS FOR RECENT BRITISH GRADUATES

A RECENT broadsheet on "Graduates' Jobs", issued by Political and Economic Planning (No. 387), summarizes the results of an inquiry into the careers of 3,961 men who graduated in Great Britain in 1950. Returns were received from some 30 per cent of these, and it is unlikely that there is any main source of bias in the sample; more than half graduated in arts, more than a quarter in science, and less than one-fifth in technology. Many were older than the normal run of graduates, and most had seen war service or had done national service before going to a university. More than half had married by October 1954, and 20 per cent had married in the year they graduated or earlier.

Much the largest entries were into industry and teaching (both 23·4 per cent), mathematics and science teaching claiming 6·7 per cent, while 33 per cent of arts graduates became teachers as compared with 19·9 per cent of science graduates. The Civil Service took 8·6 per cent, 5·5 per cent (or 15·7 per cent of the science graduates and 3·9 per cent of those in technology) going into the Scientific Civil Service; 7·5 per cent went into commerce, 4·2 per cent into the universities, 4·1 per cent took up law, and 3·6 per cent went into local government service, including 8·3 per cent of the technologists. Of the technologists, 45·4 per cent went into manufacturing industry, 8·8 per cent into building, contracting and civil engineering, 6·5 per cent became consultant engineers and 6·1 per cent entered public utilities.

Industry claimed the highest proportion (23·7 per cent) of first-class honours graduates as well as second-class honours men (20·8 per cent) and 26·4 per cent of others, but over the past four years lost about 10 per cent of its entrants; the Scientific Civil Service claimed 11·0 per cent of first-class honours men and 5·5 per cent of those with second-class honours. Since 1950 it has lost 7 per cent of its intake. The universities, however, which claimed 17·8 per cent of first-class honours men, increased their share of graduates by nearly 4 per cent, whereas school teaching, which by contrast only attracted 2·8 per cent of first-class honours men in mathematics and science, 4·6 per cent of second-class honours men and 10·3 per cent of others (the corresponding figures for arts men being 6·5, 20·6 and 15·2) lost 7 per cent of its original entrants.

Commerce lost 25 per cent of the graduates who started in it; but in general there was a high degree of stability in occupation. Figures for the research associations, which took 2·9 per cent of the science graduates (as compared with 6·0 per cent for the universities) or 1·4 per cent of first-class and 1·7 per cent of second-class honours men, do not suggest that they absorb as yet any considerable proportion of the country's scientific man-power, but rather that their influence may be out of proportion to the numbers, like that of the universities, owing to the high quality.

ENGINEERING RESEARCH IN THE IMPERIAL COLLEGE, LONDON

THE report on research work in the City and Guilds College, 1952–55*, which represents engineering within the Imperial College of Science and Technology, London, where the number of engineering students now exceeds a thousand, appears appropriately when the expansion of the College is being widely discussed in relation to the need for engineers in Britain. Intended for the non-specialist and arranged in six sections, the report gives a readable and illustrated account of the many-sided contribution to national welfare and industrial advance which is already coming from the Departments of Aeronautics, Chemical, Civil, Electrical and Mechanical Engineering and Mathematics. In supersonics, while much effort has gone to the design of the new supersonic wind tunnel for the Roderic Hill Building, some theoretical work has been done on the pressures and forces acting on aircraft fuselages as they move through the air at supersonic speeds; detailed measurements are being made in a 5 ft. × 1 ft. wind tunnel on a jet ejected normal to a stream to determine how and why the jet turns along wind. General methods of analysis of aircraft structures have been developed, including the effects of non-linear elastic behaviour of materials and initial strains which arise with non-uniform heating of a structure. A systematic programme of tests over the past two years on riveted and redux-bonded joints indicates that the glued joints have better fatigue properties than their riveted equivalents, and that alloys of high static strength currently used in aircraft structures may be inferior under repeated loadings, particularly in regions of high-stress concentrations, such as joints, to the lower-strength alloys.

In chemical engineering, in connexion with the design of plant for purifying and liquefying natural gas on a large scale, the physical properties of the gas mixtures present are being further investigated, and an experimental plant has been erected for studying the distillation of liquid air. Problems of mass-transfer in solid–gas, solid–liquid, gas–liquid, and liquid–liquid systems, the drying characteristics of solids, the sedimentation of concentrated suspensions of particles in a liquid, fluidization of particles by means of an upward current of liquid, and transport by means of a gas or liquid are also being investigated, and an apparatus has been set up for studying both the sublimation of pure solids and the technical process of freeze-drying. The growth of an organic crystal from the melt has been investigated by a method in which the growth of individual faces is measured directly with a travelling microscope. The compressibilities of mixtures of steam and carbon dioxide have been measured up to 100 atmospheres and 650° C. In the high-speed fluid kinetics laboratory, the high-pressure supersonic flow through nozzles and the design of such nozzles for hot and cold gases are being studied, as well as the formation and disintegration of jets and sheets and the design of nozzles for atomization. Methods for concentrating low-grade iron ores have been examined, and an experimental technique has been designed for subjecting typical blast-furnace charges to the conditions they would encounter in descending the furnace. Other researches have been concerned with the basic chemical physics of gases and vapours, the melting of crystals containing organic molecules, mechanical wear and lubrication, the abrasion of copper and iron surfaces, flame spectroscopy and the accurate and detailed analysis of the peroxides, aldehydes, ketones, olefins and other intermediate products in the oxidation of hydrocarbons; and a fruitful study has been made of engine crank-case explosions.

In civil engineering, in connexion with the design of a large arch dam to be constructed at Dokan, Iraq, on a tributary of the Tigris, the elastic equations governing the stress distribution have for the first time been solved numerically, and the work assisted and confirmed by experimental methods using a material which has only recently become available. Work on thin-walled rectangular box girders conducted for the British Shipbuilding Research Association confirmed that introduction of expansion joints is a practice to be avoided. The Department has also fostered the application of simplified models to the analysis of building frames. Much work has been done on the fundamental strength and deformation characteristics of both reinforced and pre-stressed concrete framework members. Experiments on curved channels have yielded far-reaching results, and definite progress has been made in studying the movement of sediment along a river bed. Of particular interest are the work on the action of wind on a water surface, bearing directly on the North Sea floods of 1953, and the construction in the laboratory of a model of the Lynmouth valley with which a relation was established between the quantities of water flowing through the model and the corresponding water-levels. The resulting estimate of the flood was used by the engineer advising on the reconstruction of the damaged parts of Lynmouth. Further investigation of spillways, the fundamental and practical aspects of the shear strength of soils, the stability of earth dams and of clay slopes in railway, road and canal cuttings, the settlement of buildings, the sedimentation of water or sewage, the filtration of water through sand, and a continuing physical, chemical and biological study of new impounding reservoirs are other subjects in which the investigations of the Department directly impinge on public health or safety.

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* Imperial College of Science and Technology (University of London). Report on research work in the City and Guilds College, 1952–55. Pp. ii+61. (London: Imperial College of Science and Technology, 1955.)

In the Department of Electrical Engineering, studies have been made of the effect of eddy currents in unlaminated materials in electrical machines, of cross-magnetization on the characteristics of a cross-field generator and of saturation and armature reaction on the building-up curve of a d.c. exciter supplying the field-winding of an alternator. Studies in the Power Systems and Computer Laboratories of physical phenomena arising in the transmission and utilization of electrical energy have involved the development of special measuring equipment. Other work has concerned the improvement of methods available for carrying out the numerical calculations required in engineering design and research. Special efforts have been made to develop and extend the statistical methods of control design. The Department has also engaged in research on human perception, especially speech and hearing, as well as various circuit applications of transistors, the distortion of microwaves resulting from the presence of dielectric and conducting cylinders and the determination of the reflexion coefficient of a set of parallel plates similar in form to those used in constructing lens aerials. Work in the Ultrasonics Laboratory is concerned with the behaviour of solids, liquids and gases under the influence of ultrasonic waves of varying frequency. The application of the so-called corona effect of high voltage in dry air has also been studied.

Researches in heat transfer in the Department of Mechanical Engineering have been concerned with the utilization of low-grade heat, with marine condenser tubes, with thermal stresses in steam turbine rotors, and heat transfer to gas turbine blades, as well as with heat transfer from a rotating disk. Other investigations have been concerned with combustion in reciprocating engines, the vibration of propagating flames, combustion in gas turbines and the use of the gas turbine for chemical reactions such as the cracking of methane to acetylene. A theoretical study has been completed of the stresses in and flexibilities of curved pipes, and the axial compression of six expansion bellows of three different types has been examined experimentally by electrical resistance strain-gauge surveys. Some plane strain processes are being examined to determine the region over which plane strain conditions apply, and to establish means for obtaining basic stress–strain curves for metals at deformations much greater than those attainable in the standard tensile test. A programme of research in photoelasticity is concerned with the possible extension of the method to the examination of materials which have been plastically deformed, and under another programme the failure of materials under relatively few cycles of high stress-intensity is being examined with the view of obtaining fundamental knowledge on fatigue as well as design data. Besides the study of the troublesome vibration known as 'oil-whirl' and thin-film lubrication, a vibrational method is being developed for the fatigue testing of metals; and an apparatus has been built for vibrating cantilevers of various shapes in several modes of bending and torsion.

In the Department of Mathematics, a major investigation was concerned with the design of an arch dam, and others with the numerical solution for the flow of a viscous fluid past fixed obstacles, and the temperature distribution in two conductors sliding over one another and generating heat by friction over their area of contact.

SPIRAL PATTERNING OF SOLAR CORPUSCULAR PRECIPITATION

By E. R. HOPE
Defence Research Board of Canada, Ottawa

THE plots of radio blackout distribution in the North American and North Atlantic region, as published by V. Agy[1] and J. H. Meek[2], agree with the isochrons of the 'morning' maximum of magnetic disturbance in the Arctic region, as found by (anonymous) Soviet research[3,4]. Fig. 1 (from ref. 3) shows these isochrons (geographical loci of simultaneous occurrence), which may be explained by a diurnally rotating spiral of solar corpuscular precipitation. Fig. 2 reproduces Agy's Figs. 5 and 6 [1].

To interpret Agy's and Meek's local-time plots, which show peculiar southward lobes centred at about long. 90° W. (as in the right-hand side of Fig. 2), W. R. Piggott[5] tried plotting in G.M.T. the longitudes where the maximum rate of occurrence of blackout (storm-D ionization) is found. This plot, extending over the Atlantic-Canada sector only, showed an apparent east-to-west rotation-period of 48 hr., on which basis Piggott suggested that there must be two D-region activity centres, separated by 180° of longitude, and rotating around the pole once in two days. Agy[1] then tried changing his local-time plot (Fig. 2, right) to a G.M.T. plot. This eliminated the lobes and clearly displayed the apparent 180° rotation in 24 hr. (Fig. 2, left).

Table 1 shows the G.M.T. isochrons in Fig. 1 and Fig. 2 (left), with the longitudes where they cross the circle of latitude 60° N.

Allowing for the fact that Agy's plot is for the summer season only, while the Russian data are probably for the whole year, the agreement of isochrons 00–14 is excellent. The directions of these isochrons also correspond rather well, as may be judged by visual comparison.

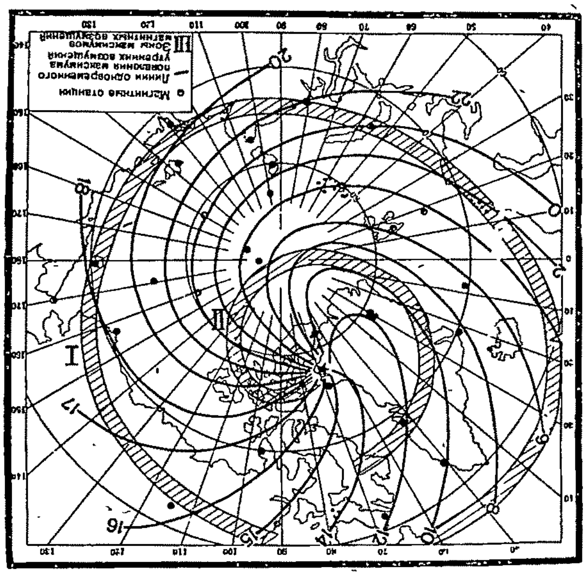

Fig. 1. Isochrons of morning maximum of magnetic disturbance (the figures attached to the isochrons represent world time). ●, Magnetic stations; —, isochrons of maximum of morning disturbance; I and II, maximum zones of magnetic disturbance. The figure, which is taken from ref. 3, is inverted to facilitate comparison with Fig. 2

We conclude that Agy's G.M.T. isochrons 00–14 are low-latitude continuations of the Soviet isochrons. (The disturbance-spiral, on magnetically disturbed days only, may extend its effects far southward; its passage appears to be detectable in the earth-currents at Tucson. See translator's comments to ref. 6.)

One is impressed by the complete independence of the work and data in the two cases. Soviet isochrons: diurnal maximum of magnetic disturbance (probably based on amplitude of magnetic variation); Agy's isochrons: maximum of fundamental Fourier harmonic of diurnal variation of *F*-layer blackout probability (*D*-layer or *E*-layer absorption).

A fact of capital interest is that west of isochron 14 the agreement abruptly disappears. Yet the northern parts of the isochrons (14, 16, 18) still agree, in both position and direction. Above 70° N., this is true even of isochrons 20, 22, 00. On Fig. 2 (left), a smoothly curving line may be drawn, beyond which the Soviet isochrons seem to disappear suddenly under a different set of north–south contours (cf. ref. 4, pp. 19, 23, "axis maximum" and its times). It will be interesting to pencil in, on the charts, the position of the great Arctic magneti anomaly[3], and to compare it with the sharp bend in Agy's isochrons.

Table 1

Isochron	Crosses 60° N. at longitude: (Agy, Fig. 2)	(U.S.S.R., Fig. 1)
G.M.T. 00	15 E.	10 E.
02	0	5 W.
04	20 W.	15
06	35	27
08	45	41
10	60	57
12	75	69
14	95	83
15	—	100
16	115	115
17	—	170 (extrapolated)
18	—	120 E. (extrapolated)
20	160 W.	60 E
22	167 W.	25 E.
00	175 W.	10 E.

Now the non-uniform rotation (Fig. 1) of th disturbance-spiral accounts precisely for Piggott' apparent 48-hr. period. Between isochrons 00 an 12 in the Atlantic sector, it will be seen that th spiral is rotating just half as fast as the sun.

Farther west, the accelerated rotation (Fig. 1) mus enfeeble the disturbance effect by spreading it over larger area. This would help the disappearance of th Soviet isochrons under what we suppose to be the independent contours in the Bering Sea area (ref. 4, p. 21

Whereas the G.M.T. plot shows actual momentar positions of the disturbance wave, the local-time plo only shows synchronic relationships along eac meridian separately. In Fig. 2 (right), the northwar progression of the local-time isochrons is due to th rotation of the disturbance-spiral, for along any give meridian the motion of the spiral is poleward. Th 'lobe' shape, a kind of artefact, is produced as follow In the eastern half of the lobe the sun is gaining o the spiral; if the observer moves from meridian t meridian at the sun's speed (as in this plot), he see the spiral in this region turning backward, west t east, and its arm moving south. The bottom of th lobe marks the point where the speeds of the sun an the spiral are about equal. After this, the spiral gain on the sun, and appears to move north along th meridian.

What the local-time plot provides is a graphica comparison of velocities. From the uniform orientation (toward 90° W.) of the contours in the lobe, an their uniform spacing, we see that different segment of the disturbance wave are rotating at differen velocities (that is, the spiral is progressively deformed and that the rotation-velocity of each segmen depends only, or mainly, on longitude.

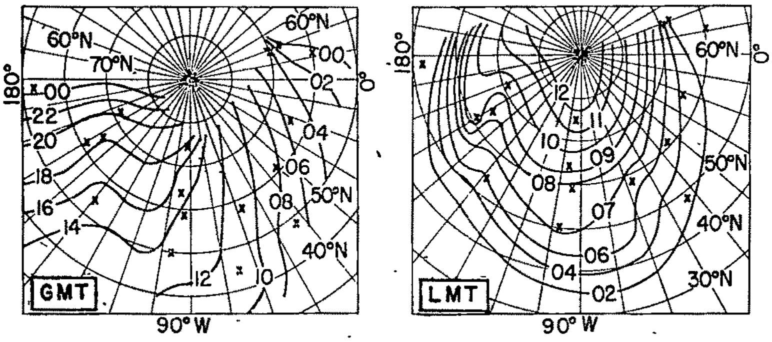

Fig. 2. Time of maximum percentage of time of blackout φ_i during summer (from Vaughan Agy, ref. 1)

I am grateful to Dr. Vaughan Agy for permissio to reproduce Fig. 2, and to the Canadian Defenc Research Board for authorizing publication of thi communication. [Oct. 22

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Immunological Methods in Plant Taxonomy

THE application of immunological analysis to plant taxonomy has been made practicable by the development of gel-diffusion methods, both by the Elek–Ouchterlony technique[1] and by the more recent immuno-electrophoretic technique of Grabar and Williams[2]. By these means the individual proteins in plant extracts may be differentiated and the extracts compared component by component with those from related species. We have applied a modification of these general methods to the investigation of the genus *Solanum*, with particular reference to the inter-relationships of certain Mexican species of potato, and the comparison of these with *S. tuberosum*, the domestic potato.

Thin slices of tuber of each species were soaked in sodium hydrosulphite (0·7 per cent solution) for 30 min., rinsed in distilled water and the sap expressed by crushing the slices, supported within folded strips of moist calico, through stainless steel rollers. Antisera were raised in rabbits to crude saps from *S. tuberosum* and *S. ehrenbergii* (a Mexican species), using a combination of Freund's adjuvant technique[3] with courses of intravenous injections. Agar containing veronal buffer (*p*H 8·5) was poured to a depth of 2 mm. on lantern slides in 'Perspex' frames; in the agar, holes were cut with a cork-borer to hold the tuber extracts to be compared, and a trough at a distance of 1 cm. to hold the antiserum. The reagents were allowed to diffuse towards one another and lines of precipitate formed, each line corresponding to an antigen–antibody system. Where lines from different extracts joined end to end they were assumed to belong to identical or cross-reacting proteins. In some cases a much improved separation of the lines was obtained by subjecting the antigen to a short (4-hr.) electrophoresis before adding the antiserum (Fig. 1).

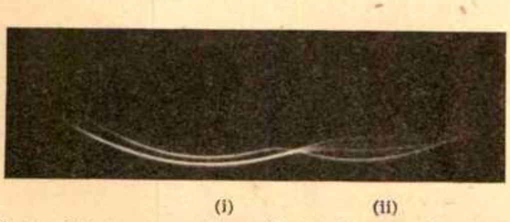
(i) (ii)

Fig. 1. *S. tuberosum* reacting with homologous antiserum. (i) Without electrophoresis the antigen shows only two lines of precipitate; (ii) with electrophoresis, one of the lines has been split into three, and their relative positions changed

With both antisera, well-marked cross-reactions occurred between all the forty species examined; but by comparison of the 'line spectra' and by cross-absorptions of the antisera, it was possible to divide the species into well-defined groups.

By using *S. tuberosum* antiserum, the fourteen Mexican species were separated into three divisions (Fig. 2*a*) and then by the use of the antiserum against *S. ehrenbergii* two of these could be further subdivided, giving a total of five groups (Fig. 2*b*). Each group, with the exception of one, corresponded to a particular taxonomic series according to the classification proposed by Hawkes[4]; the one exception (Group 4) contained species from two series. The taxonomic series corresponding to the groups mentioned here are as follows: Group 1. Series *Morelliformia*. Group 2: Series *Pinnatisecta*. Group 3: Series *Cardiophylla*. Group 4: Series *Demissa*, and *Longipedicellata*; *S. tuberosum* and other South American species. Group 5: Series *Bulbocastana*.

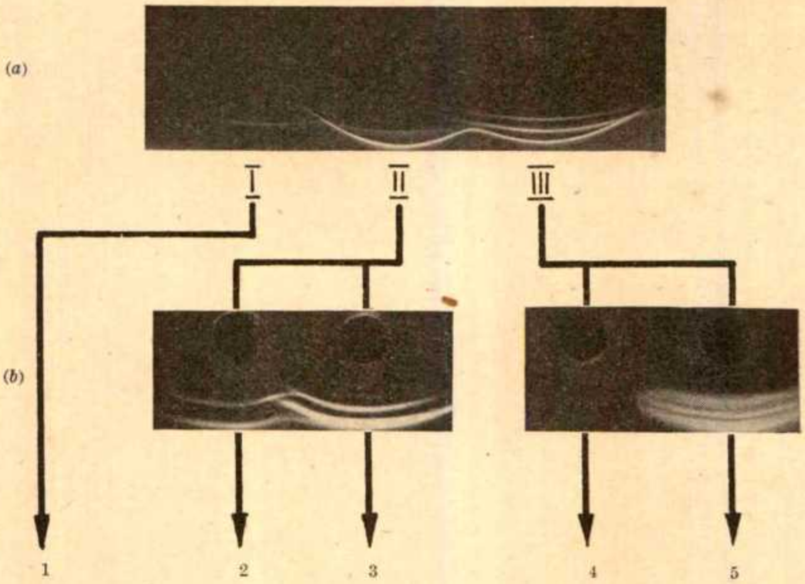

Fig. 2. (*a*) Separation of the species into three divisions with *S. tuberosum* antiserum. (*b*) The splitting of group II into two by means of unabsorbed *S. ehrenbergii* antiserum and of group III into two by means of the same antiserum absorbed with *S. tuberosum* extract

These results will be published in detail elsewhere. The work is being carried out mainly under a grant from the Nuffield Foundation.

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Effects of Single and Fractionated Doses of X-Rays on Mouse Embryos

THAT embryonic tissues *in vitro* may be affected more drastically by fractionated, than by single, doses of X-rays was shown by Spear in 1932 [1]. Working with chick embryo fibroblasts, he demonstrated that the depression of activity of these cells is far greater with two 2½-min. exposures separated by 80 min. than with a single 5-min. exposure. In view of the possible significance of these findings for our understanding of the nature of embryonic damage resulting from X-irradiation, and in view of the general interest in the question of radiation hazards to the developing mammalian embryo, the present experiment was designed to determine whether there is a difference between the effects of single and fractionated doses of X-rays on developing mouse embryos *in vivo*.

Strain-101 female mice were mated to strain-*C3H* males and irradiated with X-rays (250 kVp., 15 m.amp., 3 mm. aluminium, half-value level 0·4 mm. copper, 80 r./min.) 9½ days after the appearance of copulation plugs. Irradiation was administered either as a single dose of 300 r. or as three 100 r. fractions at 30-min. intervals. Embryos were obtained by dissection three to six days after irradiation. The majority of dissections were made on coded animals. The criteria used were lumbo-sacral spina bifida and coloboma of the eye, two abnormalities which, following irradiation on day 9½, are produced with high frequency[2] and are easy to classify accurately by gross inspection. The lumbo-sacral region was scored for length of antero-posterior axis affected ; each eye was scored separately for extent of pigment defect.

The two criteria represent strikingly different developmental disturbances. The lumbo-sacral damage consists of a disorientation of the neural tube and somites, resulting in neural arch malformation ; the eye defect represents an altered differentiation of optic cup elements, resulting in the presence of retinal sensory cells in areas normally consisting of pigment epithelium (unpublished results).

The results of single and fractionated doses of X-rays are compared in Table 1. While the incidence of malformation is not affected by fractionation, the severity of embryonic defects is far greater in response to a fractionated dose than in response to a single dose. A striking parallel can be seen between the relative effects of these two methods of irradiation on the lumbo-sacral axis and on eye pigmentation.

It would be premature to speculate on the nature of the processes responsible for the differential effect of single and fractionated irradiation on development. However, from the point of view of developmental mechanics[3], any interpretation of the nature of embryonic damage in response to X-irradiation must consider the present results, namely, that in the two widely differing embryonic systems so far studied, fractionation is more effective than a single dose, and the degree of increase in effectiveness is similar in the two systems. From the point of view of radiological practice[4], the demonstration that short-interval fractionation can increase the radiation hazard to developing embryos *in vivo* adds yet another factor calling for caution.

Table 1. COMPARISON OF THE EFFECTS OF SINGLE AND FRACTIONATED DOSES OF X-RAYS ON DEVELOPING MOUSE EMBRYOS

	Lumbo-sacral region				Eye pigment formation			
	300 r. single dose		300 r. fractionated dose		300 r. single dose		300 r. fractionated dose	
		(per cent)		(per cent)		(per cent)		(per cent)
Normal	12	11·4	12	15·0	33	15·7	22	13·8
Mildly abnormal*	90	85·7	17	21·3	158	75·2	29	18·1
Severely abnormal†	3	2·9	51	63·8	19	9·0	109	68·1
Total	105		80		210		160	

* Includes all embryos in which the extent of abnormality (measured in mm. of lumbo-sacral axis and percentage of eye surface) is less than half that found in the most abnormal embryo.

† Includes all embryos in which the extent of abnormality is at least half that found in the most abnormal embryo.

This work was carried out under contract *W*-7405-*eng*-26 for the Atomic Energy Commission.

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A Requirement for Catalase in Tyrosine Metabolism : the Oxidation of *p*-Hydroxyphenylpyruvic Acid to Homogentisic Acid

IN this communication evidence is presented that catalase is required in one of the steps of tyrosine metabolism, namely, the conversion of *p*-hydroxyphenylpyruvic acid to homogentisic acid. This oxidation requires two protein fractions which have been separated and partially purified from dog liver by treatment with organic solvents followed by fractionation with ammonium sulphate[1]. Fraction *A* is precipitated by 0·40–0·55 saturated ammonium sulphate ; fraction *B* by 0·60–0·75 saturated ammonium sulphate.

In studies to establish the function of the two protein components, it was observed that fraction *A* contained appreciable amounts of catalase and that the activity of this fraction was proportional to its catalase content. Further experiments showed that fraction *A* could be replaced by purified catalase obtained from beef or rat liver (Table 1). The product formed from *p*-hydroxyphenylpyruvic acid with fractions *A* plus *B* or with catalase plus fraction *B* was identified as homogentisic acid by chemical analysis and by paper chromatography with methods previously described[2]. Catalase appears to be specifically required in this oxidation, and could not be replaced by ferritin, hæmoglobin or cytochrome *c*.

Various amounts of catalase were added to constant amounts of fraction *B* (sufficient in the presence of excess catalase to oxidize 5 µmoles of substrate in one hour) to study the effect of catalase on the reaction. When catalase was present in limiting amounts, the rate of reaction, as measured by oxygen uptake, was proportional to the amount of catalase added. 5γ of catalase was sufficient to give about one-half the maximal rate and 1γ produced significant activity. However, at least 30γ of catalase was required to give the maximal reaction-rate. The low activity observed when fraction *B* was tested alone

Table 1. EFFECT OF VARIOUS CATALASE PREPARATIONS ON THE OXIDATION OF *p*-HYDROXYPHENYLPYRUVIC ACID TO HOMOGENTISIC ACID

Incubation conditions: The main compartment of the Warburg vessels contained 1·0 ml. of 0·2 *M* phosphate buffer, *p*H 6·5, 20 μmoles of neutralized glutathione, 100γ of 2,6-dichlorophenolindophenol, the enzyme preparations described below and water to make a total volume of 2·0 ml. The side-arm held 5 μmoles of *p*-hydroxyphenylpyruvic acid in 0·5 ml. of 0·2 *M* phosphate buffer, *p*H 6·5, or buffer alone in the control flasks. The centre well contained 0·2 ml. of 20 per cent potassium hydroxide. Incubation was at 37° C. for 1 hr. with air as the gas phase and a shaking rate of 180 oscillations per min

Catalase preparation Source	(Per cent purity)	γ of catalase*	Fraction *B* (900γ/flask)	Substrate oxidized in 1 hr (μmoles)
Rat liver†	86	28·8	–	0
Beef liver‡	20	432·0	–	0
Beef liver	20	27·0	+	4·8
Rat liver	86	28·8	+	4·9
Rat liver	86	9·6	+	3·9
Rat liver	86	4·8	+	2·5
Rat liver	62	5·0	+	2·5
None	—	—	+	0·7

* Based upon the activity of pure rat-liver catalase; 1 unit of activity is defined as the amount necessary to decompose 63·2 per cent of the remaining peroxide in one sec. 1 unit of activity is equivalent to 5·85γ of pure rat liver catalase. We are indebted to Drs. R. Greenfield and V. Price for assay of these preparations.

† The rat liver catalase preparations were kindly supplied by Dr. R. Greenfield. The principal contaminant in these preparations, a protein with S_{20}, W of 6·3–6·5 (ref. 8), was eliminated as the active component by comparing the activity of catalase preparations of different purity.

‡ Crystalline beef liver catalase from Worthington Biochemical Corporation.

(Table 1) was probably due to a small amount of catalase still present, since it is very difficult to obtain fraction *B* completely free of catalase.

When large amounts of catalase (432γ) were incubated with all additions except fraction *B*, no oxidation of *p*-hydroxyphenylpyruvic acid occurred (Table 1). Even in the presence of enzymatically generated peroxide, catalase did not catalyse the oxidation of *p*-hydroxyphenylpyruvic acid to homogentisic acid.

The exact mechanism by which catalase participates in this reaction has not been established. If hydrogen peroxide is involved, it would have to arise from the oxidation of *p*-hydroxyphenylpyruvic acid, since there is no oxygen uptake in the absence of the substrate.

It is well known that catalase can function as a peroxidase with various compounds[3], such as alcohols[4,5], nitrite[6], phenols and amines[7], and it has long been suspected that under physiological conditions catalase may not only decompose hydrogen peroxide but also participate in oxidative reactions. The present studies on the oxidation of *p*-hydroxyphenylpyruvic acid to homogentisic acid have demonstrated, for the first time, a requirement for catalase in the oxidation of a normally occurring substrate. It is possible that catalase, in association with other oxidases, may participate in other reactions of this type.

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Effect of Blocking the Reticulo-endothelial System on the Storage of Vitamin A Ester and Alcohol in the Liver of the Rat

VITAMIN A is absorbed through the lymphatic system mostly in the esterified form[1] and is stored in the liver predominantly as ester with small amounts of the free form. Its absorption via the lymphatic route raises the question of the reticulo-endothelial system being associated with its storage mechanism in the liver. Experiments, carried out in this laboratory, consisting of intraperitoneal injection of indian ink followed by oral administration of oily solutions of vitamin A, show a marked interference in the deposition of the esterified form of the vitamin in rat liver, the free form remaining unaffected.

Male rats of this Institute were raised on a diet low in vitamin A composed of white rice, casein, yeast, groundnut oil and minerals, and were used when they weighed 75–100 gm. One group of rats was kept on the basal diet alone to serve as negative control; each of a second group of six rats was given one intraperitoneal injection of 1 ml. of normal saline daily for seven days and a single oral dose of 3,000 μgm. of vitamin A in 0·2 ml. of groundnut oil on the last day of the injections, and a third group of six rats received treatment similar to the second group, except that 1 ml. of a 20 per cent suspension of indian ink ('Reeves Fixed Indian Ink') in normal saline, instead of normal saline alone, was used. All rats were fasted for 24 hr. after the dose and bled to death by drawing as much blood as possible from the heart while under light ether anæsthesia. Plasma was extracted according to the method of Kimble[2] and the liver with anhydrous sodium sulphate and peroxide-free diethyl ether[3]. The two forms of vitamin A were separated and determined as described by Ganguly *et al.*[4], excepting that a Klett-Summerson photoelectric colorimeter, with a red filter, standardized against standard vitamin A, was used for the determination of the Carr–Price reaction.

The results, as presented in Table 1, show a markedly lower concentration of the ester form of vitamin A in the liver and a markedly higher value of the same form in the blood of rats treated with indian ink, as compared to those treated with saline, demonstrating that blocking of Kupffer cells interferes with the storage of vitamin A ester in the liver of the rat; this confirms the earlier findings of Kagan *et al.*[5] in the guinea pig. In contradistinction to the vitamin A ester values, the vitamin A alcohol values are almost unaffected in the liver, probably indicating different mechanisms of storage of the two forms of vitamin A in the liver and lending

Table 1. EFFECT OF INTRAPERITONEAL INJECTION OF INDIAN INK ON THE VITAMIN A ESTER AND ALCOHOL VALUES IN BLOOD AND LIVER OF RATS

No. of rats	Treatment	Blood (μgm./ml. plasma)		Liver (μgm./organ)	
		Vitamin A ester	Vitamin A alcohol	Vitamin A ester	Vitamin A alcohol
6	Negative control	*	*	10·2 (8–12)	1·4 (1–1·8)
6	Saline + 3,000 μgm. vitamin A	1·9 (1·6–2·2)	1·2 (0·8–2·0)	2,238·3 (1,980–2,450)	56·0 (45–65)
6	Indian ink + 3,000 μgm. vitamin A	5·1 (3·5–8)	1·9 (1–2·5)	1,168·8 (900–1,322)	54·3 (47–61)

* Too low for determination.

support to such a concept put forward by Krinsky and Ganguly[6]. In separate preliminary experiments, in which liver homogenates of normal stock rats were dialysed against a series of buffers ranging from pH 7·0 to pH 4·0, we have found that the two forms of vitamin A are precipitated at different pH values. This observation also lends further support to this concept. Further work is in progress and a detailed report will be published elsewhere.

This investigation was aided by a research grant from the Indian Council of Medical Research and by the Rockefeller Foundation.

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Differences between the Electrical Charge carried by Normal and Homologous Tumour Cells

Differences between the behaviour of normal fibroblasts and sarcoma cells have been observed in tissue culture by Abercrombie and Heaysman[1]. Normal fibroblasts affect each other's movements by contact inhibition, whereas sarcoma cells do not show inhibition either with respect to each other or to normal fibroblasts. Time-lapse colour films taken with the interference microscope (shown at the Bristol meeting (1955) of the British Association by E. J. Ambrose and M. Abercrombie) have shown that this difference in behaviour is due to differences in the mechanism of contact formation in the two cases, being dependent upon a loss of adhesiveness of the cell surface of the tumour cells. This reduction in the adhesiveness of the tumour cell suggests that the electrical properties of the surface may have altered during the malignant transformation. These properties may be investigated by electrophoretic measurements of cellular mobility. For example, studies of bacteria during growth, in the presence of bacteriostatic agents, have revealed marked changes in the nature of the cell surface, changes which are passed on to the progeny during subsequent growth, either in the presence or the absence of the drug. Thus the growth of *Aerobacter aerogenes* in the presence of proflavine[2] or crystal violet[3] gives rise to new populations of cells, which, although biologically indistinguishable from the original strain, have a distinctive electrometric behaviour.

The electrophoretic technique used for this work[4] has now been extended to a study of the surface behaviour of normal and homologous tumour cells. The tissue cells, separated by the perfusion method of Anderson[5], were washed twice on a centrifuge run at low-speed with $M/30$ phosphate buffer solution (pH 6·8, ionic strength 0·13) and finally suspended in the same solution. Tumour cells and red blood cells were washed in a similar way. All determinations of mobility were carried out in the buffer solution. Samples of hamster kidney tumours[6] induced by stilbœstrol were obtained in a highly distinct and compact form. Samples of rat liver tumours induced by butter yellow were also examined. Red blood cells from the same tissues were used as internal controls. This method eliminated any possibility of alterations due to changes in the serum proteins of the tissues, which could become absorbed on the cell surface. Red blood cells for a given mammal were found, in fact, to have a mobility which was independent of their source. Preliminary studies of ascites tumour cells (mouse Ehrlich carcinoma) showed that the mobility of the intact cells was independent of size of cell and tumour age.

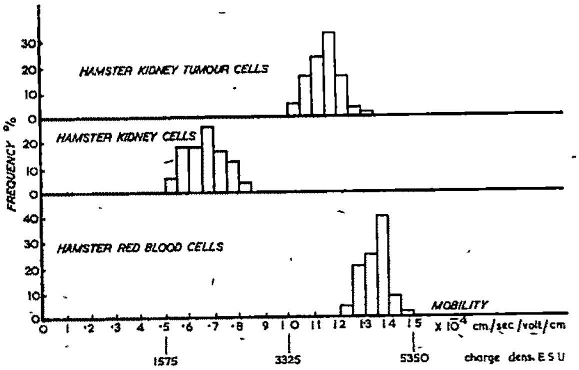

Fig. 1. Electrophoretic mobilities of intact cells. Histograms showing the mobility of red blood cells, normal and tumour kidney cells of the hamster. Each cell type shows a Gaussian distribution about the mean

Typical histograms for the normal and homologous tumour kidney cells are shown in Fig. 1. The average charge density of the tumour cells is almost twice that observed with the normal cells from which they have been derived. A similar increase in mobility was observed with the liver tumours. In this case, the tumour values were not so homogeneous, because these tumours are more diffuse than kidney tumours and suffer from some contamination with normal cells. The increase in the mobility of the tumour cells indicates either a change in the number of charged groups attached to the high-molecular weight material, for example, the carboxyl-rich chains of the protein, or a change in the ability to absorb positive ions. That the latter may in fact be the case is suggested by observations of de Long, Coman and Zeidman[7], that tumour tissues show a decreased calcium content in comparison with normal tissues.

Changes in the nature of the cell surface may possibly provide a new approach to the chemotherapy of cancer and enable a preferential attack to be made on the malignant cell.

We thank Prof. A. Haddow for his interest in this work, and we are indebted to Prof. J. A. V. Butler for valuable help and suggestions. We also wish to thank Dr. E. Horning, who supplied the samples of hamster kidney tumours, and Dr. D. Darcy, who supplied the rat liver tumours. One of us (J. H. B. L.) acknowledges continued financial support from the British Empire Cancer Campaign. This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the

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Influence of a Magnetic Field upon the Leucocytes of the Mouse

THIS communication contains the results of one part of the research programme aimed at studying the effect of magnetic fields on living organisms and tissues. Female *C3H* strain mice from the Roscoe B. Jackson Memorial Laboratory were kept for 4–5 weeks in magnetic fields of 4,200 gauss strength, produced by 'Alnico' permanent magnets. The animals were placed in individual cages 3·5 in. inner diameter and 1·40 in. height. The magnetic field-strength was in the centre of the cages 4,400 gauss, decreasing to 4,000 gauss toward the periphery of the cage, as measured with a Dyne-Empire Model *D*-79 gauss meter. Control animals were kept in identical cages, wherein the pole-pieces of the magnets were simulated with 1-in. thick brass disks to provide identical conditions with respect to temperature, illumination and cosmic radiation[1]. The food of the animals consisted of standard Rockland mouse diet in pellet form. Blood samples taken from the tail at intervals of 7–14 days were investigated with respect to white blood count, red blood count and differential count.

The first experimental series was performed on mice forty weeks old during the spring of 1955. In this series nine mice were kept in magnetic fields for five weeks and in standard plastic cages, 4–5 animals in each cage, for an additional eight weeks after removal from the field. In this series no control animals were used.

The second similar experimental series was performed during late summer and autumn of 1955 on mice nine weeks old. In this series, nine mice were kept for four weeks in the magnetic fields and remained during the fifth week in their individual cages, however, removed from the field. Thereafter they were transferred to standard plastic cages, 3–4 animals in each cage for an additional thirteen weeks. In this series four control mice were kept for five weeks in individual cages and thereafter transferred to a plastic standard cage. The blood samples were taken from all animals, treated and controls alike, always on the same dates.

(*a*) In both series a significant decrease in the number of segmented cells is observable within the first two weeks while the animals were kept in the magnetic fields. This change cannot be attributed to the confinement to small cages, because the controls confined to identical cages seemed rather to indicate an increase in the number of segmented cells. The average decrease is 28·7 ± 6·7 per cent for the first and 47·9 ± 8·6 per cent for the second series (errors mean standard errors); indicating that the effect is significant on the level: $P < 0{\cdot}001$. Table 1 illustrates for the animals of the second series the individual differences between starting value (base line) and lowest value reached within the first fourteen days, as a percentage of the starting value.

(*b*) After removal from the magnetic field the number of segmented leucocytes increases and reaches a maximum a few weeks after removal from the field. The mean increase is for the first series 135 ± 30 per cent and 226 ± 65 per cent for the second, expressed in per cent of the minimum. These values indicate that the effect is significant on the probability level: $P < 0{\cdot}001$. That this maximum cannot be considered as a result of the transfer of the animals from the small cages to standard cages is proved by two circumstances: (1) no such increase was observed with the controls; (2) the majority of the mice manifested the maximum in the number of segmented cells one week after removal from the field; that is, at a time when they were still in small individual cages.

(*c*) The increase is followed by a decrease below the base-line value: the mean decrease being 59·4 ± 7·0 per cent in the first and 33·2 ± 8·2 per cent in the second series; the values given in per cent of the previous maximum. This effect is significant on the probability level: $P < 0{\cdot}001$.

(*d*) In the second series, where the observations were continued over a period of 124 days, the last counts again gave base-line values.

In the number of the lymphocytes a significant increase was observed in both experimental series after the animals were removed from the magnetic fields. The mean increases between the value shown at the time of removal and the following maximum, expressed as a percentage of the lower value, were: 270 ± 56 per cent in the first and 28·1 ± 6·5 per cent in the second series respectively. The effect can thus be considered significant on the probability level: $P < 0{\cdot}001$. The control animals did not show any significant change in the number of their lymphocytes. The count taken on the 124th day in the second series seems to indicate an increase of 38·6 ± 16·6 per cent above the base-line value; however, the probability-level of this effect is only $P = 0{\cdot}02$. No significant change was observed in the red blood count in either of the two experiments.

The observations on histological changes of organs of the mice kept in a magnetic field will be published elsewhere.

Table 1

No.	2	3	4	5	6	7	8	9	0	Mean
Treated	−60·3	−58·5	−23·6	−10·2	−68·7	−30·7	−69·0	−26·0	−84·5	−47·9±8·6
Controls	+72·8	+193	−38·2	+14·4						+61 ±50

We wish to acknowledge the valuable technical assistance of Miss Martha Walker, who did the hæmatological work. We also wish to express our gratitude to the Dorothy Shattuck-Stensland Foundation for the generous grant which enabled the purchase of the magnets and covered all experimental expenses. Acknowledgment is due to the Administration of St. Francis Hospital and particularly to Dr. J. W. Henry, head of the Pathology Department, for his valuable advice, as well as to the Forro Scientific Co. for permission to conduct some experiments in their laboratories.

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Effect of Cortisone on the Serum Gamma-Globulin

Nicol and Snell[1] showed that cortisone depresses the phagocytic activity of the reticulo-endothelial system during the first two weeks of treatment, and that if the cortisone injections are continued the reticulo-endothelial system apparently recovers during the third and fourth weeks. Nicol and Bilbey[2] reported that cortisone also produces changes in the blood. They showed that when 10 mgm. of cortisone is given daily intramuscularly for one or two weeks, the total leucocyte count falls, due to reduction in the number of lymphocytes and polymorphs; but if the cortisone is continued for three or four weeks the total leucocyte count returns to normal, due to increase in the number of polymorphs, although the lymphocyte count remains low.

The present communication deals with the effect of cortisone on the antibody-level in the serum, the serum γ-globulin-level being taken as the measure of the antibody-level, since most antibodies are found in association with the γ-globulin fraction of the serum protein. In this investigation the γ-globulin-level was estimated by first separating the γ-globulin fraction by paper electrophoresis, then treating the electrophoretic paper with dyes and estimating the optical density of the protein dye complex by means of a photoelectric cell. In this manner the percentage of γ-globulin in relation to the total protein in the serum could be assessed.

Twelve male guinea pigs, aged about one year, were used for this investigation. Blood samples were first taken from each animal by heart puncture and the γ-globulin-level of normal serum estimated as described above. Each animal then received a daily dose of 10 mgm. of cortisone intramuscularly for five weeks, the blood samples were taken at weekly intervals and the γ-globulin-level of the serum estimated. More than forty estimations of this kind were made during the five weeks of cortisone treatment.

In all the animals the γ-globulin level became markedly reduced during the first two weeks of the cortisone injections and thereafter remained at a low level. In two of the animals, however, it increased slightly during the fourth and fifth weeks. These findings are in agreement with Bjørneboe, Fischel and Stoerk[3], who showed that cortisone inhibits the production of antibodies during active immunization and also after immunization is well established. They are also in line with the other blood changes recorded by Nicol and Bilbey[2]. Further, they emphasize the profound depression of the body defences produced by cortisone, and the great necessity to protect patients from intercurrent infection especially during the early stages of cortisone therapy.

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Action of Ribonuclease on the Multiplication of the Influenza Virus

Recent work of Ada and Perry[1] on the nucleic acid composition of influenza virus has shown that the infectious particles lack deoxyribonucleic acid, and that they contain about 0·8 per cent of ribonucleic acid. The degree of infectiveness is, in fact, a function of the ribonucleic acid content; the 'incomplete' form of the virus is characterized by a low infectivity/hæmagglutination ratio, and its ribonucleic acid content is lower than that of the standard form[2].

Indirect evidence for the importance of nucleic acid in the virus constitution is also given by the inactivation curve of virus infectivity by ultra-violet light; maximum effect is obtained[3] at a wave-length of 2652 A.

In the case of the tobacco mosaic virus, Casterman and Jeener[4] have observed a marked inhibition of synthesis of the virus by ribonuclease. The present work was undertaken with the hope of further defining the role of ribonucleic acid in virus growth, by studying the inhibitory action of ribonuclease on the multiplication of influenza virus.

Virus of strain *PR*8 was cultivated in the allantoic cavity of the embryonated egg, or in test-tubes on a fragment of chorioallantoic membrane suspended in 1 ml. of diluted Hanks solution (method of Tamm *et al.*[5]). The hæmagglutinating power was assayed with chicken red-blood cells, by serial dilution of the culture medium. The infectivity was estimated by the method of Reed and Muench[6], after inoculation of embryonated eggs.

The enzymatic activity of the ribonuclease (G.B.I. or Armour) in the culture medium corresponded to concentrations of 0·1–0·7 mgm./ml. Tubes containing oxidized (inactive) ribonuclease served as controls. The following results have been obtained.

(1) The presence of ribonuclease in the culture medium inhibits completely the synthesis of the influenza virus cultivated on fragments of chorioallantoic membranes. In the controls, the hæmagglutinating titre rises regularly during incubation.

(2) Ribonuclease added to the culture medium at various times after introduction of the virus inhibits

Table 1. TREATMENT BY RIBONUCLEASE AT VARIOUS TIMES AFTER INFECTION BY THE VIRUS

Time between virus and ribonuclease injections	Hæmagglutinating titres, after incubation for 24 hr. at 37° C. Controls	Treated
(*a*) *In vivo*		
− 30 min. (before)	$10^{3\cdot 1}$	$10^{0\cdot 6\pm 0\cdot 3}$
+ 3 min. (after)	$10^{3\cdot 0}$	$10^{0\cdot 6\pm 0\cdot 3}$
+ 60 min.	$10^{3\cdot 0}$	$10^{1\cdot 6\pm 0\cdot 5}$
+ 2 hr.	$10^{3\cdot 4}$	$10^{3\cdot 4}$
+ 6 hr.	$10^{3\cdot 2}$	$10^{3\cdot 3\pm 0\cdot 1}$
(*b*) *In vitro*		
0 hr.	$10^{3\cdot 0}$	$10^{0\cdot 6\pm 0\cdot 3}$
+ 1 hr.	$10^{3\cdot 6}$	$10^{1\cdot 6\pm 0\cdot 2}$
+ 2 hr.	$10^{3\cdot 3}$	$10^{2\cdot 7\pm 0\cdot 3}$
+ 4 hr.	$10^{3\cdot 7}$	$10^{2\cdot 5\pm 0\cdot 3}$
+ 6 hr.	$10^{2\cdot 8}$	$10^{2\cdot 6\pm 0\cdot 2}$

virus multiplication, but only within the first two hours after infection. The same experiment with the chick embryo gives similar results: the enzyme (0·1 ml. of an 8 mgm./ml. solution) was injected into the allantoic cavity at various times after the virus had been injected (Table 1).

(3) Fragments of chorioallantoic membrane treated during 1 hr. with ribonuclease, and then well washed in saline at 37° C., support the growth of hæmagglutinating particles, but there is a lag-time of about ten hours.

(4) A good correlation has been observed between infectivity and hæmagglutinating power: the hæmagglutination titre can thus be considered as proportional to the number of active virus particles.

The following hypotheses may be considered in order to explain the facts.

(*a*) Ribonuclease acts directly on the ribonucleic acid of the particles, before they enter the cells of the membrane. This hypothesis can be discarded at once, since a suspension of influenza virus treated with ribonuclease, and then purified by adsorption on and elution from red blood cells, keeps its agglutinating and infective powers intact.

(*b*) Ribonuclease prevents the adsorption on, or penetration of the virus into, the host cells. This explanation is unlikely; the multiplication of the virus is not affected when the chorioallantoic membrane is infected with the virus in the presence of ribonuclease and washed after 1 hr. Adsorption and penetration of virulent particles are thus not prevented by the enzyme.

(*c*) Ribonuclease alters the metabolism of the host cell and thus prevents the synthesis of the virus.

In order to test this last hypothesis, the following experiment has been carried out: phenylalanine-^{14}C was added to fragments of the membrane previously treated with oxidized or reduced ribonuclease; no difference was found in the specific radioactivity of the proteins. The turnover-rate of the proteins is thus not affected by the ribonuclease The incorporation of adenine-^{14}C, on the contrary, is much reduced in membranes treated with the active enzyme. Further experiments are needed in order to decide whether this inhibition is correlated with a decrease in ribonucleic acid turnover. However, this inhibition of adenine incorporation into membranes treated with ribonuclease cannot entirely explain the inhibitory action of the enzyme on virus growth, since such membranes are still capable of supporting virus synthesis.

In conclusion, ribonuclease, in the reduced state only, prevents synthesis of the influenza virus provided that it acts during the first two hours after infection, that is, during the beginning of the lag period. It does not act directly on the ribonucleic acid of the infectious particles, and it does not prevent their adsorption on and penetration into the host cells.

A possible explanation of our findings is that the influenza virus separates into ribonucleic acid and protein when it penetrates into the cell, as has already been suggested for other viruses; in this free state, the virus ribonucleic acid might be sensitive to ribonuclease. If so, ribonucleic acid has essentially the same function in the influenza particle as deoxyribonucleic acid in the bacteriophages, and it might thus be responsible for genetic continuity.

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Incorporation of Adenine and Uracil into Ribonucleic Acid during Enzyme Induction in Resting Yeast

Spiegelman *et al.*[1], Pardee[2] and Creaser[3] have shown that purine or pyrimidine analogues inhibit induced enzyme formation in various micro-organisms. This strongly suggests that synthesis of nucleic acid is necessary for the formation of adaptive enzymes. Gale and Folkes[4] have shown that incorporation of uracil into ribonucleic acid is increased during induced formation of galactosidase in disrupted *Staphylococcus*.

Similar results have been obtained in our laboratory. We have observed an increased incorporation of labelled adenine and uracil into ribonucleic acids during the induced formation of cytochrome *c*[5], cytochrome peroxidase and catalase[6] in resting yeast (strain 'petites colonies').

The formation of these proteins is induced by oxygen in cells grown anaerobically. The mutant 'petites colonies' never acquires a functional respiratory system, and shows no Pasteur effect. In this strain, oxygen acts merely as an inducer of catalase, cytochrome *c* and cytochrome peroxidase; it is not consumed and cannot be involved in any energy-producing system[5].

The 'petites colonies' mutant was grown anaerobically, the cells washed with water and resuspended in a medium containing glucose, potassium acid phosphate and magnesium sulphate, but without a source of nitrogen or growth factors. They were incubated again for 1 hr. under anaerobic conditions. 8-^{14}C-adenine or 2-^{14}C-uracil was then added to the suspension; one half was shaken in the air, the other under anaerobic conditions. Samples were mixed with 10 per cent trichloracetic acid, the sediment was

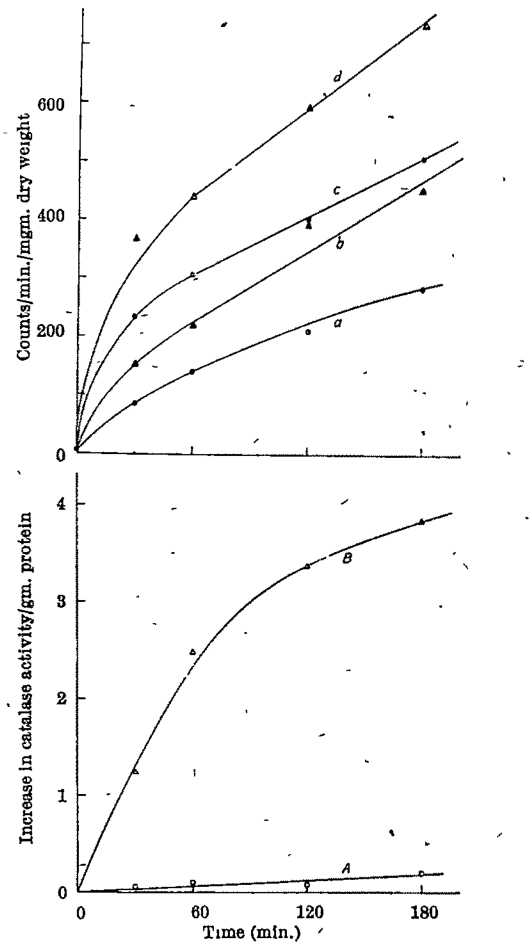

Fig. 1. Incorporation of radioactive carbon from uracil (curves *a* and *b*) and from adenine (curves *c* and *d*) into acid-insoluble compounds. Curves *A* and *B* show the increase in catalase activity per gm. of cell protein. *A*, *a* and *c* are the controls; *B*, *b* and *d* the induced cells

thoroughly washed to remove all acid-soluble compounds, plated, and its radioactivity measured.

The results of such an experiment are shown in Fig. 1. The incorporation of radioactive carbon from adenine or uracil is considerably increased during the induction of the enzyme.

On the other hand, when the same yeast strain was grown under aerobic conditions, it contained large amounts of catalase, which did not increase on further shaking in air. In this case, the rate of incorporation of adenine into nucleic acids was the same under anaerobic conditions as in the air.

The purine bases and the pyrimidine nucleotides liberated by hydrolysis of the nucleic acids were isolated by chromatography. When 8-^{14}C-adenine was added to the yeast suspension, both purines were labelled; when 2-^{14}C-uracil was added, both pyrimidine nucleotides contained radioactive carbon. The specific activities of the four components increased simultaneously during the induction of the enzymes. However, the relative increase was greater for guanine than for adenine, and greater for cytidylic acid than for uridylic acid.

The purines (adenine, guanine, hypoxanthine) from acid-soluble compounds have also been isolated. Their specific activities decreased more rapidly during adaptation than in the control.

It appears from my results that an increased synthesis, or a modification, of nucleic acids is associated with enzyme induction. One may conclude that ribonucleic acid is involved, because the induction increased the incorporation of uracil into the uridylic nucleotide obtained from nucleic acids.

The increased incorporation of adenine caused by the inducer is observed even when enzyme formation is blocked by *p*-fluorophenylalanine. According to Halvorson and Spiegelman's results[7], this analogue inhibits amino-acid utilization for protein synthesis in yeast. It may be concluded that the increased incorporation of adenine does not depend on the actual formation of any new enzyme system. The modification or synthesis of nucleic acid may be a condition for synthesis of induced enzyme; it is not a consequence of the formation of new enzyme molecules.

Ammonium sulphate fractionation of a yeast extract at *p*H 6 gave several fractions containing ribonucleic acid. The specific activities of both adenine and guanine of the different fractions differed considerably, and the percentage increase in specific activity due to enzyme induction was different for each ribonucleic acid fraction. This makes it very probable that the effect observed does not reflect any general change in ribonucleic acid metabolism, and that it involves certain specific nucleic acid fractions which will eventually be isolated.

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Response of the Sheep to Sublethal Doses of Fluoroacetate

As part of a study of the capacity of the sheep to metabolize lower fatty acids, the effect of continued administration of sublethal doses of fluoroacetate is being investigated.

Contrary to reports of the action of fluoroacetate on other animals[1], we have found that for sheep its toxicity is profoundly influenced by the route of administration and by the nature of the fodder.

Sodium fluoroacetate (2 mgm. daily) was administered to adult merino sheep (40–50 kgm. body-weight) as follows: 1 mgm./20 ml. water as a drench twice daily, or 1 mgm./5 ml. water as a subcutaneous injection twice daily; 2 mgm./litre of water/day dripped continuously into the abomasum through a fistula; or 2 mgm./litre 0·9 per cent saline/day dripped continuously either into the peritoneal cavity or into the jugular vein. Three groups of animals that were treated in these ways were provided respectively with rations comprised of (*a*) 800 gm. wheaten chaff, (*b*) 800 gm. lucerne chaff, or (*c*) 800 gm. wheaten chaff plus 100 gm. gluten. The concentration of citrate in the blood was determined[2] at regular intervals during treatment.

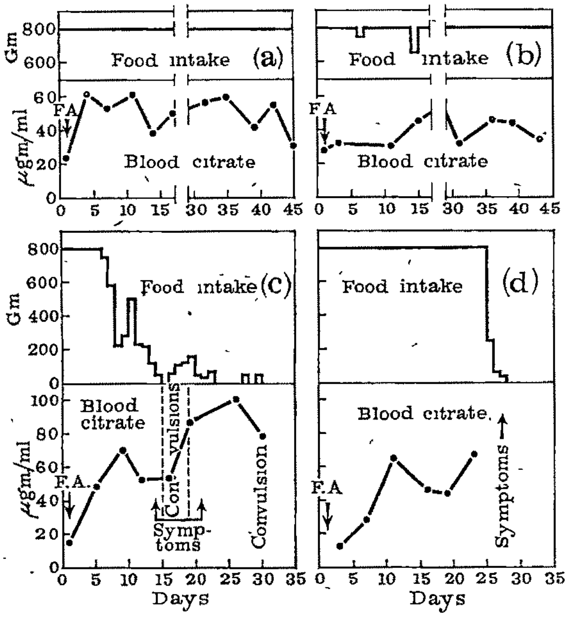

Fig. 1. Food intake and blood citrate-levels of four sheep receiving fluoroacetate. (*a*) Lucerne chaff diet, fluoroacetate drenched; (*b*) wheaten chaff–gluten diet, fluoroacetate drenched; (*c*) wheaten chaff diet, fluoroacetate drenched, (*d*) lucerne chaff diet, fluoroacetate via abomasal fistula

Sheep fed wheaten chaff developed symptoms when fluoroacetate was administered by any of the above routes. Failure to eat the full ration after seven to ten days of treatment and an almost total loss of appetite after twelve to eighteen days were constant features. Some died after a few days of treatment, apparently from heart-block; in the others, muscular inco-ordination and body tremors appeared after fourteen to eighteen days of treatment and culminated in periodic tetanic convulsions of short duration that continued until death ensued a few days later. During this latter stage, the animals that refused all but a small fraction of the ration wheaten chaff readily ate a full ration of lucerne chaff when this was offered, and eventually recovered despite the continued administration of fluoroacetate.

Those on the lucerne chaff ration continued to eat the whole of it and showed no symptoms for periods up to forty-five days, provided the fluoroacetate was administered by drench or by subcutaneous injection. When administered by intravenous injection or via an abomasal fistula, however, death occurred within ten to twenty days, and was not preceded by the characteristic syndrome shown by the animals that were maintained on the wheaten chaff ration: they consumed their ration until a day or so before death and showed no sign of tetanic convulsions.

The group fed wheaten chaff and gluten maintained their appetite and evidenced no symptoms for periods up to forty-five days, during which fluoroacetate was administered either as a drench or a subcutaneous injection.

Three animals in which rumen fistulæ had been established were fed on wheaten chaff, and a supplement of 20 gm. of acetic and 20 gm. of propionic acids adjusted with sodium hydroxide to *p*H 5·5 was introduced each day into the rumen. This supplement, however, did not prevent the symptoms. The sequelæ were identical with those that appeared when wheaten chaff alone was fed.

The symptoms were not closely correlated with the concentration of citrate in the blood. Some animals on wheaten chaff became convulsed during periods when their blood contained 60γ of citrate/ml., whereas others were apparently normal when their blood contained up to 80 γ/ml.

The animals consuming the lucerne rations did not become convulsed after treatment with fluoroacetate *per os*, although the citrate concentrations in their blood rose to 60 γ/ml.

The response of typical animals to treatment with fluoroacetate is indicated in Fig. 1.

The effects of lucerne or of a supplement of gluten suggests that protein may protect the ruminant against sublethal doses of fluoroacetate. Investigations are being continued.

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Length of the Muscle Fibres of the Rat Diaphragm

Since its introduction in 1946[1] the phrenic nerve diaphragm preparation from the rat has become one of the most commonly used mammalian nerve–muscle preparations in experimental research. Although indirect stimulation is most often employed, direct stimulation of this preparation has been increasingly used in recent years.

The general opinion is that the directly evoked muscle impulse arises at the cathode and runs along the entire length of the muscle fibre. It cannot, however, traverse the boundaries of the muscle fibre in which it is set up.

When the stimulating electrodes span the entire muscle, all the fibres of the muscle may respond if the current density is high enough to stimulate each fibre individually. With stimulation at one end, however, the response depends on the proportion of the length of the muscle fibres to the length of the muscle, and the whole muscle reacts only if the fibres run the whole length of the muscle[2]. When direct stimulation is applied, it is important to know how great a fraction of the muscle is actually stimulated. Consequently, knowledge of the length of the muscle fibre is valuable. According to Brown and co-workers[3], the length of the single fibres of the rat diaphragm does not exceed 5 mm.

Hajdu and Knox[4] have shown that end-plate potentials can be most easily recorded from a narrow zone midway between the central tendon and the ribs transversely to the fibre direction. That the end-plates are actually localized in this zone with a rather small scatter is easily shown by means of histochemical technique. On stimulating fully curarized preparations either at one end or all over, we have been surprised by the often negligible difference in the height of contractions elicited (Barstad, unpublished work). It therefore seems open to question whether the fibre-length can be limited to 5 mm.

We have tried to elucidate the problem by means of histological as well as electrophysiological technique. Rat diaphragms were cut into strips 5–10 mm.

broad, parallel to the fibres, from the costal insertion to the central tendon. The strips were placed in a saturated aqueous solution of sulphur dioxide[5] at room temperature for eight to fourteen days. They were heated in distilled water to boiling point and then immediately cooled to room temperature. This procedure was carried out four or five times.

After blunt dissection, entire single fibres were isolated with the aid of a binocular of magnification 20. The fibres, both unstained and stained with Heidenhain's hæmatoxylin, were studied under a microscope. The transverse striation was easily observed in all cases.

Twenty single fibres from rat diaphragms were successfully isolated in this way. In each case the fibre could be traced continuously from the costal margin to the central tendon. A greater number of fibres were broken up into two or three parts during dissection. It thus seems very probable that at least some of the fibres run the whole length of the muscle.

To supplement these findings we recorded action potentials from completely curarized isolated rat-diaphragm preparations that were stimulated by electrodes at the costal insertion of the muscle. Square wave pulses with a frequency of 10 per min. and a pulse width of 0·6 m.sec. were supplied by an electronic stimulator with an output of 75 m.amp.

Despite a troublesome shock artefact, it was possible to record potentials close to the central tendon. The decrease in action potential in the tendinous part of the muscle was roughly parallel to the decrease in the proportion of muscle tissue in this part of the preparation as shown in cross-sections stained with hæmatoxylin and eosin.

This finding also indicates that at least a considerable number of the muscle fibres run the whole length of the muscle.

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A Radiographic Method for the Study of the Function of the Cow's Udder

In studying the function of the milk gland, with the view of increasing milk production, particular attention has been devoted in recent years to the milk-ejection mechanism (the let-down reflex). Ely and Petersen[1] demonstrated the important part played by oxytocin in milk ejection; Grachev[2] and Barishnikov *et al.*[3] emphasized the influence exerted by the central nervous system.

In almost all the reports available, the methods of studying the let-down reflex have been based upon catheterization of the udder and the measurement of changes in pressure within the udder during different phases of milking. Contradictory findings obtained in this way may be attributable to variation in details of technique, such as the diameter of catheter used, depth of insertion, or possibly irritation of the udder by the indwelling catheter.

We have attempted to develop a method which would permit objective registration of motor activity in the udder. This method consists of demonstration by X-rays of changes within the collecting ducts and cisterns of the udder by means of a contrast medium filling this system.

Preliminary experiments were carried out using isolated cow's udders. The suitability of various contrast media, the technique of filling the milk ducts and cisterns, and the amounts of medium required were worked out. 'Ultraren' (aqueous iodide solution) proved the most satisfactory contrast medium, and 20 ml. sufficed to display the cistern of one milk gland of an udder of average size.

The method was then tested in a cow (No. 80, red spotted breed) with low milk production (3 litres daily) which had recovered from mastitis of the left posterior quadrant. Tests were preceded by a period of acclimatization to experimental conditions. Thus, the cow was accustomed to the X-ray room, gradual darkening of the room, the sound of the X-ray apparatus, etc., by being milked under identical conditions at the same time daily. She seemed entirely accustomed to the experimental environment after ten days. Adaptation was considered complete when the milk yield in the X-ray room equalled that obtained under normal conditions in the cow-shed.

Preparation for radiographic study was then carried out as follows. The tip of the teat was gently wiped, and a fine sterile rubber catheter introduced. A 'Nelaton' catheter No. 2 was used, dipped in 'Pateol' (urological antiseptic lubricant). The procedure caused no defensive reaction in the cow. About 20 ml. of milk was allowed to drip from the catheter, 20 ml. of contrast medium was slowly injected, and the catheter withdrawn. A 35 per cent solution of 'Ultraren', heated to 37° C., did not seem to cause any irritation of the udder, as evidenced by no change in radiographic appearance. The following is a brief report of some of our observations made using this method.

After mechanical stimulation of the teat filled with contrast medium, such as squeezing several times as in milking, contractions of the distal portion of the cistern, most marked in the central section of the teat, appeared within a few seconds. The shadow, initially of smooth cylindrical shape, developed an hour-glass constriction.

If a teat on the opposite side of the udder was similarly stimulated, contraction occurred after a delay of about one minute. Contractions were periodic and continued for about 15 min. The duration of each contraction was 7–15 sec., their frequency 1–2 contractions a minute. With contractions, the contrast medium was forced to the roof of the cistern, and after several contractions reached the larger milk ducts. It was possible to demonstrate that this was not merely due to simple diffusion of the contrast medium.

The relationship between contraction of the cisternal smooth muscle and milk ejection evoked by administration of oxytocin was also investigated. It was found that intravenous injection of oxytocin in dosages sufficient to cause milk ejection was not associated with contractions as described above.

The effect of squeezing the teat during milking was also noted. Following such squeezing of the base of the teat at the beginning of milking, the contrast material was observed to rise in the cistern and spurt into the milk ducts, as in isolated udder preparations.

On the basis of these preliminary observations, we believe this method is a promising one for investigation of the motor function of the udder, and hope in future investigations to re-assess current theories as to the nature of this process.

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Region *E* and the S_q Current System

The equilibrium equation for the electron density N in a solar-controlled ionospheric region, such as normal region E, is, with the usual nomenclature:

$$\frac{\partial N}{\partial t} = q_0 \cos \chi - \alpha' N^p - \operatorname{div}(N\mathbf{v}) \qquad (1)$$

where χ is the solar zenith angle, α' the effective recombination coefficient and $\mathbf{v}$ the vector drift velocity; q_0 is proportional to the intensity of the solar ionizing radiation. The solution of this equation has been discussed by Martyn[1] and by Appleton and Lyon[2]. At or near noon, $\partial N/\partial t \doteqdot 0$, and if the movement term $\operatorname{div}(N\mathbf{v})$ is small, the critical frequency fE is related in a simple manner to χ, and we can write:

$$(fE)^n = K \cos \chi \qquad (2)$$

K is a constant, $n = 2p$ and for an isothermal region has the value 4 for recombination and 2 for attachment. In practice, it is found that the values of n deduced from the approximate equation (2) usually lie between 2 and 4, and this has been interpreted by most workers as evidence for a height gradient in the effective recombination coefficient or non-isothermal conditions in the layer. An alternative approach, and one which we adopt here, is to suppose that the apparent variations in n with time and place may result at least partly from neglect of the movement term $\operatorname{div}(N\mathbf{v})$.

It is now generally believed that the S_q magnetic current systems are located at or near the level of region E, and Martyn[3] has shown that vertical drift may be expected to modify the electron density distribution at places where the current systems have east–west components. Such modifications will appear in fE and these in turn may influence the index n. Curve A in Fig. 1 shows average values of n deduced (by the method of least squares) from equation (2), using monthly mean noon values for the years 1952–54 for all available stations in a longitude zone centred approximately on the 150° E. meridian. For these years of low solar activity only minor corrections for changing month-to-month activity were necessary. It will be seen that there is a clear variation of n with latitude, with quite marked singularities at or near Tokyo and Watheroo. These stations are situated near the mean latitudes of the foci of the S_q current systems, and it seems probable that the singularities in the curve are to be associated with the fact that the foci are overhead at approximately 1100 hr.

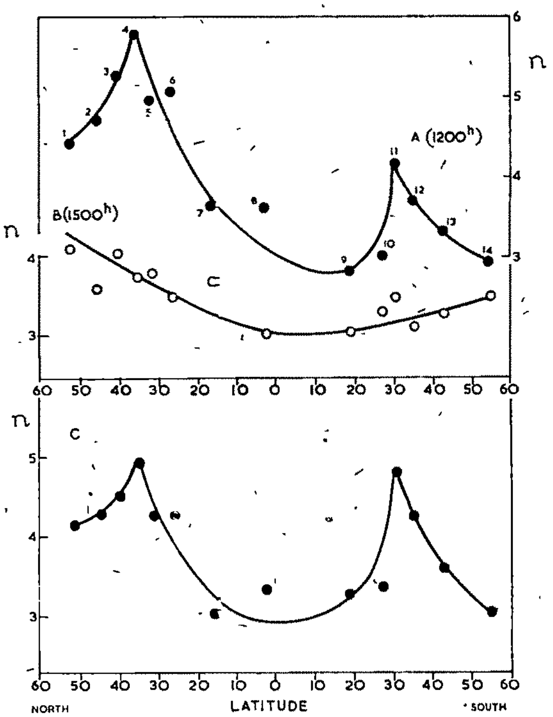

Fig. 1. Index n for stations centred approximately on the 150° E. meridian, derived from values of fE for 1952–54. Curve A: 1200 hr.; curve B: 1500 hr.; curve C: 1200 hr. reduced to common solar distance.

1, Adak. 2, Wakkanai. 3, Akita. 4, Tokyo. 5, Yamagawa. 6, Okinawa. 7, Baguio. 8, Singapore. 9, Townsville. 10, Brisbane. 11, Watheroo. 12, Canberra. 13, Hobart. 14, Macquarie Island

The values of n are a measure of the seasonal variation in fE, and depend quite markedly on any differential influence between seasons. In January the solar distance is some 3 per cent less than in July, and when the appropriate small corrections are made to the monthly mean values of fE to allow for this, the marked asymmetry in curve A is largely removed (Fig. 1, curve C). The small residual differences between stations in the higher northern and southern latitudes may possibly be due to the magnetic asymmetry of the Earth.

We have made a similar study for two other longitude zones (centred on 10° E. and 70° W.) and find confirmatory evidence for these singularities north and south of the equator. Now magnetic studies show that, in summer, the current systems are much stronger than in winter, and also that the foci are then some 10° nearer the equator. At the foci, no vertical drift will occur; at higher latitudes (current towards the west) drift will be downwards, and at lower latitudes (current towards the east) drift will be upwards. Martyn and also Appleton and Lyon have shown that the changes in electron density to be expected as a consequence of vertical drift depend on both the velocity of drift and on the height-gradient of this velocity. If downward drift is associated with a decrease in fE, and vice versa, then an explanation for the marked peaks in n near latitudes 35° N. and 30° S. can be formulated

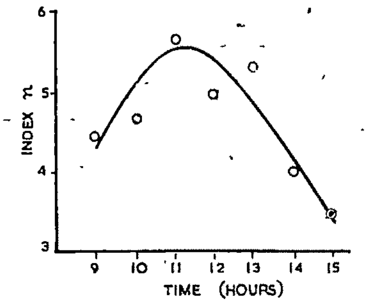

Fig. 2. Index n for various hours at Tokyo (1952–54)

in terms of vertical drift assuming that, with change of season, the foci of the current systems move north–south across these latitudes and the current intensity varies in the manner indicated by magnetic studies[4].

The S_q current system moves around with the Sun, and near 1500 hr. at all latitudes less than about 70° the east–west component is very small, so that vertical drift effects may also be expected to be much reduced. We have calculated the index n from the seasonal variation in fE at 1500 hr. at all stations. These values are shown in Fig. 1, curve B, and it will be seen that they are generally less than at noon, and that at this hour no peaks appear at any latitude. This remarkable change between 1200 and 1500 hr. tends to confirm that our interpretation of Fig. 1, curve A, is probably valid. Moreover, when the influence of the current systems is removed, there appears to be a gradual decrease in n towards the equator. This may be evidence for a change in E-layer characteristics (such as vertical temperature gradient) from temperate to equatorial latitudes.

For certain stations we have also calculated the index n for each hour between 0900 and 1500, and the values found for Tokyo are plotted in Fig. 2. In these calculations the appropriate corrections for the equation of time and varying sunspot number and solar distance have been made. It will be seen that the variation over the day is markedly asymmetric, forenoon values being considerably larger than those at corresponding afternoon times, and the peak value is not at noon but at about 1100 hr. This type of variation is just that to be expected, since the east–west component of the S_q current system, and hence vertical drift effects, are a maximum an hour or so before noon.

If 'normal' values of fE (that is, those unaffected by S_q effects) occur when the focus is overhead, we can estimate the approximate order of magnitude of the change in region E ionization at various latitudes as a result of vertical drift. For the latitude of Tokyo, our results suggest that in June and December the peak ionization density is respectively decreased and increased by some 3–4 per cent, whereas at the equator the corresponding increase seems to be about 10 per cent. It is to be emphasized that the fE perturbations involved are very small and these figures are only approximate indications of the orders of magnitude. However, the experimental results certainly indicate a marked increase in vertical drift effects towards the equator, a conclusion which is in accordance with theoretical considerations.

A more extended study shows that region E exhibits a number of departures from a Chapman-type layer, and it is now clear that these are largely, if not entirely, to be explained in terms of vertical drift.

We have made a similar study of n for region F and find that although there is some evidence f anomalous values near the latitudes of the curre foci, there are no sharply defined maxima of th kind found for region E. A more detailed discussio of these and other results will be published elsewher

The above work was carried out as part of th programme of the Radio Research Board of th Department of Scientific and Industrial Researc and this is published by permission of the Direct of Radio Research.

Note added in proof. Appleton *et al.* have recent published (*Nature*, 176, 897; 1955) a description work which provides other ionospheric evidence f the influence of the S_q current system in region E.

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Determination of the Thickness of Ice Shelves by Seismic Shooting Methods

Seismic soundings of the thickness of the floati ice shelves of Antarctica have so far been attempte by two expeditions, the Second Byrd Antarct Expedition of 1933–35[1], and the Norwegian–Britis Swedish Antarctic Expedition 1949–52[2,3]. Furth measurements are likely to be made by sever expeditions during the International Geophysic Year 1957–58.

Reports which have appeared to date do not gi a satisfactory interpretation of the detailed recording The reasons for rejecting Poulter's earlier interpreta tion[1], which assumed that sea water percolat through ice shelves to sea-level, have already bee outlined[2]. My preliminary report[2] used an empiric method, based on the known thickness of ice at o station, to interpret the travel times of echoes other stations in terms of thickness, as the detaile interpretation of the echoes was not clear. Th method indicated that the ice shelves were of almo uniform thickness, a result which appeared to one's experience of these features.

Now that a detailed study of the results has bee made, this picture has proved to be inconsistent wi various related observations. A new and consiste interpretation of the results is therefore proposed.

The major inconsistency found was the lack agreement of ice thickness with the surface heig of the ice shelves. These heights proved to be mo accurate than originally anticipated, the standa deviation for ten measurements at different times f a station at 115 km. from Maudheim being 3·3 The variation of surface height with the prelimina estimates of ice thickness shown in Table 1 cou only be explained by large variations in the me density of the ice shelf with location. Poulter h actually used his results to make such deductio However, detailed interpretation of the seism velocity–depth curves shows that depth–densi profiles in Queen Maud Land do not vary rapid with location. Assumptions such as varying ro loads carried at the bottom of the ice fail to satis the density variation which would be needed correlate surface heights with the preliminary esti

Table 1

Station No.	Surface height (m. above sea-level)	Thickness of ice shelf (a) Prelim. estimate (m.)	Thickness of ice shelf (b) Present estimate (m.)	Mean density (new estimate)	Thickness of water layer (m.)	Depth of sea-bed (m. below sea-level)
178	37	185*	210	0·84	285	455
172	56	(169)	407	0·88	206	555
170	64	(192)	484	0·89	363	779
169	70	(199)	504	0·88	624	1,054
167	71	(194)	544† 492†	0·89	99	572

* Based on ice and firn density measurements on core samples at Maudheim, which give mean density 0·82.
492 m. is the depth to the first reflecting surface in the ice, probably due to morainic material, and 544 m. is the approximate depth to water.

Table 2. Arrival Times of Echoes on Ice Shelves (in milliseconds) after Explosion Time

Station No.	Ice-water interface P Seismometer* No. 1	Ice-water interface P Seismometer* No. 6	PS No. 1	PS No. 6	Double P No. 1	Double P No. 6	Triple P No. 1	Triple P No. 6	Sea bottom P No. 1	Sea bottom P No. 6
178	(130)	(132)	—	—	254	256	376	377	520	522
172	231	233	—	—	—	—	—	—	514	517
170	271	273	407	416	539	540	—	—	772	774
169	281	284	—	—	563	564	—	—	1.143	1,145
167	274	276	—	—	537	538	—	—	429	431

* Seismometers 100–150 m. from shot point.

ates of thickness. In addition, mean densities necessary for such correlation would not fit the values obtained by Schytt[4] at Maudheim to a depth of 100 m., as do the new mean densities shown in Table 1.

In order to interpret the results in a way consistent with the surface height observations, it is necessary to assume that we have been dealing with the second reflexion of a *P* wave at station 178, but with the first reflexion of the *P* wave at the other four stations. The arrival times of the main reflected pulses are shown in Table 2, tabulated according to the new interpretation. The pulse now interpreted as being the *PS* phase at station 170 was originally assumed to be the same as the triple reflexion of the *P* wave at 178, and was considered to favour the preliminary method of interpretation. Confirmation as to whether or not this is the *PS* phase could be obtained by future workers measuring the horizontal component of motion, which should be much larger than the vertical component for short spreads such as we used. Both the vertical component of amplitude in relation to that of the *P* wave reflexion and the mean arrival time of this pulse are of the correct order for the *PS* phase, but, as the spread of arrival times over the six seismometers appears to be about double that calculated, some doubt remains.

Another check on the new interpretation is provided by working out the reflexion coefficient for the energy reflected by the ice-water interface after making allowance for attenuation of the *P* waves. This has been done by measuring the amplitude of successive multiple reflexions, and agreement with the theoretical value is much closer than that provided by the preliminary figures. Finally, a pulse on the records at 178 has been recorded which arrives in the middle of the Rayleigh waves and is apparently the first *P* reflexion at this station. The clarity of the pulse was not sufficient to be taken as an echo on its own merits, but in view of the foregoing it is now assumed to be the first reflexion.

The revised interpretation of the results is shown in Fig. 1. Full use has been made here of the surface heights of the ice shelves in order to estimate changes in ice thickness.

The idea of an approximately constant equilibrium thickness of ice shelves of about 200 m., which was expressed in the preliminary publications, is not correct. It still appears likely that an approximate equilibrium thickness is maintained at a given locality, as indicated by surface levelling at different times at Maudheim, but this 'equilibrium thickness' obviously varies with position. Consequently any equation relating accumulation and spreading of ice sheets must also take into account variations of thickness as the ice shelf moves forward.

The proposal that 'ice hills' form where there is insufficient depth of water to float an ice shelf, which would otherwise be expected to be present, fits the new interpretation of observations still more closely than the earlier interpretation.

As regards the section of the profile over which the ice was resting on rock, no significant changes in

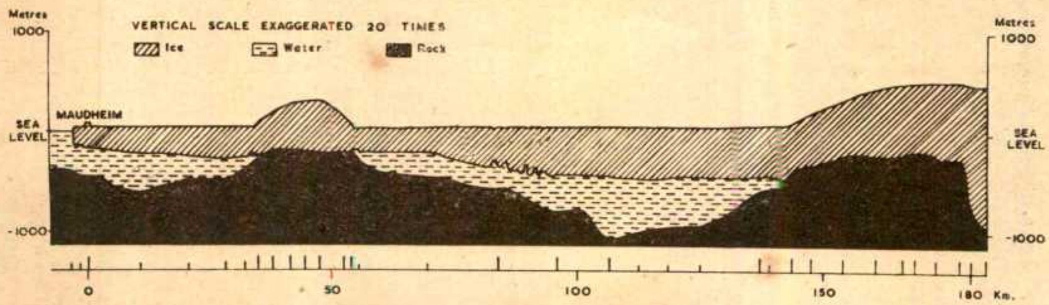

Fig. 1. Main seismic profile. The long vertical lines above the distance scale show points at which echoes were obtained from the bottom of the ice, while the short lines indicate points at which echoes were recorded from the sea bottom only

interpretation from the preliminary publications have resulted from the more detailed study.

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Control of the Staining Procedure after Paper Electrophoresis

WHEN quantitative techniques are attempted for the analysis of serum proteins separated by electrophoresis on filter paper, it is recognized that the staining procedure, followed by removing the surplus stain, constitutes sources of error. In order to get more satisfactory reproducibility we apply on each paper strip (after electrophoresis but before staining) 0·02 ml. of a 0·05 per cent solution of polyethylenimine (Badische Anilin und Sodafabrik, Ludwigshafen (Germany)) in water. This polybase, $-[-CH_2-CH_2-NH_2-]_n-$, has the advantage of being stained by naphthalene black 12 *B* as well as by sudan black; therefore it can be used equally well as a reference substance for protein staining and lipoprotein staining. The molecule (mol. weight approx. 30,000–40,000) of the polybase (called 'Polymine') is of linear build and possesses such an affinity for cellulose that the stained spots cannot easily be eluted but must be estimated by direct-reading colorimetry. The paper strip *a* (see Fig. 1) shows the separation of normal serum proteins (Whatman paper No. 1, *p*H 8·6, 10 V./cm.) and a spot of 0·02 ml. 'Polymine' standard on each side. Strip *a* has been stained with naphthalene black and strip *b* with sudan black. It is well known that in pathological sera the uptake of dyes is variable; in such cases the 'Polymine' standard can serve as a reference because the solubility interrelationships between dye, solvent and polybase are constant.

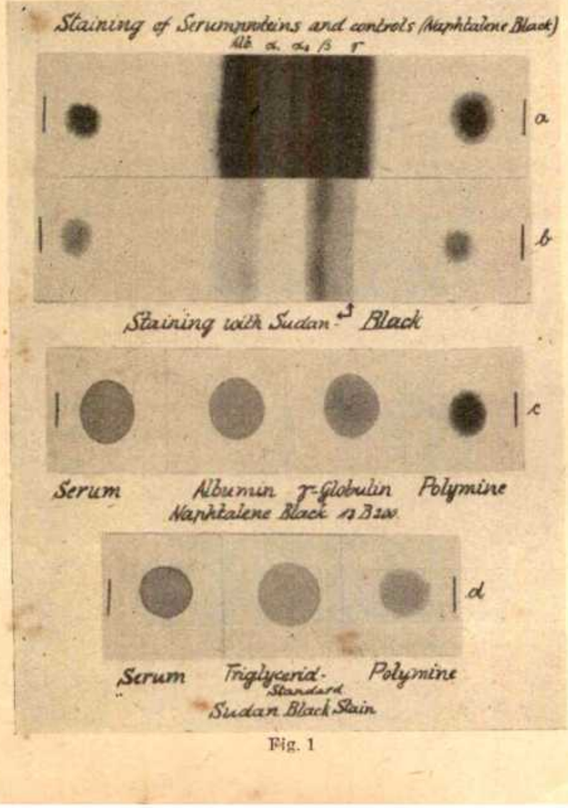

Fig. 1

Table 1

	Volume (ml.)	Amount (γ)	Planimeter reading	First standard deviation
Stained with naphthalene black				
Serum, dil. 1 : 40	0·02	35	0·92	1·8
Albumin, human	0·02	30	0·90	1·7
γ-Globulin, human	0·02	30	0·83	1·6
'Polymine' (0·05 per cent)	0·02	10	1·00	2·0
Stained with sudan black				
Serum, dil. 1 : 1	0·02	150 (lipids)	1·25	1·7
Triglyceride-standard	0·02	80	1·20	1·5
'Polymine' (0·05 per cent)	0·03	15	1·00	2·7

On paper strip *c* the staining of some proteins with naphthalene black is compared with the staining of the 'Polymine' standard on the right. Paper strip *d* is stained with sudan black; in the middle section there is a drop of 0·02 ml. of triglyceride standard, containing 60 γ of triolein and 20 γ of tristearate, which we have used[1] as reference for lipoprotein staining. The spot on the left of it is a drop of 0·02 ml. of normal serum diluted 1 : 1 with sodium chloride (physiol.). The dye uptake of such a drop gives a fair measure of the total lipids of the serum. Table 1 shows the mean results of twenty-five spots of each substance, as read in the electronic densitometer Model 525 of the Photovolt Corp.

The different diffusion (spread) of the spherical colloids (proteins) and the linear colloid ('Polymine') is noticeable.

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A New Solvent for Quantitative Paper Chromatography of Sugars

MANY mobile phases are found in the paper chromatography of sugars; but the separation of sucrose, fructose and glucose is somewhat difficult, because their R_F values are very near each other[1]. The separation is enough for identification purposes, but it is not good enough for elution or photometric readings, because the sugars are still partly mixed. The solvent suggested below divides the sugars quite well with the following R_F values (at 20° C.): sucrose, 0·17; glucose, 0·26; mannose, 0·30; arabinose, 0·32; fructose, 0·32; xylose, 0·33; ribose, 0·41.

The solvent, which was studied for non-volatile organic acids[2], is: normal propyl alcohol, 50 c.c.; benzyl alcohol, 72 c.c.; water, 20 c.c.; 85 per cent formic acid, 20 c.c. It must be freshly prepared. The photometric readings give with this solvent a graph of well-separated curves, so that errors due to the computation of common areas are eliminated.

It is preferable to evaporate the solvent with warm air before spraying with the reagent.

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Ultra-Violet Absorption of Oxygen in Organic Solvents

It has been found that, in a number of organic solvents, dissolved oxygen gives rise to absorption in the far ultra-violet. This absorption is completely eliminated when oxygen is removed by boiling, or by bubbling nitrogen or other gases through the solvent.

In Fig. 1 are shown spectra of cyclohexane at 30° C. in equilibrium with oxygen at several partial pressures. In the wave-length range studied, the absorbance due to oxygen is found to be directly proportional to the partial pressure of oxygen above the solution. Similar spectra have been obtained with *n*-hexane, *n*-heptane, methanol, ethanol and diethyl ether.

To determine whether the absorption might be due to free oxygen, the solubility of oxygen in cyclohexane was measured. At a partial pressure of one atmosphere, approximately 0·27 vol. of oxygen (reduced to standard temperature and pressure) dissolves in one volume of cyclohexane. The absorbance of an equivalent concentration of gaseous oxygen is negligible in the spectral range considered, so the absorption of the solution must be due to interaction between oxygen and the solvent.

Assuming that this interaction results in the formation of a molecular complex which is in turn responsible for the absorption, a reaction of the form $mO_2 + nS \rightleftharpoons (O_2)_m{\cdot}S_n$ with equilibrium constant $k = a_c/a_0{}^m a_s{}^n$ may be supposed to apply, where O_2 is oxygen, S is solvent, m and n integers, and a_c, a_0 and a_s are the activities of the complex, oxygen and solvent respectively. For the activity of oxygen the partial pressure p may be substituted. Assuming, furthermore, that the solution is ideal and that Beer's law holds for the complex, a new equilibrium constant is found: $k' = D/p^m x^n$ (D is the absorbance at a given wave-length due to the complex, and x is the mole fraction of solvent).

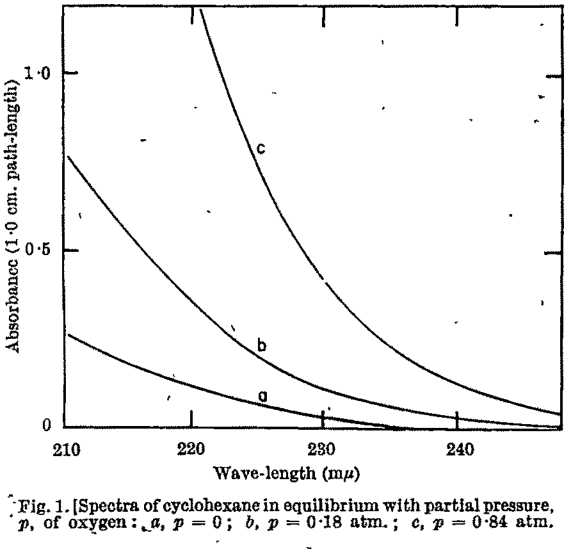

Fig. 1. [Spectra of cyclohexane in equilibrium with partial pressure, p, of oxygen: a, $p = 0$; b, $p = 0{\cdot}18$ atm.; c, $p = 0{\cdot}84$ atm.

As the solvent is present in large excess, x is essentially independent of p. Consequently, from the proportionality of D to p, one must conclude that $m = 1$.

The value of n was found by determining the dependence of absorbance on solvent composition, for a series of mixtures of cyclohexane and *n*-heptane at a given partial pressure of oxygen. The absorbance was considered to be the sum of the absorbances of the cyclohexane and of the *n*-heptane complexes, the contributions of each being governed by the separate equilibrium constants k'.

As oxygen absorbs considerably less in *n*-heptane than in cyclohexane, although equally soluble in the two solvents, definite conclusions could be drawn only with regard to the latter. The results indicate that, for cyclohexane, $n = 1$; or, in other words, cyclohexane and oxygen form a 1 : 1 molecular complex.

This investigation was supported by a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth, National Research Council. One of us (J. F. S.) was a Scholar in Cancer Research of the American Cancer Society.

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Ectotrophic Mycorrhiza in Renantherous Species of *Eucalyptus*

There appear to be in the literature no detailed studies of mycorrhiza in *Eucalyptus*. Brief references are made by Samuel[1], in South Australia, and Smith and Pope[2], in South Africa.

It might be thought mycorrhiza plays no significant part in success or failure of *Eucalyptus* introductions since so many species have been successfully cultivated as exotics in numerous countries. While this is true of *Eucalyptus* as a whole, introduction records show that species of the group *Renantherae* are largely exceptional to this.

The failure of the *Renantherae* is striking when it is realized that they have been introduced on many occasions because they contain a larger percentage of good timber species than any other group of the genus. The situation is well illustrated by records from Cyprus. Chapman[3] lists twenty-one renantherous species in a total of about seventy introductions since 1878; but not one of them could be found growing on the island in 1953, although representatives from all other groups were found.

Table 1

	Heat-sterilized soil + *Scleroderma* spores			Heat-sterilized soil		
	Growth* (6 mths.) (in.)	Colour	Mycorrhiza	Growth* (6 mths.) (in.)	Colour	Mycorrhiza
Renantherae						
E. dives	5·3	Normal green	Abundant	3·2	Yellowish	Nil
E. pauciflora	6·2	Normal green	Common	3·3	Yellowish	Nil
E. macrorrhyncha	11·3	Normal green	Abundant	7·8	Yellowish	Nil
Macrantherae						
E. bicostata	9·5	Normal green	Nil	8·3	Normal green	Nil

* Average maximum growth in height. There were many seedlings per pot

The *Renantherae* have been found on genetic grounds to be a very distinct natural unit within the genus *Eucalyptus*[4]. They differ from the rest of the genus in many respects, and this led to the idea that their mycorrhizal requirements may also differ. Experience in Iraq in 1953 at the forest nursery at Eski Kellek supported this view. Here some eucalypts grew easily, and the plants were as healthy and vigorous as stock of a similar age grown under comparable conditions in Australia. Species of the *Renantherae*, however, raised there at the same time, were weak and chlorotic and mostly died. The particular species were *E. dives*, *E. pauciflora*, *E. robertsonii* and *E. fastigata*. Afterwards, in Australia, at Canberra, similar symptoms were induced in the same species by growing them in soil sterilized by heating. This effect is contrary to that commonly obtained using sterilized soil, as Stahl[5] demonstrated by his well-known experiments, and indeed his results apply to most *Eucalyptus* species other than the *Renantherae*.

Trials were continued to test the idea that lack of mycorrhiza was responsible for failure. Three species of the *Renantherae*, *E. dives*, *E. pauciflora* and *E. macrorrhyncha*, were used and compared at the same time with *E. bicostata*, belonging to the group *Macrantherae-Normales*. Pot cultures using spores from fruiting bodies of the gasteromycete, *Scleroderma flavidum*, were made for comparison with plants in sterilized soil to which spores were not added. *Scleroderma flavidum* was chosen because its fruiting bodies are found closely associated with *E. pauciflora* and *E. robertsonii* in experimental plantations near Canberra. Spores were applied liberally ½ in. below the final surface and the pot was then filled up with more heat-sterilized soil so that the growing roots had to pass through the spore layer. After four months there were distinct differences, as shown in Table 1.

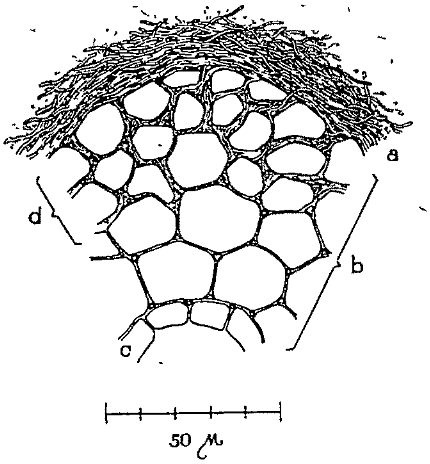

Fig. 1. Cross-section of a mycorrhiza of *E. macrorrhyncha* and *Scleroderma flavidum*, showing (*a*) hyphal mantle, (*b*) cortex, (*c*) endodermis, (*d*) Hartig net

Good growth and good colour in the *Renantherae* were accompanied by the development of mycorrhiza following the application of *Scleroderma* spores, whereas *E. bicostata* grew equally well with or without the spores and did not produce mycorrhizas. The mycorrhizas in the three renantherous species were clearly visible on the outside of the ball in the pot and consisted of a thick hyphal mantle and a coralloid branching habit characteristic of the ectotrophic mycorrhiza of some hardwoods. Microscopic examination of that on *E. macrorrhyncha* showed a dense, thick hyphal mantle outside the root epidermis with a distinct Hartig net penetrating to a depth of two or three cortical cells, and exhibiting a structure (Fig. 1) closely comparable with that of ectotrophic mycorrhiza figured by Björkman[6]. The experiment shows, therefore, that *Scleroderma flavidum* is able to form an ectotrophic mycorrhiza with three renantherous species and that these grow healthily in heat-sterilized soil if *Scleroderma* spores are added; but they do not form mycorrhizas and grow poorly in soil sterilized by heating if no fungus is added. While it is probable that ectotrophic mycorrhiza occurs in species in other groups of the genus, it seems clear that it is not essential for thrifty growth in these. The experiment and observations suggest that the failure or indifferent growth of many species of the *Renantherae* in the northern hemisphere may be corrected by inoculation with the appropriate fungus. Some of the best timber-producing species are renantherous, such as *E. regnans*, *E. fastigata*, *E. gigantea*, *E. pilularis*, *E. marginata* and *E. obliqua*.

There are reasons for thinking that the situation may differ in the southern hemisphere, and there are records of satisfactory growth of renantherous species in both New Zealand and South Africa. It may well be that there is a degree of affinity in the fungal flora of these three countries, as is the case with the higher plants, which leads to the presence of adequate mycorrhiza-forming fungi.

A more detailed account will be published elsewhere. I am indebted to Dr. Erwin Gauba for the microscopic preparation and to Mr. O. Ruzicka for the drawing.

L. D. Pryor

Parks and Gardens Section,
Department of the Interior,
Canberra.
Nov. 22.

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[2] Smith, N. J. G., and Pope, F. B., *Trans. Brit. Mycol. Soc.*, **19**, 95 (1934).

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, March 26

Chemical Society (in the Great Hall, The University, Nottingham), at 9.30 a.m.—Symposium on "Antibiotics and Mould Metabolites".

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square, London, W.C.1), at 7 30 p m —Dr. E. F. Hersant · "Analysis and the Pharmacist".

Tuesday, March 27

Chemical Society (in the Great Hall, The University, Nottingham), at 10.45 a.m.—Prof. W. Wardlaw: "Alkoxides, Old and New" (Presidential Address).

Bone and Tooth Society (at the Institute of Orthopædics, 234 Great Portland Street, London, W 1), at 5 p.m.—Symposium on "Bone Tumours". Dr. A. D. Thomson. "The Classification of Bone Tumours"; Dr. C. H G. Price: "Primary Osteogenic Tumours of the Skeleton and Their Relationship to Bone Growth and Metabolism"; Dr. H. A. Sissons: "Experimental Bone Tumours".

Chadwick Trust (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5 30 p.m.—Dr. B. A. Southgate: "A Survey of Progress in the Control of Stream Pollution"* (Chadwick Public Lecture).

Institution of Electrical Engineers, Measurement and Radio Sections (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. E. Franklin and Mr. J B James: "The Applications of Transistors to the Trigger, Ratemeter, and Power Supply Circuits of Radiation Monitors".

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m.—Mr. J F. Harper · "The Rise of the Aircraft in Pest Control Agriculture".

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. R. K. Sandiford: "Atomic Energy Plant Instrumentation".

Wednesday, March 28

*Chemical Society (in the Great Hall, The University, Nottingham), at 11 a.m.—Prof Dr. Otto Hahn · "Personal Reminiscences of a Radiochemist" (Faraday Lecture).

British Nuclear Energy Conference (in the Lecture Hall, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S W.1), at 3 p.m.—Symposium on "Nuclear Energy".

Physical Society, Colour Group (at the Victoria and Albert Museum, South Kensington, London, S.W.7), at 3.15 p.m.—Annual General Meeting. 3 30 p.m.—Mr H. L. Gloag and Dr. R. G. Hopkinson: "Colour and Lighting in Buildings".

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p m.—Mr. K. E. Harris: "Some Problems of Secondary Surveillance Radar".

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. F Seligman: "Some Aspects of the Use of Radio-Isotopes".

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 30 p.m.—Dr. Frank Wokes and Mr. John J. Doherty. "The Use of Recovery Experiments in Fluorimetric Assays of B Vitamins in Food"; Dr. J. M. Shewan and Dr N. R. Jones: "Chemical Changes Occurring during the Spoilage of Chilled Fish and their Relation to Freshness Tests".

Oil and Colour Chemists' Association (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m —Dr J. E. O. Mayne: "Current Views on How Paint Films Prevent Corrosion".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr A. V. Cleaver: "Artificial Space Satellites".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Scientific Officer, Grade 1 (with a university degree of high standard with chemistry as a major subject, or equivalent qualifications, and preferably some research experience) in the Defence Standards Laboratory, Department of Supply, Maribyrnong, Victoria, Australia, to carry out research on explosives, particularly in the fields of initiation and detonation—The Senior Representative AP.48), Department of Supply, Australia House, Strand, London, W.C.2 (March 29).

Senior Lecturer (with a university degree and good industrial and/or teaching experience) in Electrical Engineering, to teach electrical engineering measurements and servo-mechanisms to post-Higher National Certificate standard, and to be responsible for organizing laboratories—The Principal, School of Electronics (Ministry of Supply), Radar Research Establishment, Malvern, Worcs March 29).

Physicist (preferably with an honours degree in physics or mathematics) in the Nuclear Power Branch at Headquarters in London, to take charge of a small section responsible for the theoretical and economic aspects, and longer-term applications of nuclear power, and the physics problems arising therefrom—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. ND/6 (March 30)

Lecturer in Mathematics—The Principal, Borough Road College, Isleworth (April 2).

Lecturer (with special qualifications in physical chemistry or in inorganic chemistry) in the Department of Chemistry—The Registrar, University College, Singleton Park, Swansea (April 4).

Lecturer (with a good university degree, preferably in electrical engineering, and a special interest in, and experience of, electrical engineering materials, for example. solid and liquid dielectrics, insulation, and magnetic materials) in Electrical Engineering—The Registrar, The University, Birmingham 15 (April 6)

Demonstrator or Assistant Lecturer (with a good honours degree in physiology, biochemistry or chemistry with subsidiary physiology) in the Department of Physiology—The Registrar, The University, Manchester 13 (April 9)

Head (with high academic qualifications, preferably an honours degree in mining, practical mining experience, and teaching experience) of the Mining and Geology Department—The Principal, Wigan and District Mining and Technical College, Wigan (April 9).

Lecturer in Chemical Engineering—The Principal, College of Technology, Manchester (April 9).

Reader or Senior Lecturer in Veterinary Anatomy at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 12).

Entomologist (with an honours degree in zoology or other suitable qualification) for fundamental and applied research on insect pests of sugar beet—The Secretary, School of Agriculture, Cambridge (April 14).

Lecturer in Biochemistry—The Secretary, The University, Exeter (April 14).

Lecturers (2) in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (April 14).

Population Ecologist (with an honours degree in science, preferably with research experience in the problems of insect population ecology) in the Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T, Australia, to be one of a group of ecologists working on fundamental field and laboratory studies, under the leadership of Dr. A. J. Nicholson, in particular studying the factors which regulate the abundance of certain forest and orchard pests—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C 2, quoting Appointment No. 180/105 (April 14).

Research Meteorologist (with a university honours degree in meteorology, physics or mathematics, and postgraduate experience of research in synoptic and dynamic meteorology) in the Division of Meteorological Physics, Commonwealth Scientific and Industrial Research Organization, Australia, to join a small group working on certain fundamental aspects of dynamic meteorology and the general circulation, and on intensified studies of some local synoptic problems, for example, the cold front of S E Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 420/94 (April 14).

Lecturer (with special qualifications in physical and/or inorganic chemistry) in Chemistry, in St. Salvator's College—Joint Clerk to the University Court, The University, College Gate, St. Andrews (April 15).

Assistant Lecturer in Zoology—The Registrar, The University, Manchester (April 16)

University Demonstrator (with a broad scientific education, and experience in some branch of chemical engineering, mechanical engineering or physics) in Chemical Engineering—The Secretary of the Appointments Committee, Department of Chemical Engineering, The University, Tennis Court Road, Cambridge (April 17).

Lecturer in Mathematics in St Salvator's College—Joint Clerk to the University Court, The University, College Gate, St. Andrews (April 21).

Assistant in Physiology—The Secretary of University Court, The University, Glasgow (April 30).

Lecturer in Physiology—The Secretary of University Court, The University, Glasgow (April 30)

Lecturer or Assistant Lecturer in Clinical Parasitology in the Veterinary School—The Registrar and Secretary, The University, Bristol (April 30).

Lecturer (preferably with a medical qualification, and some experience in teaching and research) in Pharmacology, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, April 30).

Lecturers (2) (with good academic qualifications and practical experience) in the Department of Mechanical Engineering—The Registrar, The University, Bristol 8 (April 30).

Professor of Nuclear Physics and Director of the Nuclear Physics Research Unit, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 30).

University Students and Fellows for research in experimental or theoretical nuclear physics—The Professor of Natural Philosophy, The University, Glasgow (April 30).

Geologist (with a degree or equivalent in geology, and a satisfactory knowledge of (*a*) petrology and mineralogy or (*b*) the geology and mapping of glacial and other unconsolidated deposits, or (*c*) stratigraphy and palæontology) in the Irish Geological Survey—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (May 17).

Assistant Lecturer and a Lecturer in the Department of Applied Mathematics—The Registrar, The University, Liverpool (May 23).

Associated Electrical Industries Fellows (2), one in the Department of Physics and one in the Department of Engineering—The Secretary-General of the Faculties, University of Cambridge, The Old Schools, Cambridge (May 31).

Assistant, Grade B (preferably with an honours degree, and with either teaching, research or industrial experience) in Physics—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

Chemist (with a first- or second-class honours degree in chemistry and at least two years research experience, either postgraduate or in industry), to undertake original research on the chemical constitution of coal and the basic chemistry of its use, in co-operation with a team of workers at present engaged in studying these problems—The Assistant Secretary, Ref. C.16, British Coal Utilization Research Organization, Randalls Road, Leatherhead, Surrey.

Departmental Demonstrator in Engineering Science for duties which will include both lecturing and undergraduate instruction in the laboratories—Prof. A. Thom, Department of Engineering Science, 19 Parks Road, Oxford.

Laboratory Technician (with bacteriological or virological experience) for Virus Research—The Medical Superintendent, Harvard Hospital, Salisbury, Wilts.

Master to teach Mathematics—The Head Master, Cheltenham Grammar School, Cheltenham.

Physical Chemist (with at least a first- or second-class honours degree in chemistry or chemical engineering, and many years experience), to lead a team consisting of chemists, chemical engineers and engineers carrying out development in a new field of inorganic materials technology—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1068/34.

Physicists (Scientific Officer, Experimental Officer or Assistant Experimental Officer grade), at Ministry of Supply Research and Development Establishments, near Farnborough, Hants; Malvern, Worcs; Salisbury, Wilts; and Sevenoaks, Kent, for work on guided missiles, aircraft and aircraft equipment, gas turbines, instrumentation or electronic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.77/6A/BN.

Principal Scientific Officer (Fuel Technology and Chemical Engineering) (with at least a second-class honours university degree or equivalent professional qualifications, and experience in chemical engineering and fuel technology), with the East African Industrial Research Organization, Nairobi, Kenya, to undertake research and development in industrial technology, including processing of crop products, and to study fuel economy in various industries, and generally provide technical assistance to these—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.195/463/02.

Research Fellow (with a good honours degree or equivalent and some specialized experience of paint and/or building materials, and preferably some research experience) to investigate problems of use and behaviour of paint on buildings in tropical climates—Colonial Office, Research Department (S.608), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Scientific Officers (with a first- or second-class honours degree or equivalent in electrical engineering, physics or mathematics) at the National Physical Laboratory, Teddington, Middlesex, for work on control mechanisms and electronics, principally the development of digital computers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.90/6A.

Scientific/Senior Scientific Officer (with an honours degree in engineering or physics, and preferably with experience of research and experimental work), at a Ministry of Fuel and Power peat experimental station near Falkirk, Stirlingshire, for work on mechanical winning, pressure dewatering and drying of peat for use in power stations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting C.956/5A.

Senior Assistant (Scientific) (with a knowledge of pulse techniques, high speed oscillography and methods of measuring small time intervals) at the Atomic Weapons Research Establishment, Aldermaston, for development of electronic timing and control equipment for routine testing of explosive items—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. A 551/34.

Senior Scientific or Scientific Officers (with a first- or second-class honours degree or equivalent in mathematics, physics or engineering) at the Ministry of Supply London Headquarters, for co-ordination of aerodynamic research at research establishments, and of research projects at aircraft firms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.78/6A/BN.

Technical Officer (with a degree in botany or agriculture or equivalent qualifications and a knowledge of herbage strains, and preferably some practical experience in seed production) in the Herbage Section of the Seed Production Branch—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

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REPORTS and other PUBLICATIONS

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Great Britain and Ireland

A Critical Study of Electrical Stunning and the Jewish Method of Slaughter (Shechita). By Rabbi Solomon David Sassoon. Third edition. Pp. v+48+2 plates. (Letchworth: Rabbi Solomon David Sassoon, 1955.) 2*s*. 6*d*. [181

Dunlop Research. Pp. vi+78. (London: Dunlop Rubber Co., Ltd., 1955.) [181

Wiggin Nickel Alloys No 37: 50 Years of Monel. Pp. 18. (London: Henry Wiggin and Co, Ltd., 1955.) [181

Macaulay Institute for Soil Research. Collected Papers, Vol. 4, 1951–1954. Pp. 16+70 Papers. (Craigiebuckler: Macaulay Institute for Soil Research, 1955.) [181

Northampton Polytechnic. Report of the Governing Body for the year 1954–55. Pp. 20. (London: Northampton Polytechnic, 1955.) [181

The Baker Interference Microscope. Second edition. Pp. vi+39+9 plates. (London: C. Baker of Holborn, Ltd., 1955.) [181

Library Association. Students' Handbook, 1956. Pp. 277. (London: Library Association, 1956.) 3*s*. 6*d*. [181

Ministry of Agriculture, Fisheries and Food. Fishery Investigations. Series 2, Vol. 18, No. 7: Production and a Pelagic Fishery. By D. H Cushing. Pp. vi+104+2 plates. (London: H.M. Stationery Office, 1955.) 12*s*. 6*d*. net. [181

West of Scotland Agricultural College. Advisory Leaflet No. 44: Seed Mixtures for Hill Farms. By I. V. Hunt. Pp. 4. (Glasgow: West of Scotland Agricultural College, 1955.) [181

Bulletin of the British Museum (Natural History). Zoology. Vol. 3 No. 5: The Monk Seals (Genus *Monachus*). By Judith E. King. Pp. 201–256+plates 3–8. (London: British Museum (Natural History), 1956.) 18*s*. [181

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Svenska Linné-Sällskapets Årsskrift, Årgång 37–38. 1954–1955. Pp. 192. (Uppsala: Almqvist and Wiksells Boktryckeri AB., 1955.) [181

Reports of the Great Barrier Reef Committee. Vol. 6, Part 2: A Survey of the Distribution of Reef Coral Genera in the Great Barrier Reef Region. By John W. Wells. Pp. 9. (Brisbane: Government Printer.) [181

Atvinnudeild Háskólans—Fiskideild. (The University Research Institute: Department of Fisheries.) Rit Fiskideildar, 2 Bindi, Nr. 2. Temperature Variations in the North Icelandic Coastal Area. By Unnsteinn Stefánsson. Pp. 27. Fjölrit Fiskideildar. Nr. 3: Rannsóknor á Fituinnihaldi Sunnansildar. Eftir Hermann Einarsson og Unnsteinn Stefánsson. Pp. i+8. Nr. 4: Yfirbordshiti Sjávar vid Strendur Islands Árin 1949–1953. (Surface Temperature in Icelandic Coastal Waters during 1949–1953.) Eftir Unnsteinn Stefánsson. Pp. 1+29. Nr. 5. Sildarrannsóknor "Aegis" Sumarid 1954. (Herring investigations with the Research vessel "Aegir" in the summer 1954.) Eftir Jón Jónsson og Unnsteinn Stefánsson. Pp. i+34. (Reykjavik: Atvinnudeild Háskolans—Fiskideild, 1953–1955.) [181

National Institute of Genetics, Japan. Annual Report, No. 5 (1954). Pp. iv+90. (Misima, Sizuoka-ken: National Institute of Genetics, 1955.) [181

Federation of Nigeria. Annual Report on the Geological Survey Department for the year 1953–54. Pp. v+25. (Lagos: Government Printer; London: Crown Agents for Oversea Governments and Administrations, 1955.) 9*d*. [191

Tenth Annual Report of the Council of the Queensland Institute of Medical Research, year ended 30th June, 1955. Pp. 15. (Brisbane Government Printer, 1955.) [191

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Det Kongelige Industri-, Handverk- og Skipsfartsdepartement. Norsk Polarinstitutt. Skrifter Nr. 104: Tidal Observations in the Arctic, 1946–52. By Helge Hornbaek. Pp 17. 2,50 kronor. Skrifter Nr. 105: Die Arktische Trichinose und ihr Verbreitungsweg. Von Otto Hornbaek und Hans Walter Schmidt. Pp. 34. 4 kronor. Skrifter Nr. 106: Cambrian and Ordovician Fossils from Sørkapp Land, Spitsbergen. By Harald Major and Thore S. Winsnes. Pp. 47+5 plates. 4 kronor. Skrifter Nr. 107; Stratigraphy of the Marine Late-Pleistocene of Billefjorden, Vestspitsbergen. By Rolf W. Feyling-Hanssen. Pp. 186+27 plates. 22 kronor. (Oslo: Brøggers Boktrykkeris Forlag, 1954 and 1955.) [191

International Scientific Radio Union. Proceedings of the 11th General Assembly held in the Hague from August 23rd, to September 2nd, 1954. Vol. 10, Part 6: Commission 6 on Radio Waves and Circuits. Pp. 140. (Brussels: International Scientific Radio Union, 1955.) 150 Belgian francs; 21*s*. 6*d*.; 3 dollars. [191

United States Observatory. Circular No. 63: Positions, Areas, and Counts of Sunspots, September, 1955 By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: United States Naval Observatory, 1955.) [191

Memoirs of the Indian Meteorological Department. Vol 30, Part 3: A Study of Fifty Years' Rainfall of Mangalore By K. P. Ramakrishnan and J. Narayanan. Pp. 101–153+plates 1–3. (Delhi: Manager of Publications, 1955.) Rs. 6/13/–; 11*s*. [191

East Africa High Commission. East African Virus Research Institute Report, January 1954–June 1955. Pp. i+28. (Nairobi: Government Printer, 1955.) [191

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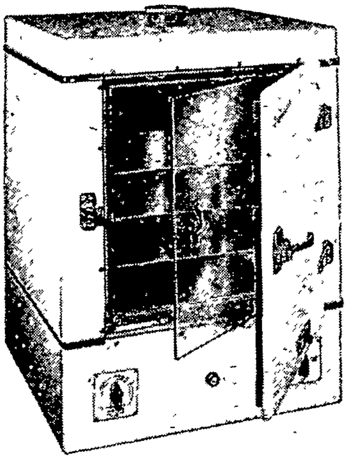

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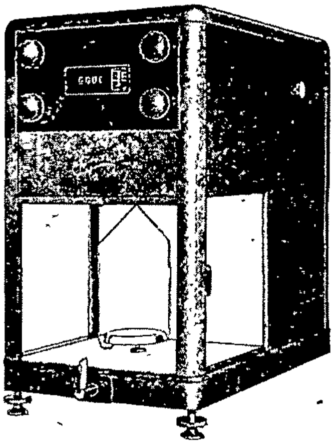

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TECHNICAL EDUCATION IN BRITAIN

SUPPORTED by some notes on technical man-power in the United States, Soviet Russia and Western Europe, and by a report on 'sandwich' training and education from the National Advisory Council on Education for Industry and Commerce, the Government has issued, on the last day possible to redeem its promise, a White Paper on Technical Education*. Apart from the fact that it excludes agricultural education, it is an admirable tract for the times; and the programme it sets forth is accompanied by accounts of technical education in England and Wales and in Scotland which are both readable and put technical education in reasonable perspective in the education system of the country as a whole. The programme includes some sound proposals, but although the White Paper bears evidence of the haste with which it was produced, it is difficult to discover in the plan now outlined any evidence of deep thinking or new initiative that would account for the long delay. On the face of it, this programme could well have been enunciated when the statement rejecting the idea of a technological university was made in December 1954.

As it is, although the way has been cleared to some extent by the further statements made last year regarding technology at the universities and the expansion of the Imperial College of Science and Technology, the piecemeal approach persists. We have still to wait for the universities to produce their plans for technological education for the quinquennium 1957–62, and until these plans have appeared it is impossible to judge how far the £100 million it is now proposed to spend on technical education will go towards fulfilling the Prime Minister's declared intention of January 18 of making good the present shortage of scientists, engineers and technicians.

What needs to be remembered, in the first place, is that the measures now proposed are measures to meet a crisis: they are ameliorative rather than preventive. The White Paper contains fresh evidence of how this sustained piecemeal approach frustrates any effective policy and places obstacles in the way of those who seek to evolve a rational system of education for Great Britain which would eliminate the recurrent difficulties; and not only afford full opportunity to talent of every kind, but also ensure that at every stage facilities exist for bringing out the full potential energy of the population and encouraging its interests in directions that are most desirable socially. There is little in the White Paper to warrant confidence that the nation will get the maximum value from the expenditure now proposed. Indeed, apart from anything else, too much depends on factors outside the Government's control: on the extent to which the co-operation rightly required from the public—from parents and teachers, from the local authorities, from the universities and from industry—is in fact achieved. Government by exhortation has its points, but it has its weaknesses also.

To the extent to which the policy outlined in the White Paper depends on public understanding and support, the Government has been wise to cast it largely in the form of a tract for the times, and to take advantage of the interest which has been aroused of late by comparisons with scientific and technical man-power in the United States and in Soviet Russia such as Lord Simon, Dr. A. V. Bowden, Sir Francis Simon and Sir Solly Zuckerman, and Mr. Nicholas de Witt in his recent book on Soviet professional man-power, have made. Nevertheless, while the White Paper deprecates excessive attention to such comparisons and stresses the circumstances which determine the particular needs of Britain for trained man-power, the magnitude of those needs is not appraised. We are given estimates of the potential supply and the generalized statement that as many as six or seven technicians may be required for one scientist or technologist, but no estimate of the probable demand. It is assumed that useful occupations can be found for all who can be trained.

That may well be true within the proviso that we give sufficient attention, as the White Paper recognizes, to encouraging adaptability and finding a place in technical studies for liberal education. Technical education, it insists, must not be too vocational or confined to one skill or trade; and more attention must be given to the teaching of good plain English, if only to facilitate bridging the gaps that separate experts in different specialized subjects from the general public as well as from one another. Nevertheless, if we are to win the support of parents, they must be convinced that there is every reasonable prospect of a satisfying career open to the boys and girls who enter technical colleges or colleges of technology.

That, of course, is one of the first conditions of success in the first and most difficult step, namely, raising the number of entrants to advanced courses in technology and securing as corollary a sharp reduction in the number of early leavers. It is, moreover, in such qualitative proposals that the White Paper offers most hope of advance, for those proposals could contribute much to the success of a more fundamental and considered long-term policy such as we have yet to see. It attacks, for example, the excessive reliance on evening classes, which are more wasteful alike of students and of staff than day classes, and proposes to double the numbers released for employers for part-time day courses. Similarly, it comes out strongly in favour of the 'sandwich' courses, which Dr. P. F. R. Venables in his recent book regarded as one of the most encouraging signs of the times; and it recognizes the reserve of talent available in modern secondary schools, which is probably best tapped by the technical colleges, as well as that available in girls schools, if girls can be induced to seize the opportunities for a congenial career which science and technology can offer.

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* Technical Education. Pp. 44 (Cmd. 9703.) (London: H.M. Stationery Office, 1956.) 1s 6d. net.

Beyond pointing to this reserve of talent and stressing the need for rousing the interest and co-operation of parents, the White Paper makes no practical suggestions as to how this is to be achieved. It does, however, make the important proposal that students proposing to attend courses leading to a technological award shall be eligible for Technical State Scholarships, and the number of these Scholarships, which are already available to those employed in industry to enable students of outstanding ability to pursue honours degree courses at universities or elsewhere, will be raised as the capacity of such advanced courses at technical colleges is increased from the present 9,500 to the proposed 15,000. Moreover, to encourage boys and girls to enter such courses straight from school, it is proposed in future to allow State Scholarships awarded on the results of the General Certificate of Education examinations to be held for courses leading to a technological award as well as for honours courses at universities.

Much here is left to the co-operation of the local education authorities in assisting such students with major awards at rates equivalent to those paid to university students, and to the assistance of industry in paying the fees of students attending advanced sandwich courses. The Government is clearly wise to seek such co-operation, but it should be fostered and stimulated as sedulously as possible. More thought might well be given to ways and means than appears on the surface in the White Paper.

It is here, however, that the piecemeal approach is at a disadvantage, and it is with the provision made for expanding the number of full-time or sandwich courses in advanced technology that doubts enter as to the effectiveness of the Government's proposals. The Government proposes that the bulk of the full-time or sandwich courses should be carried on in colleges which concentrate on advanced courses at technological level; and for this purpose it is advocated that, within the five years over which the new grant of £70 million for building and £15 million for equipment is to be expended, the twenty-four colleges at present receiving 75 per cent grant for certain of their advanced work shall divest themselves of work below the advanced level and develop speedily into colleges of advanced technology. It is also contemplated that a few other colleges may qualify for 75 per cent grant, and it appears to be implied in the White Paper that these also may develop into colleges of advanced technology. Indeed, the Minister of Education was pressed specifically in the House of Commons on March 8 to make further provision in the West Riding of Yorkshire and on Tees-side.

It would not appear that by the term 'college of advanced technology' the Government has in mind anything like the Manchester College of Technology or the Royal Technical College, Glasgow; but beyond reference to the fact that the former institution will come under the ægis of the University Grants Committee, there is no indication as to what the distinction is. Moreover, the belief that the Government has not even yet grasped the implications of its proposals is further encouraged by the statement that the part-time advanced courses provided in some one hundred and fifty local colleges conveniently placed for the students and part-time staff who work in industry make, and will be expected to continue to make, a vital contribution to the total output of technologists. In spite of sound definitions of technologists and technicians given in the White Paper, there is little indication that the distinction has been given due weight in the Government's proposals, or that the results of the inquiry into scientific and technical man-power now being carried out by the Technical and Scientific Technical Register of the Ministry of Labour and National Service are likely to be given due weight when they are published later this year. Meanwhile, Sir David Eccles suggested tentatively on March 8 that roughly one-fifth of the £70 million would be required for colleges of advanced technology or for branch colleges to relieve them of less advanced work.

It is not simply that, in the absence of the facts which such an inquiry alone can provide, no sound apportionment of resources of Britain between technical and technological education can be made. Equally important is the question whether we have the resources to establish twenty or thirty colleges of technology, and whether in attempting to do so we may not instead so disperse our resources that most of these colleges will have neither the independence, the status nor the financial resources to enable them to attract staff of the requisite calibre, or students to provide the country with a sound investment from the resources applied. The White Paper admits that regional planning must play a larger part in future if there is to be reasonable economy in buildings and staff, but the Government largely closes its eyes to the inevitable effect on the administration of such colleges.

That the administration of a college of technology is possible in association with local government is shown by the development of the Manchester College of Technology. That example, however, shows the way in which autonomy and civic pride and interest can be reconciled; but it is to be feared that in its reliance on local authorities in this matter the Government is guilty of wishful thinking, just as it is over the National Council for Technological Awards. The folly of refusing to face the facts was clearly shown by Dr. Venables in commenting on regional colleges in his recent book, and the White Paper advances no evidence to suggest that any improvement is to be expected short of placing colleges of technology like the Manchester College of Technology either under the University Grants Committee or, perhaps better still, under a Technological Grants Committee of similar status and powers and possibly charged also with the supervision of technical education in general. Until this is done, the colleges of technology in Britain are unlikely to enjoy either academic autonomy or the status which will enable them to attract teaching staff of high calibre; and even if they have a sufficiently secure financial basis for long-term planning, the local authorities responsible for the college are likely to be subject to an unreasonable strain of loyalties. Local bodies should not be expected to finance national or even wide regional purposes out of local funds; indeed, as Alderman Barber, chairman of the Bradford Education Committee, has remarked, it is impossible for a local authority, however generous or determined, to ignore the limitations imposed by the amount of rates it can raise.

Dr. Venables's restrained but reasoned argument has been ignored by the Government; and little confidence will be entertained elsewhere in the outcome of the Minister of Education's attempt to induce local authorities generally to establish strong governing bodies widely representative of industry and with powers to spend within the needs of annual estimates approved by the authority. Even if the Ministry of Education possessed the requisite experience, the Minister is not meeting Dr. Venables's point as to the need for a quinquennial or similarly secure long-term basis of planning such as the University Grants Committee supplies—a factor particularly important if the colleges are to develop, as the White Paper suggests, a substantial amount of research, especially research sponsored by industry, or to initiate post-graduate studies. The importance of academic autonomy and status is sadly under-rated by the Government. To bring the colleges of technology under the ægis of a national body of the character of the University Grants Committee, if not that body itself, would do more in a few months to give them the standing and independence which would attract first-class teaching staff than the new award to be given by the National Council for Technological Awards is likely to achieve in many years. Such merits as the latter proposal may possess are long-term in character, and what is needed is, as the Government protests, immediate, if not emergency, action.

But there is another respect in which the White Paper treats the staff issue too lightly. To establish a Technological Grants Committee or to bring the colleges of technology under the University Grants Committee would enable the colleges to compete on more even terms for highly qualified staff and would be far more effective than improved salaries alone. To prune more severely in accordance with material resources the number of colleges to be upgraded to perhaps a dozen or so would also assist, and at the same time ease the difficulty with local government which appears to cause the Government so much concern. Neither step, however, would entirely remove the difficulty over the number of teachers.

This is the weakest spot in the Government's proposals in the White Paper. It is admitted that many more teachers will be required to achieve the objectives set out in the White Paper, and the importance of quality is also recognized. Nevertheless, there is no appreciation that different types of teachers may be required for the technical colleges and technical schools and for the colleges of technology. The existing shortage of science teachers is ignored, and the Government merely expresses the hope that industry will be ready "to release yet more of its employees for part-time teaching during the day, so that its apprentices may be given the more thorough grounding which modern conditions require"; and that by offering the right conditions of service for technical college staff, local education authorities will be able to attract a reasonable share of the available technical man-power.

This is not a policy, and though the White Paper's proposals cannot be fully judged until it is known later in the year what the universities propose to do for technological education over the next quinquennium, it is hard to believe that the proposals now advanced will prove effective in the absence of the measures suggested in regard to academic autonomy and continuity. Pending the results of the inquiry now in progress under the Minister of Labour and National Service, it is to be hoped that the development of further colleges of advanced technology in Britain will proceed with caution, and that more attention will be given to the needs of the technicians. Meanwhile, however, if the organization of sandwich courses is vigorously implemented and also the new proposals for financial aid to students of technology, and if effective measures are taken to secure greater co-operation from industry and the support and understanding of parents, particularly a wider appreciation of the opportunities of careers in technology for girls, substantial steps will have been taken towards better adaptation of at least the functioning of the whole educational system of Britain to meet the nation's needs to-day. But there should also be proceeding a review of the educational system as a whole, qualitatively as well as quantitatively, in which a much more fundamental regard than is apparent in the White Paper is shown, not merely to the nation's needs for trained man-power but also to the purpose of education, to the relations at the different levels and equally to the needs of youth as individuals and citizens, no less than as scientists or technologists, as teachers, as technicians or as craftsmen.

RESEARCH REACTORS IN THE UNITED STATES

Research Reactors

(Selected Reference Material on Atomic Energy.) Prepared by the United States Atomic Energy Commission. Pp. xii+442. (London: McGraw-Hill Publishing Co., Ltd., 1955.) 49*s*.

THE United States Atomic Energy Commission prepared for the Geneva International Conference on the Peaceful Uses of Atomic Energy six volumes summarizing United States work in various fields of atomic energy, of which this handsomely produced book is one. It describes eight of the principal types of research reactors used in the United States, ranging from a 1-W. water-boiler type of reactor to the 30-MW. material-testing reactor in the Idaho desert. Each of the reactors is described, with many detailed drawings and photographs of the reactor and its components. The distribution of neutron flux is given in detail. Very full details are also given of start-up and operating procedure. Particularly full details are given of the design calculations of the M.T.R. (40-MW.) reactor.

Costs of the various reactors are given, and these vary from 250,000 dollars for a simple swimming-pool reactor to 25 million dollars for the Brookhaven graphite reactor. A detailed analysis of costs for some reactors is provided, and a warning is given that the actual cost depends very much on what buildings and laboratories are associated with the reactor. With this wealth of detail the prospective user may have some difficulty in deciding which type to adopt. In many cases financial consideration will rule out the high-powered more expensive reactors. A reactor in the 10-MW. class will cost £2–4 million and can cost up to £500,000 a year to operate. University users will be limited by cost to reactors of not more than 1 MW. of power. In this class the 1-MW. light-water reactor will probably provide the best compromise between high neutron intensity and moderate price. Its neutron flux of 10^{13} neutrons/sq. cm./sec. makes possible a very wide range of experiments. A flux of 10^{12} is generally considered to be too low for many experimental applications.

The solid-fuel research reactors require a fuel charge of 3–4 kgm. of uranium-235, and this is usually formed into a uranium–aluminium alloy and sheathed in aluminium. The United States has made agreements with many countries to supply research reactors together with 6 kgm. of enriched fuel, the fuel being lent at interest-rates of 4 per cent. Britain is supplying enriched fuel to India, Australia, France and Denmark for research reactors.

Research reactors have become an essential tool of any serious programme for the development of nuclear power, and Britain will soon be equipped with six such reactors, five at Harwell and one at Dounreay. Their use in university research is being seriously discussed at present, and this volume will help those members of university staffs who are concerned.

J. D. Cockcroft

A NEW APPROACH TO BIOSYNTHESIS

Studies of Biosynthesis in Escherichia coli

By Richard B. Roberts, Philip H. Abelson, Dean B. Cowie, Ellis T. Bolton and Roy J. Britten. Pp. xiv+521. (Publication No. 607.) (Washington, D.C.: Carnegie Institution of Washington, 1955.) 2.50 dollars (paper bound); 3 dollars (cloth bound).

FIVE years ago a group of nuclear physicists at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington began an investigation of biosynthetic processes in micro-organisms, making use of radioactive isotopes. This monograph is "a report of research" and represents the achievements to date of these men and their associates. It is an ambitious piece of work: what is presented is a fairly thorough description of the pathways by which carbon atoms from glucose become incorporated into the components of proteins, nucleic acids and lipids of *Escherichia coli* when this organism grows in a simple synthetic medium. A detailed account of the intermediate steps in amino-acid and purine and pyrimidine synthesis is not attempted, but the broad outline of a flow sheet for carbon is sketched both qualitatively and quantitatively. Many of the individual pathways had previously been studied in a range of different organisms under a variety of conditions, but here begins the first attempt to co-ordinate and integrate them in a map of the total synthesis of a bacterium.

The design of the experiments is modest—*Escherichia coli*, growing exponentially in a glucose–ammonia–salts medium, is presented with a tracer labelled with carbon-14 (carbon dioxide, acetate, an amino-acid, or glucose variously labelled) and perhaps some other unlabelled substrate. The pattern of incorporation of radioactivity in amino-acids, nucleotides, etc., is then determined both qualitatively and quantitatively after at least one further generation of growth. From the results of such experiments it is shown, for example, that amino-acids fall into biosynthetic families: serine being precursor to cysteine and glycine; pyruvic acid to alanine, valine and leucine; glutamic acid to proline and arginine; aspartic acid to threonine, methionine, *iso*leucine, lysine and diaminopimelic acid. Similar relationships with minor modifications are found in the yeast, *Torulopsis utilis*, and the mould, *Neurospora crassa*. Histidine and the aromatic amino-acids are not dealt with.

The early chapters are devoted to detailed accounts of experimental methods, fractionation and chromatographic procedures, production of randomly labelled amino-acids by growth of *Chlorella* in carbon-14 dioxide, and permeability studies. Then come chapters on the results of experiments with specific tracers, the variations caused by adaptation to energy sources other than glucose, and the extra-cellular products of metabolism.

The pathways of amino-acid and nucleotide formation are discussed in the light of the accumulated data, and it is suggested that the Krebs's tricarboxylic acid cycle is involved in the production of intermediates for synthesis rather than for terminal oxidation. A long chapter follows on sulphur metabolism and the roles of glutathione, which contains about one-quarter of the sulphur of *Escherichia coli*, and an alcohol-soluble protein fraction which amounts to about one-sixth of the total protein.

The method of 'isotope competition' is critically examined in the penultimate chapter. This method, which depends on the preferential utilization of exogenously supplied intermediates as compared with endogenously synthesized substances, has been used to gain information about biosynthetic sequences. Thus, when randomly labelled glucose is the major carbon source for growth of *Escherichia coli*, the addition of unlabelled glycine suppresses the appearance of radioactivity in the protein glycine. Addition of unlabelled serine, on the other hand, prevents the appearance of radioactivity in both serine and glycine, indicating that serine is precursor to glycine but not vice versa. Isotope competition has been successfully exploited in the case of *E. coli*, but the method is not invariably applicable; and it is pointed out that its effectiveness is in some cases due to suppression of synthesis by the addition of an intermediate, whereas in others synthesis continues at an unchanged rate but the endogenously produced material is 'swamped' by the exogenous and most of it can (if isotopically labelled) be found in the medium.

The last chapter attempts a quantitative description of the flow of carbon from glucose to cellular components and waste products. One of the tantalizing findings of this work, which in the main so beautifully balances the carbon account, atom by atom, is that the route of formation of 70 per cent of the total carbon dioxide and 90 per cent of the carbon dioxide derived from C-1 of glucose is unknown. It is suggested that the net output of carbon dioxide from the tricarboxylic acid cycle is less than 3 per cent of the observed production, so that some alternative mechanism must exist for the degradation of glucose to carbon dioxide. Recent findings in other laboratories indicate that a transketolase–transaldolase cycle might be involved.

Thus the report ends with new questions being posed—which is just as it should be. This is an essentially personal account, with five authors whose different styles are apparent but not disconcertingly so. Some readers will challenge the conclusion that the micro-organisms used are freely permeable to ions and small molecules, including hexose phosphates and glutathione, and others will question whether the time is ripe for application, as it were, of Kirchhoff's laws to living organisms. There is little discussion of related findings by other workers using other techniques, but (perhaps as compensation) there is a classified bibliography of well over a thousand post-1940 papers on the biochemistry of *Escherichia coli* and other topics relevant to the text. Two useful appendixes on the kinetics of incorporation and dilution are also included. There is a wealth of illustration, including some thirty full-page reproductions of radioautographs. The text, which is reproduced by a lithographic process, is easy to read and the figures are well drawn, but some, in the chapter on sulphur metabolism, have inadequate legends. The few misprints are mainly confined to tables.

The Carnegie Institution of Washington was founded "to encourage, in the broadest and most liberal manner, investigation, research, and discovery . . .". It is well-served by a director such as Dr. Merle A. Tuve, who enthusiastically supports a group of his physicists when they break away into microbiology and when they justify themselves, as in this first major progress report, by writing of "the intense personal pleasure that has come to us in this research". KENNETH MCQUILLEN

THE HAUNTING OF BORLEY RECTORY

The Haunting of Borley Rectory

By Eric J. Dingwall, Kathleen M. Goldney and Trevor H. Hall. Pp. xiv+181+5 plates. (London: Gerald Duckworth and Co., Ltd., 1956. Published under the auspices of the Society of Psychical Research.) 16*s*. net.

THIS account of the evidence for abnormal happenings in what the late Harry Price described as "the most haunted house in England" well maintains the tradition of the Society for Psychical Research for honest and cautious study of alleged parapsychological phenomena. A heavy task was undertaken at the invitation of the Society by three trained investigators. Their story is at times as interesting as a detective novel; it reveals queer actions of some very curious people; it leaves very little to be explained of the actual haunt itself and a good deal to be puzzled over in the motives, actions and reactions of the people principally concerned. The general conclusion is that credulity, malobservation, trickery and fraud account for the great bulk of the recorded evidence.

Criticism has been directed against the Society for Psychical Research for having so long delayed an inquiry into Borley Rectory. The relevant facts are these. The case first achieved more than local notoriety in June 1929, when the incumbent, the Rev. Eric Smith, wrote to the editor of the *Daily Mirror* asking for advice as to whom to consult as to the best method of clearing the rectory of its bad local reputation as a haunted house. The results were visits from a reporter and from Harry Price. Articles published in the paper brought crowds of sightseers to the rectory; the situation developed rapidly and was soon out of control. Serious investigation became impracticable, and in any event Harry Price had taken over the case. Two visits were actually paid by Lord Charles Hope, later a member of the Society's council, in July 1929; he came away with the view that the phenomena were produced by normal means and with the suspicion that Harry Price was responsible for some of them. Public interest was maintained, however, by Harry Price sending a rota of (untrained) investigators to report on the haunting and by his two books on Borley Rectory. The Society took up the challenge of this continued publicity in 1949 after Mrs. Eric Smith had written to the *Daily Mail* to express her disbelief in the haunting of the rectory. Price had died in 1948 but his literary executor, Paul Tabori, gave facilities to the investigators to examine his files and correspondence in the Harry Price library. A large part of the case against Harry Price comes from his own writings and papers. Doubts about the genuineness of the phenomena produced in the presence of Mrs. Foyster, wife of a later incumbent of Borley, were also expressed by Price and are strongly underlined in this report.

The destruction of the rectory by fire in 1939 has not ended the story of the haunt, nor the popular interest in Borley. The writers of this book give good reasons why the vague stories of its early haunting and also the more recent accounts need not be taken seriously, and why their report can fairly be taken as "The End of Borley Rectory". The tragedy is that it brings discredit to the name of one who had done so much to bring psychical research to the notice of the general public.

F. J. M. STRATTON

GENETIC RECOMBINATION

Symposium on Genetic Recombination

Given at the Research Conference for Biology and Medicine of the Atomic Energy Commission, Oak Ridge, Tennessee, April 19–21, 1954. (Reprinted from *Journal of Cellular and Comparative Physiology*, Vol. 45, Supplement 2, May 1955.) Pp. vii+321. (Philadelphia, Pa.: Wistar Institute of Anatomy and Biology, 1955.) n.p.

IN the late 'twenties and early 'thirties there was great interest among geneticists and cytologists in attempts to understand the mechanism by which genetic crossing-over takes place. It was believed by many that this would prove a profitable way to attack the problem of gene and chromosome structure. Although several useful working hypotheses were formulated, these hopes were not realized. In fact, no widely accepted hypothesis consistent with all the facts known about crossing-over in higher forms has yet been proposed. Perhaps one of the most ingenious of the earlier suggestions, especially in the light of the recent proposal of Watson and Crick as to how macromolecules of deoxyribonucleic acid might reproduce, was the one presented by the late John Belling.

In recent years a marked revival of interest in the crossing-over approach has been stimulated by a series of inter-related developments in genetics. Among these is the large body of evidence that pneumococcal transforming principles are deoxyribonucleic acid, the demonstration that genetic information in bacterial viruses is transmitted in the form of this macromolecule, and the realization that the Watson–Crick double helix structure of deoxynucleic acid might well explain how genetic information is replicated.

A symposium on "Genetic Recombination" was held in the United States during April 19–21, 1954, at the Oak Ridge National Laboratory, and this volume consists of sixteen papers summarizing what had been accomplished at the time of that meeting. The subjects dealt with include pneumococcal transformations, transduction and other recombination mechanisms in bacteria; crossing-over in fungi, algæ, higher plants and higher animals; and, finally, the oxygen effect on chromosome aberrations in higher forms. The symposium dealt with, but did not finally answer, the important question of whether the recombination mechanisms in bacterial viruses and higher plants and animals are fundamentally the same. Chromosomes of the latter contain protein as well as deoxyribonucleic acid and are many orders of magnitude larger than the deoxyribonucleic acid helices of viruses. In addition, in a number of higher forms it is known that, in contrast to recombination in bacterial viruses, a single cross-over produces complementary recombination structures. It may therefore be too much to hope that a single mechanism will account for both processes.

Progress in understanding genetic recombination is at present being made so rapidly and requires so much specialized knowledge for its full appreciation that it is difficult for the general geneticist or biologist to keep up to date. Reports of symposia such as the Oak Ridge one are a great help in this respect.

G. W. Beadle

THE NATIONAL GALLERY, LONDON

The National Gallery 1938–54

Pp. 124+20 plates. (London: National Gallery, 1955.) 12*s*. 6*d*. net.

In 1938 the National Gallery, presumably for reasons of economy, ceased to publish a Director's annual report. That practice is now to start again and, in the meantime, the Trustees have issued a most welcome comprehensive survey of the years 1938–54. This is a model of lucid statement. It not only gives a detailed account of those things one expects to hear about—the evacuation of the collection to Manod quarry at the beginning of the Second World War, the acquisitions during the period under review, and the development of a Scientific Department and a Conservation Department—but, in addition, it records activities which annual reports usually take for granted. It explains, for example, the duties of the senior members of the staff—the keepers and assistant keepers—and gives the public some insight into the extraordinarily complicated work involved in compiling catalogues of the standard of those already produced by Mr. Martin Davies and Mr. Neil MacLaren. Before the War a catalogue of the whole collection was available, but the information it contained was too slight to be of very much use to scholars. The detailed catalogues of the British, French, Spanish, Early Netherlandish and Earlier Italian Schools issued during and after the War have, however, set a standard of scholarship which is a model to the galleries of the world. A new general catalogue, which, one hopes, will be of a more lively character than the pre-war edition, is also in preparation.

The report is not only comprehensive, it is also honest. It records in detail the treatment given to every picture that has been restored and cleaned since the Conservation Department was set up in 1947, and reveals the extent to which scientific examination can solve problems which the eye alone can only guess at. The cleaning of Piero della Francesca's "Nativity" has, for example, shown quite certainly that the thin condition of parts of this picture is due not to its being unfinished, as has often been suggested, but to drastic overcleaning in the past. Again, examination of Van Dyck's "Charles I on Horseback" showed that, when it was first relined, the canvas had been cut in two because of its great size. The work of removing previous relinings and restoring the original canvas involved the construction of a special table and the placing of an awning over the studio roof which had not been repaired since the War.

The question of war damage and its repair is one of the two disquieting subjects in the report, the other being the more serious one of lack of funds. Bomb damage put the west wing of the building out of action, and it was decided to instal as soon as possible a badly needed air-conditioning plant which would serve the rooms in this wing as they were re-opened. The plant was installed after delay, and the rooms are gradually coming into use; but even by the end of 1956, eleven years after the end of the War, parts of this block of the gallery will still not be available for the exhibition of pictures. This is the more serious when one realizes that since 1938 the collection has been increased by about a hundred and eighty pictures. A number of these have been transferred to the Tate Gallery, but there have also been transfers to the National Gallery from the Tate. Rebuilding does, however, progress, if only slowly. The problem of the lack of funds available for purchases is more urgent. A national collection, however large, is never complete. There will always be certain pictures which, if they come on the market, should be bought for the National Gallery rather than any other. But the annual government grant to-day, £10,500, stands only a few hundreds higher than it did in 1880. The Gallery has an additional income of about £10,000 from endowments, but with only £20,000 a year available, it is quite unable to compete for masterpieces unless Parliament votes a special grant-in-aid. The need for a very much larger annual grant is undeniable.

This report is not written for the profession only. It is written for all those persons who care for fine pictures, and it should be read by them. It can be strongly recommended.

K. J. Garlick

Cotton Growing Problems

By Prof. Basil G. Christidis and George J. Harrison. Pp. vii+633. (London: McGraw-Hill Publishing Co., Ltd., 1955.) 73*s*.

FIFTY years ago there was not much background of scientific knowledge about cotton in the field, but few crops to-day are better known, so that the biggest problem facing the cotton-grower is how to write a concise account of our garnered knowledge and to expose the gaps in it. The natural starting-point for a grower is the seed, but the first half of this book deals with varieties, crop rotation and soil fertility; then the seed appears, to be followed up through its planting and cultivation.

This lack of balance is also evident in the use of references; there is little discrimination between major studies, minor observations and tertiary oddments.

There are large omissions, notably in the chapter on irrigation, which does not refer to the two volumes of Willcocks and Craig, nor even to my own recent book. The remarkable sixteen-year set of field experiments by D. S. Gracie is not cited until long after Part 3, on fertilization, has been concluded, and then in a line only. There is no hint that the cotton hair is built of growth-rings, that the cotton plant has a root, or that the whole crop of all varieties grown in Egypt is derived and maintained from 'individual selection'. The bibliography includes more than a thousand entries, in spite of omissions, but is difficult to use because it is split into eight separate groups, one for each part of the book, covering sixty-two scattered pages.

Many observations from the Greek cotton research station at Sindos by Prof. B. G. Christidis are quoted, and are evidently comprehensive. I wish that Prof. Christidis could have dealt with this, his first-hand knowledge, in more detail; for the differences of soil and climate found under conditions in Greece can be most illuminating, and a book thus severely localized in its material would have been more generally suggestive in formulating the problems of cotton-growing.

W. LAWRENCE BALLS

The Analysis of Drugs and Chemicals

By Dr. Norman Evers and Wilfred Smith. Pp. xii+546. (London: Charles Griffin and Co., Ltd., 1955.) 60*s*. net.

THE forerunner of this book, by Evers and Elsdon, appeared more than twenty-five years ago and acquired a deserved reputation as a useful book to those engaged in the field covered by the title. Since that time, many new drugs and chemicals have come into general use, only a proportion of which have been included in the "British Pharmacopœia", or the "British Pharmaceutical Codex". The present volume deals with the official drugs and a number of the more important unofficial ones, together with those chemicals which find application in pharmacy. It is in the same form as its predecessor, but has been completely rewritten.

There is no clear-cut classification of the heterogeneous materials used in medicine, and the distinction between drugs and chemicals can only be arbitrary. Nevertheless, some sort of grouping is necessary and this has been appropriately done under the following headings: inorganic chemicals; organic chemicals; natural compounds and their derivatives; fixed oils, fats, waxes and soaps; volatile oils; crude drugs; miscellaneous pharmaceutical materials; and galenicals and other pharmaceutical preparations. These groups are preceded by chapters on general analytical methods, and followed by one on the use of statistics in chemical analysis and by several useful appendixes.

The book is intended to supplement the "British Pharmacopœia" and the "British Pharmaceutical Codex"; it must be used in conjunction with these volumes, since it is rarely indicated whether the substances mentioned, or the tests to be applied, are official or not. When so used, it should prove useful to the advanced student and to those engaged in the examination of named substances. It will be of only limited value to those concerned with unknown substances, for example, the toxicologist; the "of" in the title must not be read as including "for".

J. R. NICHOLLS

College Chemistry

An Introductory Textbook of General Chemistry. By Prof. Linus Pauling. Second edition. (Series of Chemistry Texts.) Pp. xii+685. (San Francisco: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1955.) 6 dollars; 51*s*.

FOR the new edition of this book Prof. Linus Pauling has revised throughout both the text and illustrations. In the first part the facts, concepts and theories are presented more gradually and factually, and the sequence of chapters altered to provide a more systematic arrangement. Each of the six parts has an introduction describing the chapters in it and explaining why each topic is introduced in the given order. The amount of organic chemistry is increased, and at the end there are two new chapters on chemical substances related to living organisms and one on nuclear chemistry.

Chapter 3 on the electron and nuclei of atoms, in which the subjects are treated historically, is clear and easily understandable. It is followed by one on the periodic law treated on a factual basis, which is then explained on the basis of atomic structure. The descriptions of the preparation and properties of elements and compounds are related as far as possible to atomic and molecular structure. The subject of valency is particularly fully and carefully treated, and much attention is given to the geometry of molecules. The sections on physical chemistry are clear and are introduced in appropriate places. Much use is made of the historical approach throughout the book.

There is no doubt that the book has been greatly improved in the new edition. Many teachers who desire to introduce modern aspects of theoretical chemistry into their courses will find how this can be done without sacrificing fundamental chemistry by a study of Prof. Pauling's thoughtful book.

Rational Approach to Chemical Principles

By Dr. John A. Cranston. Second edition. Pp. xii+231. (London and Glasgow: Blackie and Son, Ltd., 1955.) 10*s*. 6*d*. net.

THIS small book, now in its second edition, evidently fills a need in giving a brief account of the background of physical chemistry of about intermediate degree examination standard. There may be some doubt as to whether it is really rational to introduce quantum numbers before the simple gas equation; but if students are prepared to swallow whole this preliminary summary of atomic structure, the rest is plain sailing. In the present edition, the author has included many more numerical examples in physical chemistry, which no doubt will be found useful, and the book will continue to serve a modest but useful purpose.

J. A. V. B.

THE INTERNATIONAL GEOPHYSICAL YEAR

GEOPHYSICAL STATION AT COATS LAND, ANTARCTICA

By J. M. WORDIE, C.B.E.

THE station recently established by the Royal Society in Coats Land in the Falkland Islands Dependencies will be one of the most comprehensive among the many others now being set up in the Antarctic for the International Geophysical Year. The different sections of the programme are being given full opportunity to develop in whatever direction seems the most promising. Moreover, the station, which is a large one, has been set up not only in an important area, but also in favourable local conditions.

It should be noted, however, that this is not the only British station in Antarctica. There is already a well-equipped geophysical station at the Argentine Islands on the west coast of Graham Land in lat. 65° 15′ S., long. 64° 16′ W. Geophysical work in the Dependencies began in 1948 when ionospheric observations were first made at Port Lockroy. Later, the Argentine Islands base, about twenty miles farther south, was developed as more suitable for geomagnetic and upper-air work in general, and this station is now dealing with solar radiation, ozone observations, and a geomagnetic programme, which began on January 1, 1956. Ionosphere observations, however, continue at Port Lockroy. These two places in combination form an important link in the line of International Geophysical Year stations situated near the 70°–80° W. meridian line. Both are organized and manned by the Falkland Islands Dependencies Survey under the authority of H.E. the Governor, Mr. O. R. Arthur, who has continued the policy of the previous Governor, Sir Miles Clifford.

Apart from this, there will also be subordinate International Geophysical Year stations, mainly for meteorological and glaciological purposes, at Marguerite Bay in South Graham Land; at King George Island in the South Shetlands; and at South Georgia.

The Royal Society's station on Coats Land carries out the suggestion made at the second meeting of the Special Committee for the International Geophysical Year in Rome in September 1954, that a station should be set up on the Antarctic continent in the important area of the inner Weddell Sea. It was not until a year later, however, that a final decision was made by the Society. The chief difficulty had been doubt about navigation conditions in the Weddell Sea and in the waters off Coats Land, and these doubts were not resolved until the beginning of August 1955.

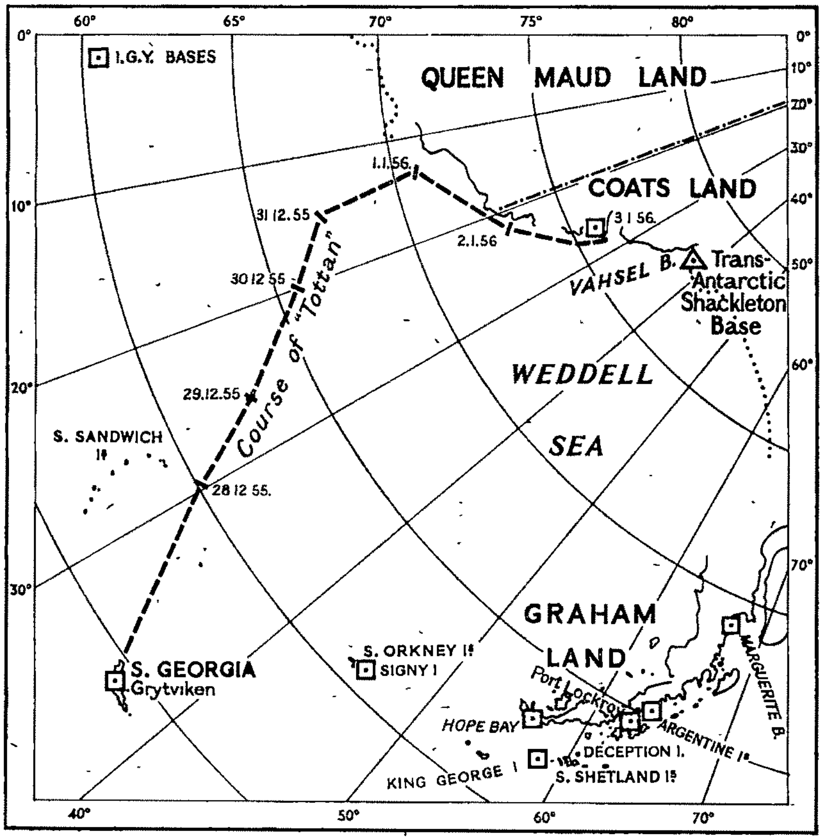
The Weddell Sea has held an ill reputation in the past, but records showed that the ice conditions were adverse only in the western part of the sea, where the pack-ice accumulates in its passage northwestwards. The evidence from Coats Land itself indicated that the Weddell Sea offered no unusual ice difficulties in the eastern and north-eastern approaches. A tongue of pack-ice in the sixties of south latitude stretches eastward from Graham Land. At the eastern end it has been successfully penetrated even by low-powered ships by a route south of the South Sandwich Islands. In January 1912 and again in January 1915 ships broke through to open water; in the case of Shackleton's *Endurance* in 1915, the southern ice edge, reached in lat. 70° S., was found to be separated from the Coats Land ice cliffs by more than a hundred miles of completely open sea. This open water continued as a broad land channel for some 250 miles farther southward along the coast to as far as lat. 76° S. Shackleton took his ship down this land channel partly under sail, running before the wind. This wide open channel was also seen from the air more recently, in December 1951 and January 1952, on flights from the Norwegian base at Maudheim in Queen Maud Land. Both the penetrable tongue and the wide land channel appear to be normal. The secret of entry to the Weddell Sea is to pass through the tip of the tongue in its eastern part and so into land water.

Tentative plans, finally put into operation in August 1955, had already been drawn up for a party of ten men to form an advance unit to erect the living-hut and observing accommodation. There was an early setback as the *Jopeter*, the ship first chartered to carry the party south, was crushed and later abandoned early in September in the ice off East Greenland. The ship selected to replace the *Jopeter*, however, was the well-known *Tottan*, a slightly smaller vessel but with a high reputation for strength and manœuvrability in ice. She has been under the command of Captain Leif Jakobsen, who has had wide experience not only in the difficult ice conditions off East Greenland but also as mate of the *Norsel* in the ice-encumbered waters off Queen Maud Land east of Coats Land. The *Tottan* sailed from Southampton on November 22, little more than three months after the first orders for the hut and equipment had been given. Credit for this speedy carrying out of the Royal Society's plans must go to H.E. the Governor of the Falkland Islands, to the authorities at the Crown Agents, and to Mr. F. K. Elliott, secretary of the Falkland Islands Dependencies Survey.

The *Tottan* reached South Georgia on Christmas Day 1955, and took her departure on December 26, her itinerary being as follows:

December	28	lat.	60° 19′ S.	long.	29° 40′ W.
,,	29		62° 55′ S.		24° 30′ W.
,,	30		65° 25′ S.		20° 00′ W
,,	31		67° 10′ S.		15° 00′ W
January	1		70° 30′ S.		13° 10′ W.
,,	2		73° 40′ S.		21° 05′ W.
,,	3		76° 31′ S.		27° 23′ W.

She met pack-ice three days after leaving South Georgia. Penetrating the tongue took about three more days; and she reached open water in lat. 68° S. She had taken a route in about the fifteenth meridian west of Greenwich with very little ice hindrance, which appears to have been easily brushed aside. She then proceeded, just as Shackleton in the *Endurance*, down a great open water channel into the Weddell Sea.



Part of Antarctica showing some International Geophysical Year bases

On January 6 a base site was finally chosen in approximately lat. 75° 28′ S. The exact position has to be confirmed. The *Tottan* was occupied landing the hut and stores until January 22, when she took her departure back to South Georgia on a seven-day return voyage by a slightly more westerly route. There was apparently nothing exceptional in the season, and both in and out voyages confirmed the forecast about the approachability of the Coats Land coast north of lat. 76° S.

Surgeon Lieut.-Commander Dalgleish has described his arrival at the ice cliffs of Coats Land on New Year's Day. Eastwards was the ice-gripped continent fringed with cliffs of ice; but when looking westwards away from the coast it was easy to imagine the ship was in a tropical sea. For two days the *Tottan* steamed along the ice cliffs in an open sea. On January 3 in lat. 76° S., she found herself in much shallower water—as little as 15 fathoms—and had to move away from the coast. Open leads in the pack led her a little way south of lat. 76°, but this was her farthest; and the head of the sea being at that time unapproachable she turned back north to look for a landing place in a lower latitude. Three possible bays were reconnoitred in the neighbourhood of the wide Dawson–Lambton glacier, and landings made at two of them. Conditions of the land-ice at all three places, however, were unpromising. Fortunately, in about lat. 75° 28′ S., a suitable place was finally found. Orders had been given that no station was to be established unless it could be placed south of lat. 75° S. on the Coats Land coast, this northern limit being set by the knowledge that the area of maximum auroral frequency lies farther south. The place chosen seems to fulfil all the necessary conditions, and is described as completely satisfactory for the scientific programme. It is almost certainly Shackleton's "excellent landing place" described by him in 1915 as Glacier Bay; it has now been named Halley Bay (see p. 606 of this issue).

Dalgleish describes two ice headlands, two miles apart, converging to an apex, where an easy slope gives access to the ice sheet. The ice sheet is considered grounded, and no exposed rock was visible. From the top of the slope there was a gentle rise of 5 ft. per mile to the east. The main continental plateau was about thirty-five miles distant. The base is 1½ miles from the slope and is either on "a low piedmont or a grounded ice-shelf". No evidence of any activity or ice movement was noticed at the base site.

Unloading began on January 6. Conditions were easy for tractors, but the work had to be done mainly at night to avoid the slush. It was now high summer and eleven days of sunshine enabled more than two hundred tons of stores to be taken to safety on the hut site.

About five thousand Emperor penguins were found on the fast-ice in an adjoining bay and must indicate the persistence of similar conditions year after year. A few days after arrival the sea ice on which the penguins had been nesting broke up and the penguins went out to sea. They are expected to return to their nesting site at the end of March and beginning of April, by which time the sea will have begun to freeze.

With Surgeon Lieut.-Commander Dalgleish there are three scientists, Major G. Watson, R.E.M.E., Dr. Stanley Evans and Mr. D. Limbert. During the present reconnaissance year the observations at the base will be on a limited scale. In meteorology, apart from daily observations, a Dobson ozone spectrophotometer will be in use for the first time in high latitudes. There will be no work in geomagnetism, and the magnetic hut is not due for erection until January 1957. Auroral observations will begin using an 'all-sky' camera which has been specially modified by Mr. James Paton. This consists of a mirror and a camera which takes a picture of the sky every minute and gives a complete record of auroral displays. The only ionospheric work to be undertaken this present year will be measurements of atmospheric noise. Glaciology will not be prominent in the reconnaissance year, nor will seismology or gravity.

The latest reports from the Royal Society base are that the skeleton of the hut is in place, but that it will take about two months before the roof and the side walls are complete. Since the *Tottan* left on

January 22, the base has been visited by the *Theron*, Dr. V. E. Fuchs's Trans-Antarctic Expedition ship, on her way south to the head of the Weddell Sea. Dr. Fuchs called again on February 8 after setting up his own base on the Filchner Ice-shelf at lat. 77° 57′ S., long. 37° 16′ W., about twenty-five miles west of Vahsel Bay. In due course it is hoped that an overland route will be established between the bases, which are more than two hundred miles apart.

Plans for the future are that next year the two expeditions will share a large ice-breaking sealer. She will go south in November 1956 carrying eighteen men for the International Geophysical Year party and eighteen men for the Trans-Antarctic party, and will arrive at Coats Land in January 1957. There will be a brief visit by a relief ship in January 1958; and the geophysical party is due to leave the Weddell Sea in January or February 1959 to return to Britain.

CHINESE ASTRONOMICAL CLOCKWORK

By Dr. JOSEPH NEEDHAM, F.R.S.
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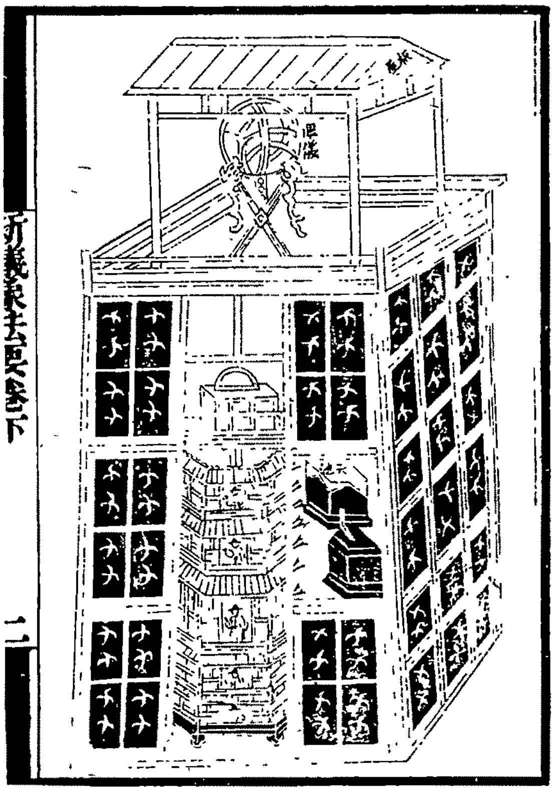
WANG LING
Trinity College, Cambridge

AND

Dr. DEREK J. PRICE
Christ's College, Cambridge

It is generally agreed that the invention of the mechanical clock was one of the most important turning-points in the history of science and technology. According to the view accepted until recently[1-4], the problem of slowing down the rotation of a wheel to keep a constant speed continuously in time with the apparent diurnal rotation of the heavens was first solved in Europe in the early fourteenth century A.D. Trains of gearing were then combined with the verge and foliot escapement and powered by a falling weight. Recent research has shown, however, that these first mechanical timekeepers were not so much an innovation as has been supposed[5]. They descended, in fact, from a long



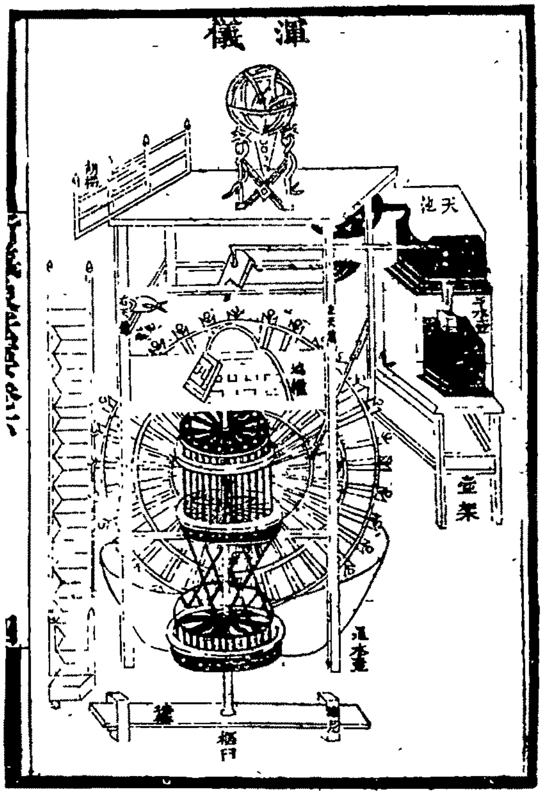


Fig. 1. Astronomical clock of A.D. 1088 from Su Sung's "Hsin I Hsiang Fa Yao", ch. 3, p. 2*a*. External appearance. The armillary sphere on the platform above, the celestial globe in the upper chamber of the tower, and the pagoda with the time-announcing jacks below this. On the right, the housing removed to show the water-tanks. Estimated total height about 30 ft.

Fig. 2. The same as Fig. 1. General view of the works. Vertical shaft with jack-wheels in the foreground, behind this the driving-wheel with its scoops. Water-tanks on the right, part of the anti-recoil device on the left at the top. Escapement not shown in this diagram, though the device above the wheel is probably intended for part of it.

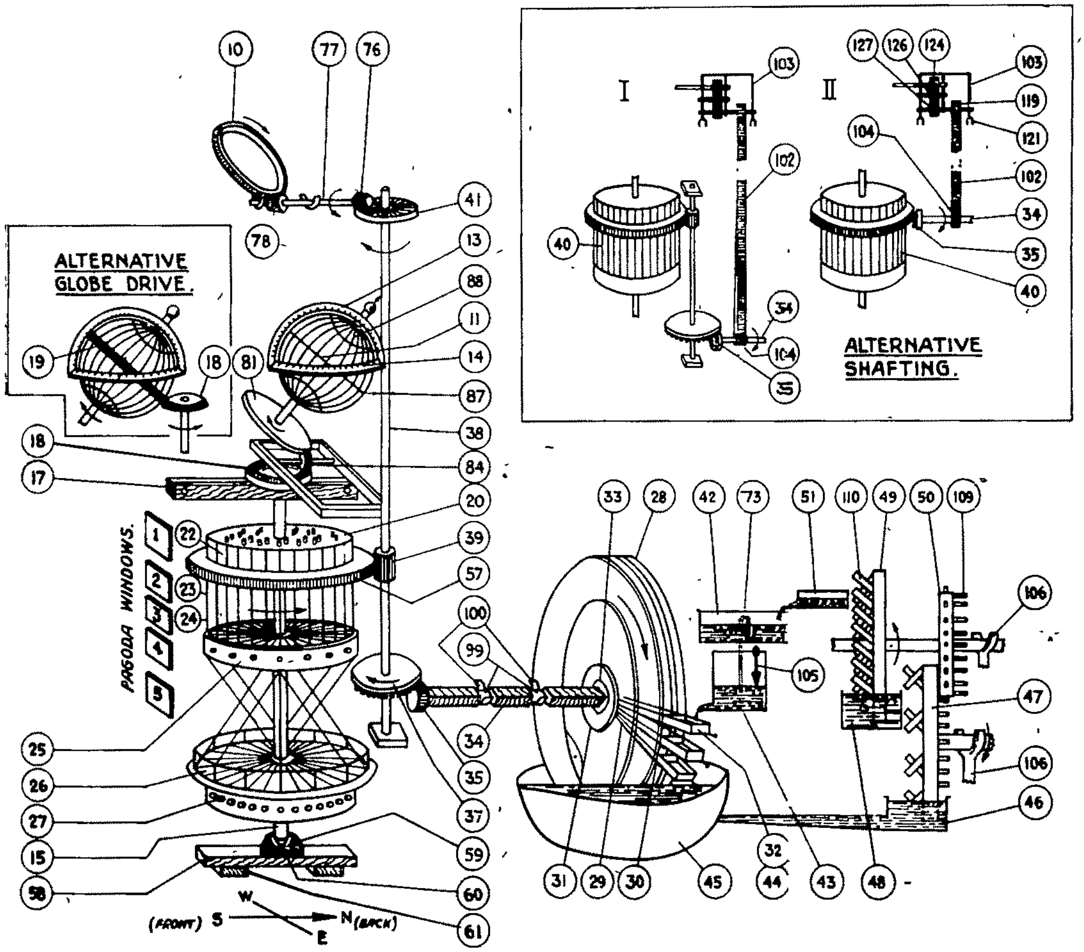


Fig. 3. General reconstruction. The numbers indicate technical terms which will be given and explained in the full publication. Gearing at the top of the jack-wheel shaft on the left drives the celestial globe. The long shaft rotating the armillary sphere was in later models replaced by successively shorter chain drives, as shown in the inset. On the right are the two norias which raised the water to the uppermost reservoir, sufficient for twenty-four hours running. (*Drawn by Angel*)

series of complicated astronomical 'clocks', planetary models, mechanically-rotated star-maps and similar devices designed primarily for exhibition and demonstration rather than accurate time-keeping. Although such devices are of the greatest interest as the earliest complex scientific machines, it has not hitherto been possible to adduce more than a few fragmentary remains, and literary descriptions tantalizingly incomplete, which lack sufficient detail for clear understanding of the mechanical principles involved. But the examination of certain medieval Chinese texts, the relevance of which has not been realized, has now permitted us to establish the existence of a long tradition of astronomical clock-making in China between the seventh and the fourteenth centuries A.D.

The key text is the "Hsin I Hsiang Fa Yao" [New Design for a (Mechanized) Armillary (Sphere) and (Celestial) Globe], written by Su Sung in A.D. 1090, the appropriate sections of which we have fully translated. This describes in great detail an astronomical clock of large size (Figs. 1 and 2) powered not by a falling weight, but by a scoop-wheel using water or mercury. Besides the rotation of the sphere and globe by trains of gear-wheels, the clock embodied elaborate time-keeping jack-work. The escapement consisted of a weigh-bridge which prevented the fall of each scoop until full, and a trip-lever and parallel linkage system which checked the rotation of the wheel at another point. An anti-recoil device was also built in. The basic principle involved is thus more like the anchor escapement of the late seventeenth century than the verge and foliot type, although the time-keeping is, of course, governed mainly by the flow of water rather than by the escapement action itself. This type of effect is therefore the 'missing link' between the time-keeping properties of a steady flow of liquid and those of mechanically produced oscillations. So complete is the description, which has yielded more than a hundred and fifty technical terms of eleventh-century mechanics, that it has been possible to prepare detailed working drawings of the clock (Figs. 3 and 4).

The full understanding of this text has enabled us to interpret many descriptions of other clocks contained partly in the dynastic histories and partly in other sources, some from books now lost, but preserved in the "Yü Hai" encyclopædia of A.D. 1267. Thus an important astronomical clock driven by mercury was built by Chang Ssu-Hsün, a Szechuanese, in A.D. 979. The tradition seems to start with an instrument completed in A.D. 725 by the Tantric monk, I-Hsing, and an engineer named Liang Ling-Tsan, the description of which would not have been

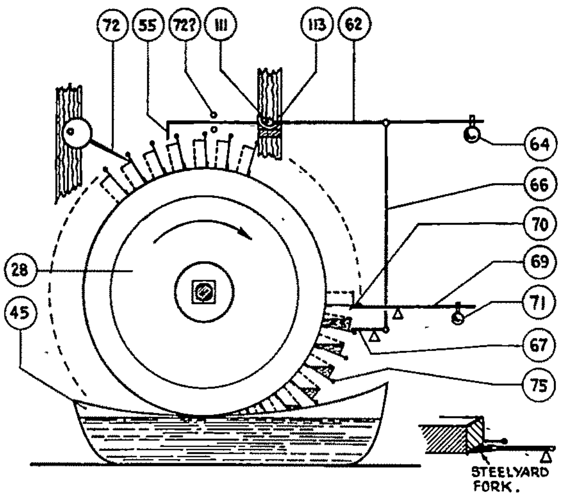


Fig. 4. Diagram of the escapement, with its weigh-bridge and parallel linkwork. The clepsydra flow delivered into the scoop at 70. (*Drawn by Angel*)

comprehensible without thorough prior study of Su Sung's text.

Earlier texts describe celestial globes or demonstrational armillary spheres rotated by clepsydra water. These range from the work of Chang Hêng about A.D. 130 to that of Kêng Hsün about 590, but evidence of any escapement is absent. We supposed at first that these employed only the sinking float of a large clepsydra. This was the system of the Hellenistic anaphoric clock with its rotating astrolabic dial[6], and perhaps also of the famous striking water-clocks of the Byzantine[7] and Arabic[8] culture-areas. But textual and historical considerations incline us rather to the view that the clepsydra water dripped on to a scoop-wheel, turning a shaft with a trip-lug which constituted a pinion of one. This acted on a toothed ring on the apparatus, moving it tooth by tooth.

It thus appears that the Chinese tradition of astronomical clockwork was more nearly in the direct line of ancestry of the late medieval European mechanical clocks. Moreover, the detailed description of this previously unrecognized type of water-driven clock has made it possible to find similar devices incompletely described (perhaps because incompletely known) in Indian[9], Arabic and Hispano-Moorish[10] texts. Of the transmission of influences little can as yet be said, though there are indications that the European centuries just preceding the fourteenth knew devices with water-powered and mechanically checked driving-wheels[11]. This would suggest that the time of transmission was rather that of the Crusades (as in the case of the wind-mill) than that of the Pax Tartarica and Marco Polo.

All the texts now translated, with commentary and discussion, will, it is hoped, be published as a special monograph by the Antiquarian Horological Society, to which the results of the investigation have been communicated.

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[9] Burgess, E., "The Sûrya-Siddhânta, a Textbook of Hindu Astronomy", pp. 282, 298, 305 ff., edit. Phanindralal Gangooly (University, Calcutta, 1935).

[10] Rico y Sinobas, M., "Libros del Saber de Astronomia del Rey D. Alfonso X de Castilla" (Aguado, Madrid, 1864).

[11] Drover, C. B., "A Mediæval Monastic Water-Clock", *Antiquarian Horology* (Dec. 1954).

NUCLEIC ACIDS AND PROTEIN SYNTHESIS

In recent years it has become increasingly evident that the nucleic acids play an important part in cellular metabolism, and the general interest in the recent developments in this field was well demonstrated by the size of the audience which attended the Biochemical Society's symposium on "The Structure of Nucleic Acids and their Role in Protein Synthesis". This meeting was held at the London School of Hygiene and Tropical Medicine on February 18 last.

In opening the morning session, which was concerned mainly with recent chemical and physical evidence about the structure of the nucleic acids, the chairman, N. W. Pirie (Rothamsted Experimental Station), defended the work of P. A. Levene, which of recent years has been criticized for obscuring the issue by over-simplification. He also suggested that some suitable word should be coined to embrace the terms 'purine' and 'pyrimidine'.

The first paper in the symposium was given by Dr. R. Markham (Agricultural Research Council Virus Research Unit, Molteno Institute, Cambridge), who outlined the discoveries which have been made in the past ten years and which have more or less revolutionized ideas about the structure and the complexity of the nucleic acids. Much of his talk was devoted to a discussion of the degradative approaches which have led to the picture of nucleic acids as straight-chain molecules made up of nucleoside residues linked by 3′ : 5′-phosphodiester bridges. He also emphasized the importance of the hydroxyl group at C′2 as a part of the structure of ribonucleic acids which might be involved in the biological transformations of the molecules, and he pointed out that its absence in deoxyribonucleic acids has precluded a chemical investigation of the latter by methods which have proved so successful in the study of the ribonucleic acids. The deoxyribonucleic acids have, however, been found to have structural regularities ; but he doubted whether the self-replicating mechanisms which have been postulated recently by various workers will fit all the experimental observations.

In discussion, Dr. F. H. C. Crick outlined a scheme by means of which he believed these difficulties could be overcome. He also doubted whether the less common purines and pyrimidines have any real biological significance.

The second paper of the morning session was given by Dr. M. H. F. Wilkins (Medical Research Council Biophysics Unit, King's College, London), who described some of the elegant X-ray crystallographic work which has come from King's College, London, and which has been responsible for our present conception of deoxyribonucleic acids as double helices. He pointed out that the X-ray data indicate that the molecule has two grooves of unequal depths, and that in the nucleoprotamines the polypeptide chains lie inside these grooves, the non-basic amino-acid residues occurring in pairs so as to be able to loop away from the main helix. The data obtained with nucleohistones are not so easily interpreted, but they suggest a substantial amount of orientation of the protein on the nucleic acid molecules.

Dr. Wilkins deplored the current tendency of physicists to explain the relationship between nucleic acids and protein synthesis by numerological arguments, and suggested that, among other things, certain of their premises are faulty. This evoked a reply by Dr. Crick, who pointed out that the number of amino-acids in each protein has been found to be essentially the same, namely twenty, if a few minor suppositions are made.

The afternoon session, with Prof. J. N. Davidson (Biochemistry Department, University of Glasgow) in the chair, was concerned with the relationship of the nucleic acids with protein synthesis; he introduced the session with a general survey of the present knowledge of the various sub-cellular elements and the problem of their isolation.

The study of protein synthesis in higher organisms was discussed by Dr. B. A. Askonas (National Institute for Medical Research, London), who described the use of radioactive tracers to follow amino-acid incorporation into proteins in various cell fractions. A particularly suitable system for this kind of experiment is to be found in cells synthesizing protein in response to a specific stimulus such as occurs in immunological reactions. It is, however, difficult to obtain results of this type with sub-cellular preparations, and it is necessary in such cases to follow the labelling of various fractions isolated by physical methods. Fractions rich in nucleic acid are found to have most activity.

Dr. E. F. Gale (Medical Research Council Unit for Chemical Microbiology, Cambridge) described some of the recent work which he has carried out on disrupted *Staphylococcus aureus* suspensions, following the incorporation of labelled amino-acids. Deoxyribonucleic acid is a powerful stimulatory substance and loses its activity on hydrolysis. Ribonucleic acid is not so active, but on enzymic degradation becomes very active indeed. The identification of the various factors influencing the incorporation of specific amino-acids with specific polynucleotides has, however, been found to be incorrect, and it appears that specific substances of unknown nature are liberated when the nucleic acid is broken down.

In comment, Dr. W. E. Cohn remarked that nucleic acid preparations may yet prove to contain substances of which we have no knowledge at present.

The bacteriophage–bacterium system was the subject of the last paper in the session, which was given by Dr. K. Burton (Medical Research Council Cell Metabolism Research Unit, Oxford). This system is of particular interest in view of the injection of virus nucleic acid which is known to take place on infection; but it was pointed out that a not inconsiderable amount of protein is also introduced at the same time into the bacterium. In the case of the *T* even bacteriophages which parasitize *Escherichia coli*, it is actually possible to follow the synthesis of bacteriophage nucleic acid because of the presence of a specific pyrimidine, 5-hydroxymethyl cytosine, in the latter, and it is certain that study of this system will be of great importance in the future. Results obtained so far, however, do not seem to fit with any simple replication mechanism of the types which have been proposed.

The meeting ended with a general impromptu discussion of template mechanisms involving nucleic acids. Although the general tenor of the symposium was somewhat speculative, the interest of the audience and the many questions raised in discussion showed that the choice of subject was a good one, and the Biochemical Society and its symposium organizer, Dr. E. M. Crook, are to be congratulated on the success of the meeting.

OBITUARIES

Prof. W. C. McC. Lewis, F.R.S.

With the death of William Cudmore McCullagh Lewis on February 11, Britain lost one of its finest physical chemists. After graduating with distinction at the Royal University of Ireland in 1905, he carried out research work at the Universities of Liverpool, Heidelberg and London and was appointed lecturer of University College, London, in 1910. The best-known of his many early researches were his experimental verification, with F. G. Donnan, of the Gibbs adsorption isotherm and his theoretical treatment of the Joule–Kelvin effect. These two substantial advances have long since found their way into standard text-books. In 1913 Lewis was appointed to the Brunner professorship of physical chemistry at the University of Liverpool, a chair which he held until his retirement in 1947. He was elected a Fellow of the Royal Society in 1926.

During his first decade at Liverpool, Lewis led an active school in experimental studies of chemical kinetics. The most notable single publication in a long series of papers on catalysis is his "Calculation in Absolute Measure of Velocity Constants and Equilibrium Constants in Gaseous Systems" (1918). Not all the conclusions of this paper have proved to be correct. It is now known, for example, that diatomic molecules do not dissociate by a first-order mechanism, and that activation generally is not by direct interaction with the radiation field. These, however, are points of detail in comparison with his main conclusions, which are that velocity coefficients in gaseous systems can be treated by the methods of statistical mechanics and that in certain examples the rate of chemical change is simply the rate of molecular collisions multiplied by the fraction of the total number of molecules which have sufficient energy. Trautz had independently come to the same conclusion in 1916 but, on account of the First World War, the *Zeitschrift für anorganische und allgemeine Chemie* was not available to Lewis, and both can claim equal credit for their outstanding contribution. The Trautz–Lewis collision theory gave a very considerable impetus to the study of chemical change.

In collaboration with Blair Bell, Lewis led, in the early 1920's, another active team of physical chemists in cancer research. This circumstance probably explains why, like Arrhenius before him, he later transferred his research interest to biochemical and physiological problems.

Lewis is most widely known as the author of "A System of Physical Chemistry", a graduate text-book in three volumes which went into four English editions in nine years. To the task of preparing it he brought the experience of a skilled experimentalist, the wide learning of one conversant with many foreign tongues and the sympathy of one accustomed to teach. His book reveals a breadth of outlook which is not entirely unexpected from one familiar with the methods of research of so many different universities; there is in it no vestige of the narrowness so often found in books written by those who teach only where (and often only what) they were taught. His book is by no means perfect. At the time of its appearance the character of physical chemistry was rapidly changing, and the author must have worked exceptionally hard to keep abreast with the many developments of that period. As things turned out, material which Lewis had to put in an appendix to his third volume appears in the introductory passages of modern text-books. Despite its shortcomings, however, his text-book exerted a wide influence and can truly be described as the first original treatise of advanced physical chemistry in the English language.

Nature had endowed W. C. McC. Lewis not only with a brilliant intellect but also with magnificent physique, so that the reflexion of most men on meeting him was that here was a grand type of man. The dignity of his appearance was heightened by his impeccably correct bearing and mellifluous voice. The frequent gleams of humour in his eye and flashes of Irish wit in his utterances saved him from being ponderous or pompous. He was an extremely retiring man and abhorred publicity. His attendance at public scientific gatherings averaged one in twenty years. He made lasting friends of those whom he taught, and proved himself to be throughout his career a great scientist and a kind man.

E. A. MOELWYN-HUGHES

Dr. Harold King, C.B.E., F.R.S.

DR. HAROLD KING, a former member of the scientific staff of the Medical Research Council, died suddenly at his home in Dorset on February 20 at the age of sixty-eight.

The son of a schoolmaster, King studied chemistry at Bangor under K. J. P. Orton and in 1911 published, with Orton, his first group of papers, on the chlorination of aromatic compounds. From Bangor he moved for a few months to a company of tar distillers at Beckton, but, finding the atmosphere uncongenial, he accepted in 1912 an appointment with Burroughs Wellcome. Here he came into contact with F. L. Pyman, G. Barger and H. H. Dale, and acquired his abiding research interest in the chemistry of pharmacologically active compounds. In 1919, King was asked to join a small group of workers who were to establish the reputation of the new National Institute for Medical Research at Hampstead; here he remained for the rest of his working life.

A man of quiet and retiring disposition, King preferred his laboratory bench to all other attractions, and his gradual emergence as a scientific figure of international repute seemed almost to surprise him. Early contributions on hyoscine, muscarine and the cinchona alkaloids were followed, in 1924, by the first paper of a long series on trypanocidal arsenicals. While no outstanding new drug was synthesized during these investigations, there emerged a much fuller understanding of the relationship between constitution and trypanocidal action, and eventually, in collaboration with the late Warrington Yorke and E. M. Lourie, King developed an entirely new group of chemotherapeutic drugs, the diamidines.

Although probably the most active British chemist of his generation in chemotherapy, with many contributions on trypanocides, antimalarials, amœbicides and on the chemotherapy of virus infections, King's interests ranged over a much wider field, and his most outstanding contributions were in the field of the chemistry of natural products. In 1935, he published in *Nature* a brief note on curare, followed by a masterly series of papers extending over fourteen years in the *Journal of the Chemical Society*; in these he reported methods for the isolation of pure curare alkaloids; he also provided complete proof of the structure of *d*-tubocurarine and related alkaloids and clarified the botanical problem of the origin of the different curares. Moreover, he stimulated work at the National Institute on the polymethylene di-quaternary ammonium salts, simple analogues of tubocurarine, now in general therapeutic use as the well-known methonium compounds.

In 1932 also, King, together with the late Dr. O. Rosenheim, suggested a new structural formula for the steroids, which was quickly accepted as an outstanding clarification of the field, and made possible the rapid progress which followed in elucidation of the structural relationships of the sex hormones and the cardiac aglycones.

Although he did not welcome administrative responsibility, Dr. King was for many years an efficient secretary to the Chemotherapy Committee of the Medical Research Council, and during the War, secretary also to the Committee for Penicillin Synthesis. In 1933, he was elected to the Royal Society, and in 1941 was awarded the Hanbury Medal of the Pharmaceutical Society.

One additional publication deserves special attention, since it relates to King's activity outside the laboratory; in 1946 he read a paper to the South London Entomological and Natural History Society on the "Sex-attractant Principles of Moths". Few men can have derived such constant pleasure from their hobby as did King from his collection and study of British moths. No colleague could regard himself as a friend until he had been privileged to examine that collection, and no other subject could thaw King's natural reserve in the same way. Perhaps this collection showed his true character more clearly than any scientific paper; a lover of order, peace and beauty, King was a true naturalist. Those of us who passed through his laboratory as junior colleagues will always remember him with affection, not only because he was helpful, but also because of his likeable personal idiosyncrasies, his determination to do things for himself, his staunch insularity and his refusal to discourage or disparage the ideas of his juniors, however wild those ideas may have seemed to a man of his scientific insight.

Dr. King married in 1923 Miss E. M. Croft and is survived by her and his one son. T. S. WORK

Dr. Robert M. Yerkes

THE death occurred on February 5 of Dr. Robert M. Yerkes who, for well over fifty years, played a dominant part in the development of animal psychology and, in particular, the study of the behaviour of apes and monkeys. Yerkes graduated in 1899 from Harvard University, where he was given his first teaching post. In 1917, the year the United States entered the First World War, he left to become professor of psychology and director of the Psychological Laboratory at the University of Minnesota. During the course of this appointment he became special adviser on the selection of officers to the Armed Services, and chairman of the Research Information Service of the U.S. National Research Council. He also held a number of other official advisory appointments, and in 1921 became chairman of a Committee on Problems of Sex that was set up by the National Research Council. This body, of which Yerkes continued to be chairman until 1947, was highly influential in developing the study of reproductive physiology and of endocrinology.

Yerkes will be best remembered for his studies of the behaviour of apes; his own research interest was mainly in the question of intelligence and ideational behaviour. His first big monograph on the subject, entitled "Mental Life of Monkeys and Apes", was published in 1916. The work for which he is best remembered was done after 1924, when he was appointed professor of psychology at Yale University. It was during this phase of his career that Yerkes established and organized the Yale Laboratory of Primate Biology at Orange Park, Florida. This Laboratory specializes in work on chimpanzees, and has been responsible not only for most of the behavioural studies that have been made of apes, but also for much of the information we have about their reproductive physiology.

In 1929 Yerkes published, in collaboration with his wife, Ada W. Yerkes, a monumental work called "The Great Apes". This book immediately became, and remains, a source book of information on almost all aspects of the apes except their anatomy. In 1943, shortly before he retired from the active direction of his department at Yale, Yerkes published another book under the title "Chimpanzees: a Laboratory Colony", which is also the authoritative work in its field. S. ZUCKERMAN

NEWS and VIEWS

Industrial Metallurgy in Birmingham: Prof. E. C. Rollason

PROF. E. C. ROLLASON, at present Henry Bell Wortley professor of metallurgy in the University of Liverpool, has been appointed to the chair of industrial metallurgy in the University of Birmingham in succession to Prof. A. J. Murphy, who has been appointed principal of the College of Aeronautics (see *Nature*, **176**, 55; 1955). Prof. Rollason has distinguished himself in both university work and industry. He took his M.Sc. degree at Birmingham in 1932 and gained his first experience of teaching at the County Technical College, Wednesbury. Returning as senior lecturer to the Department of Metallurgy in Birmingham in 1935, he carried out research which led to the Ph.D. degree, and contributed to the development of teaching methods in the Department. At the outbreak of war, Prof. Rollason was seconded to the firm of Murex Welding Processes, Ltd., to pursue researches on the welding of armour plate and other important defence problems. In 1942 he accepted the post of research manager; he later became a director of the Company, and played an important part in building up the Research Department. Prof. Rollason returned to academic life in 1951 when he was appointed to the chair of metallurgy at Liverpool, where he has devoted himself to the reorganization of the laboratory training and the development of the undergraduate and postgraduate schools. Prof. Rollason has taken an active part on the Research Board and committees of the British Welding Research Association, and is the author of many papers on the metallurgy of stainless steel, metal spraying, and the welding of ferrous and non-ferrous metals, as well as of a successful text-book, "Metallurgy for Engineers".

Millport Marine Station, Scottish Marine Biological Association: Mr. E. Ford

MR. E. FORD is retiring from the joint post of director of the Millport Marine Station and secretary to the Scottish Marine Biological Association, which he has held since 1949. Previously the secretaryship had been a part-time post not held by the director of the Station. At the same time as Mr. Ford was appointed, the Association took under its auspices the Oceanographic Laboratory at Edinburgh and, in his capacity as secretary, Mr. Ford became responsible for both laboratories. He successfully achieved the formidable task of administration involved in the organization of the Association's office at Millport, from which the affairs of both laboratories are controlled. During the seven years of his directorship at Millport, Mr. Ford has been responsible for major developments, and the Station has become a research institute of major importance. Much of the research accommodation has been rebuilt and enlarged, the library reorganized and a workshop and stores erected. With aid from the Carnegie Trust of the Universities of Scotland, a new aquarium has been erected and a new classroom is now just completed. The scientific staff has increased, and a second research vessel has been acquired.

Dr. C. H. Mortimer

DR. C. H. MORTIMER, who succeeds Mr. Ford, has been for some twenty years a member of the staff of the Windermere Laboratory of the Freshwater Biological Association, reaching the grade of senior principal scientific officer. After graduating in zoology from the University of Manchester, Dr. Mortimer took a research degree at the University of Berlin. His first work was on cytology and reproduction in *Cladocera*; but after appointment to Windermere his interest moved to the physical and chemical aspects of organic production in freshwaters. He has carried out notable research on the exchange of dissolved substances between mud and water and more recently on water movements. This has carried him as far afield as Lake Michigan in the United States and Loch Ness in Scotland. There is much in his approach to the problems of water movements and fertility which is common to freshwaters and the sea. His change, therefore, from the one type of aquatic research to the other is natural and should prove highly productive.

Royal Geographical Society: Medals and Awards, 1956

H.M. The Queen has approved the award of the Royal Medals of the Royal Geographical Society as follows: *Patron's Medal:* John Giaever, Norwegian Polar Institute, leader of the Norwegian–British–Swedish Antarctic Expedition, for contributions to polar exploration; *Founder's Medal:* Charles Evans, leader of the Kangchenjunga Expedition 1955, for contributions to Himalayan exploration.

The Council of the Society has made the following awards: *Murchison Grant:* Dr. Alice Garnett, for contributions to physical geography and geographical education; *Mrs. Patrick Ness Award:* Robert Dovers, Australian National Antarctic Research Expedition, for contributions to Antarctic exploration and mapping; *Gill Memorial:* R. A. Skelton, superintendent of the Map Room, British Museum, for studies in the history of cartography and exploration; *Back Grant:* Richard Hamilton, senior scientist, British North Greenland Expedition; *Cuthbert Peek Grant:* David Oates, Fellow of Trinity College, Cambridge, for archæological surveys in Iraq.

Imperial Chemical Industries Transfer Scholarships

With the aim of increasing the number of university science graduates, Imperial Chemical Industries, Ltd., is to provide annually over the next few years about fifty scholarships of a new type, designed to enable students who have not specialized in science at school to commence serious study of science at the university itself. To be known as I.C.I. Transfer Scholarships, they will make it possible for students to take a preliminary science course of one year's duration at certain universities, and then go on to take normal honours science courses. The scholarships will be available for the first time during 1956–57 at the University of Cambridge; Imperial College of Science and Technology, London; King's College, Newcastle; the University of Liverpool; and the University of Oxford. The value of the scholarships will be based on State Scholarship rates, and there will be continuing small awards to scholars who successfully pass on to take honours science courses. The scheme has the full support of the Ministry of Education and of the universities and colleges concerned. Imperial Chemical Industries believes that these scholarships will help to solve one of the major problems of present-day industrial Britain—namely, the training of a greatly increased number of scientists and technologists. There are many young men who have taken arts courses at school and done well in them, but who, on going forward to the university, may wish to specialize in science subjects rather than taking advanced work in arts. At present they are not able to do this, for unless they have studied science at school they are unable to enter honours schools of science and technology in English universities. The scholarships are expected to produce 40–50 additional scientists or technologists per year, but that will be only a part, and probably a small part, of their influence if they serve to encourage a wider provision of elementary science courses in the universities.

Royal Society Antarctic Station at Halley Bay

All the authorities concerned have agreed to a recommendation of the Council of the Royal Society that the bay in Coats Land, Antarctica, in which the advance party of the Royal Society Antarctic Expedition for the International Geophysical Year, led by Surgeon Lieutenant-Commander D. Dalgliesh, landed from the M.V. *Tottan* on January 6, be called Halley Bay; and that the site of the hut, which is 1½ miles inland from the coast, be known as Royal Society Base (see p. 598 of this issue). Edmond Halley was a former secretary of the Royal Society, and this year is the tercentenary of his birth. His scientific work made pioneer contributions to many of the subjects which will receive further concentrated observation during the International Geophysical Year. Thus he studied the theory of the Earth's magnetic field, and in 1698 and 1700 made two voyages to the North and South Atlantic Ocean, which resulted, in 1701, in the publication of the first magnetic chart. His further studies enabled him to realize that the aurora borealis is associated with the Earth's magnetism. He discussed with much care the problem of trade winds, which were very important to the sailing ships of his day, and carried out some fundamental work on ocean currents, and noticed the variation of gravity as he approached the equator.

Department of Scientific and Industrial Research Bill

The Department of Scientific and Industrial Research Bill (London: H.M.S.O. 6*d*. net), issued simultaneously with the Department's annual report for the year 1954–55, and which received its first reading in the House of Lords on March 20, proposes to replace the present Advisory Council for Scientific and Industrial Research by an executive Council, referred to in the Bill as the "Research Council". The body, like the present Advisory Council, will comprise persons eminent in industry and in science, but will in future be in executive charge of the Department, subject to the over-riding responsibility of the Committee of the Privy Council for Scientific and Industrial Research and of the Lord President of the Council as its chairman. The Bill also provides in a specific Act of Parliament for the expenditure of the Department to be met out of moneys provided by Parliament, and the Imperial Trust for the Encouragement of Scientific and Industrial Research is accordingly dissolved. There appears to be nothing in the Bill which provides specifically, however, for financing the work of the Department other than on a year-to-year basis. The present annual report, while noting an increase of £260,000 in the net estimate of the Department for 1955–56 compared with 1954–55, records a failure to maintain the annual rate of increase in staff of two hundred required by the five-year plan. Some concern is expressed about the work of the research associations, more particularly in the smaller industries, and the advantage of linking the research association serving such an industry with an established and related research association serving a larger industry is emphasized. Confidence is none the less expressed that during the past five years the research association movement as a whole has demonstrated its strength and vitality and that most of British industry believes firmly in the value of its research associations.

Awards for Advanced Courses at Technical Colleges

In a written answer on March 15 to a question in the House of Commons, the Minister of Education, Sir David Eccles, said that during 1953–54, the latest year for which figures are available, 9,829 awards were obtained by students of advanced courses at technical colleges. Of these, 237 were internal degrees in science and 209 internal degrees in technology at the University of London; 722 external degrees in science and 283 external degrees in technology; 110 associateships of the Royal Institute of Chemistry; 248 Higher National diplomas; 6,940 Higher National certificates; 350 college diplomas (technical); and 90 college diplomas (science).

Agricultural Research in Scotland

In a written reply on March 9 to a question in the House of Commons, the Secretary of State for Scotland, Mr. J. Stuart, said that eight institutes for agricultural research in Scotland are financed by the Department of Agriculture for Scotland and administered by independent governing bodies under the general scientific guidance of the Agricultural Research Council. Expenditure on agricultural research for the current financial year amounted to £875,800, of which £140,050 was capital expenditure; on agricultural education to £362,300, of which £148,300 was capital and £159,000 maintenance expenditure on agricultural colleges, and £55,000 on farm schools; and on agricultural advisory services to £537,400. These figures take no account of expenditure at Scottish universities on agricultural education met by the Universities Grants Committee.

Projected Giant Radio Telescope in Australia

In 1954 the Carnegie Corporation of New York offered the Australian Commonwealth Scientific and Industrial Research Organization 250,000 dollars towards the construction of a giant radio telescope for its Radiophysics Division, subject to the provision of sufficient further funds from other sources. Since then the Australian Commonwealth Government has promised to pay half the cost of the project, and further private donations have been received including a second 250,000 dollars from the Rockefeller Foundation. These generous contributions are sufficient to permit the construction of an instrument, and arrangements have been made with the London firm of consulting engineers, Freeman, Fox and Partners, to undertake a design study. In this work they will be assisted by Dr. B. N. Wallis. Details of the instrument will depend on structural factors and available finance; but the broad specification is for a steerable reflecting telescope of the maximum feasible aperture which will work without deterioration in performance down to a wave-length of 21 cm. (the atomic hydrogen spectral line). A corresponding instrument, of 250-ft. aperture, is nearing completion at Jodrell Bank in England, and the construction of others is contemplated in the United States; but this is the only one projected for the southern hemisphere. It will be invaluable in completing the coverage of the whole sky, and, with this in mind, the International Astronomical Union and the Royal Astronomical Society have each expressed themselves as strongly favouring the project.

Natural History of Coral Atolls

During the American atom-bomb tests in the Marshall Islands in 1946, known as 'Operation Crossroads', comprehensive investigations on the geology, ecology and oceanography were carried out not only at Bikini atoll where the weapons experiments took place but also, as controls, at the neighbouring atolls of Eniwetok, where the ecology had been somewhat disturbed by wartime military operations, and at Rongerik and Rongelap, which had scarcely been touched by the outer world. The studies were continued by expeditions in 1947 and 1950, when the geological structure at Bikini was explored by several diamond-drill holes, and when seismic refraction and aerial magnetic surveys were made over this atoll, an adjacent guyot and the surrounding sea-floor. The conclusions of the large team of workers engaged in this project have lately been published by the United States Geological Survey (Professional Paper No. 260, 1955; parts *A–R*, 684 pp., 218 text figs. and 224 plates). Along the submarine slopes of Bikini and of the nearby seamount, specimens of olivine-basalt, basaltic ash and basic volcanic tuff were dredged from depths of 1,000–2,010 fathoms (6,000–12,060 ft.), providing the first direct evidence of the volcanic nature of the base on which a coral atoll is built. In the deepest borehole (2,556 ft.) the coral reef was not bottomed, the strata penetrated consisting entirely of fine detrital limestones, in composition almost a pure calcium carbonate, all originally deposited in lagoonal waters not less than 30 fathoms in depth. The oldest sediments reached are of (?) Oligocene age. Seismic refraction studies have confirmed and extended the results of drilling by indicating that several thousand feet of relatively unconsolidated calcareous rock overlies a volcanic core with a highly irregular topography. Unlike the borings undertaken at Funafuti atoll (to a depth of 1,114 ft.) in 1896–98 and at North Borodino (1,416 ft.) in 1934–36, the drilling at Eniwetok (1,285 ft.) and Bikini (2,556 ft.) has yielded cores of limestone rock which is quite free from dolomitization. It is a measure of the intensity of the collecting carried out during the recent surveys that more species of corals are now known from Bikini atoll than from anywhere else in the world.

Animal Husbandry

The sixth holder of the Devon County Agricultural Association Lectureship endowed at Seale Hayne Agricultural College was Prof. J. E. Nichols, of the University College of Wales, and in his series of four lectures on "Animal Husbandry", given during 1954–55 and now published (pp. 40. Newton Abbott: Seale Hayne Agricultural College, 1956; 4s.), he deals with general principles and then the particular problems of beef and dairy cattle, sheep and pigs. His final lecture is concerned with the methods and aims of to-day and to-morrow. In the first two lectures he gives particular attention to the sequences of change in bodily form and function in relation to nutritional requirements and to costs: to the interacting factors which affect beef and milk production and, in particular, the need for cowmanship. In his third lecture the differences in husbandry arising mainly from fertility-rates are discussed with respect to sheep and pigs, and in his final lecture an attempt is made to bring the present and the immediate future into perspective. Prof. Nichols points out that intensive management is best reserved for the phases during which intensive production takes place in order to reduce wastage of stock and conserve feed resources. In general, intensive conditions—whether they refer to housing, to feeding, to control or to stockmanship—are most needed and are best applied to the peak periods of lactation, to before and just after parturition, and again to the finishing period of bacon, pork, mutton and beef. So far as cattle are concerned, as part of the requirements for intensification, the simple point of dehorning comes into the picture; in itself it enables saving in space as well as of energy to be made.

Soil Science in New Zealand

The New Zealand Society of Soil Science held its first conference, under the presidency of Mr. N. H. Taylor (director of the Soil Bureau, N.Z. Department of Scientific and Industrial Research), as Section M of the eighth New Zealand Science Congress at Auckland in 1954. The proceedings have now been published (N.Z. Soc. Soil Sci., 54 Molesworth Street, Wellington, N.Z.; pp. 32; 4*s*.), and the presidential address issued as a reprint from the *Transactions of the Royal Society of New Zealand* (**82**, 961; 1955; 1*s*.). In his address, "The Role of Soil Science in New Zealand Problems", Mr. Taylor discussed the subject under four main headings: problems arising from the interdependence of land use and society, and from the use of soils for engineering purposes, for the growing of plants or for the support of animal life. Practical examples mentioned are the selection of the most suitable sites for urban development, road foundations and pipe-line corrosion, while on the biological side are questions of irrigation and forestry or the relationship between soil and the incidence of dental caries. During the conference, symposia were held on forest soils, the aims and values of soil analyses and on the pumice soils. Full summaries of the papers read on each occasion are published in the proceedings, together with the discussion that followed. Shorter abstracts are given of the papers contributed at other sessions.

Automatic Recording of Temperature and Vapour Pressure or Dew-point

In normal measurements of the humidity of the air near the surface, readings are taken of dry- and wet-bulb temperatures, and the vapour pressure, dew-point and relative humidity are calculated from tables. For automatic recording there are available the thermograph, giving a continuous record of dry-bulb or wet-bulb temperatures, and the hair hygrograph, giving a record of relative humidity. Again, the vapour pressure and dew-point have to be calculated from tables. To study the water economy of plants, continuous records of vapour pressure and dew-point are needed, and to obtain these Dr. U. Berger-Landefeldt, of the Technical University of Berlin, has devised an automatic electrical recorder which he describes in the December issue of *Weather* (**10**, 405; 1955). Continuous readings of wet- and dry-bulb thermometers are made and are arranged by suitable circuits to solve the hygrometric formula and give continuous records of dry-bulb temperature, vapour pressure and dew-point. Records obtained by the instrument are shown in the article, and it is explained how the large variations in vapour pressure of 8 mm. of mercury are due to the vigorous transpiration of the alfalfa plants over which the instrument was placed.

Formation and Properties of Diamonds

In a paper entitled "Diamant" (*Zprávy Výzkumného ústavu pro minerály v Turnově*, 4, 577+33 figs.; 1955; Czech, with Russian, English and German summaries), Dr. Primus Ružička offers an explanation of the formation of diamond by the reaction $2CO \rightarrow CO_2 + C$ under great pressure, the pressure finally building up enough to break through the sedimentary rocks and emplace the pipes of kimberlite. He employs this theory to link up a number of observations: sharp octahedra and holohedral forms crystallized more slowly and at lower pressures than rounded crystals, which mostly belong to the ditesseral polar (blende) symmetry class. Type II diamonds crystallized slowly at a lower pressure than type I; and the lamellar structure common in type II diamonds is due to the intercalation of layers of a graphite or 'pseudo-graphite' structure. Bort is regarded as a late product, formed during and after the emplacement of the kimberlite. An explanation of the differences, particularly in crystal habit, between diamond from different localities is offered. In the final sections (pp. 91–114), the anisotropy of the hardness of diamond is discussed, particularly in connexion with the industrial applications of diamond.

Earthquakes during February

During February the greatest earthquake was of magnitude 7¼, and had its epicentre south of Honshu, Japan, with depth of focus 450 km. Earthquakes of magnitude between 6 and 7 occurred on February 1 in the Marianas Islands; on February 9 and later, aftershocks in Lower California; on February 12 and later, aftershocks near the north-west coast of Luzon, Philippine Islands; and on February 19 in the Queen Charlotte Islands. A shock on February 1 in the Fiji Islands had a depth of focus of 600 km. The swarm of shocks, with the principal one on February 9, in Lower California (epicentre south of the point 32° N., 116° W.) did minor damage in the Imperial Valley and at San Diego, and many of the shocks were felt in Los Angeles. Of this swarm, twenty-nine shocks greater than magnitude 5 occurred during February 9–17, and according to the seismological laboratory at Pasadena the later epicentres were somewhat to the east of the principal one. On February 14 an earthquake with its epicentre near the east coast of Honshu caused several injuries and minor property damage in Tokyo. Its magnitude was 5¾ and depth of focus 60 km. On February 15 in Peru an earthquake was responsible for two deaths in the Callehon Huaylas region, while on February 20 in Turkey an earthquake at Eskisehir caused extensive property damage and was responsible for the deaths of four people; many others were injured.

Open Days at the Atomic Energy Research Establishment, Harwell

The Atomic Energy Research Establishment at Harwell was founded ten years ago, and, to mark the occasion, a series of 'open days' is to be held in the week ending June 2. On the first four days, members of both Houses of Parliament, correspondents of the British, Commonwealth and foreign

Press and representatives of the neighbourhood will be invited to tour the establishment. On June 1 there will be a 'university open day', when scientists and technologists from universities and Government research establishments and representatives of industry will be invited. As a result of the changes in security classification made before the International Conference on the Peaceful Uses of Atomic Energy at Geneva last year, much of the work at the Establishment is no longer subject to security restrictions. Consequently, visitors will have more freedom to see a wider range of work at Harwell than was possible until recently.

Society of Chemical Industry : Seventy-fifth Annual Meeting

In connexion with the seventy-fifth annual meeting of the Society of Chemical Industry, which will be held in London during July 9–14, a series of lectures will be given under the title of "Achievements of Industrial Chemistry". They will be introduced by Dr. L. A. Jordan on July 11, speaking on "Modern Methods of Research", and thereafter they will fall into two parallel series. The first series, under the title of "Products of Industrial Chemistry", will be as follows : new products of the fermentation industry, by J. J. H. Hastings (July 12) ; hydrocarbon macromolecules, by C. W. Bunn (July 12) ; carbohydrate macromolecules, by Prof. M. Stacey (July 13) ; nitrogen- and chlorine-containing macromolecules, by Prof. H. W. Melville (July 13). The second series will be on "Tools of Industrial Chemistry", and will be as follows : metals as plant construction materials, by Dr. N. P. Inglis (July 12) ; non-metals as plant construction materials, by Herbert W. Cremer and G. Brearly (July 12) ; manufacturing techniques, by W. d'Leny (July 13) ; records and control, by Dr. G. M. Dyson (July 13).

The Night Sky in April

New moon occurs on April 11d. 02h. 39m., U.T., and full moon on April 25d. 01h. 40m. The following conjunctions with the Moon take place : April 4d. 05h., Mars 4° S. ; April 11d. 17h., Mercury 4° S. ; April 14d. 14h., Venus 4° N. ; April 19d. 19h., Jupiter 6° N. ; April 27d. 05h., Saturn 3° N. In addition to these conjunctions with the Moon, Venus is in conjunction with Aldebaran on April 14d. 20h., Venus 9·1° N. Mercury is too close to the Sun in the first half of the month for observation, but after that it can be observed in the evening ; its time of setting on April 30 is 21h. 25m., which is two hours after sunset. Its stellar magnitude varies from −1·2 to 0·2, and the visible portion of its illuminated disk from 0·880 to 0·460 ; its distance from the Earth is 125 and 85 million miles on April 1 and 30, respectively. Venus sets at 23h., 23h. 35m. and 23h. 40m. at the beginning, middle and end of the month, respectively, its stellar magnitude varying between −3·9 and −4·1, and its distance from the Earth between 75 and 54 million miles ; the visible portion of the illuminated disk varies from 0·570 and 0·401. Mars rises at 3h., 2h. 35m. and 2h. on April 1, 15 and 30, respectively, stellar magnitude 0·7–0·3, the increase in brightness being due to the distance from the Earth decreasing from 121 to 98 million miles ; at the beginning of the month it lies a little south of *h* Sagittarii, and its eastward movement is easily detected by observing its positions with reference to this star over a few nights. Jupiter is visible throughout the night, setting in the morning hours at 4h. 20m., 3h. 20m. and 2h. 20m. on April 1, 15 and 30, respectively. Its stellar magnitude varies from −1·9 to −1·7 owing to its distance from the Earth increasing from 435 to 457 million miles. Saturn rises at 23h. 05m., 22h. 05m. and 21h. at the beginning, middle and end of the month, respectively ; its westward movement can be noticed by comparing its positions during the month with β and ν Scorpii, and its stellar magnitude varies from 0·5 to 0·3 owing to its distance from the Earth decreasing from 866 to 839 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich : April 2d. 4h. 08·4m., 21*G* Sgr. (*R*) ; April 17d. 23h. 13·1m., 1 Cnc. (*D*) ; April 19d. 0h. 28·5m., 60 Cnc. (*D*) ; April 21d. 23h. 03·4m., *e* Leo. (*D*), *R* and *D* referring to reappearance and disappearance, respectively. The Lyrid meteors attain a maximum about April 21, but moonlight will make their observation very difficult.

Announcements

Dr. Alexander Muir, head of the Pedology Department, Rothamsted, and the Soil Survey of England and Wales, has been appointed deputy director (Soils Division) of Rothamsted Experimental Station in succession to the late Dr. E. M. Crowther.

The following appointments in the University of London have been announced : Dr. E. G. Healey, lecturer in zoology in the University College of Wales, Aberystwyth, to the University readership in zoology tenable at Bedford College ; Dr. D. C. Spanner, lecturer in plant biophysics at the Imperial College of Science and Technology, to the University readership in botany tenable at Bedford College.

The University of Leeds has appointed Dr. H. C. Versey, reader in applied geology, to a personal chair in the Department of Geology. Dr. P. Padget has been appointed Oppenheimer Geological Fellow in the Institute of African Geology of the University.

The annual general meeting and conference of the Mammal Society of the British Isles will be held in the Zoology School of the University of Cambridge during April 6–9. On April 6, at 8.30 p.m., a public lecture on "The Mammalian Placenta" will be given by Prof. J. D. Boyd, professor of anatomy in the University. Further information can be obtained from the conference secretary, K. M. Backhouse, Department of Anatomy, St. Bartholomew's Hospital Medical College, Charterhouse Square, London, E.C.1.

The Institution of Mechanical Engineers has recently established a set of lectures for boys, to be called the Leonardo da Vinci Lectures, and the first three will be given on April 9, 10 and 11 (at 3 p.m.) as follows : "Fundamental Energy", by Prof. D. G. Christopherson (professor of mechanical engineering, Imperial College of Science and Technology, London) ; "Applied Energy", by Sir Claude Gibb (chairman and managing director, C. A. Parsons and Co., Ltd.) ; and "Nuclear Energy", by Sir Christopher Hinton (member for engineering and production, United Kingdom Atomic Energy Production). Tickets (which are free) for one or more lectures and further information can be obtained from the Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.

Erratum. In the article "Polar Wandering" in *Nature* of March 24, on p. 551, col. 2, par 2, the second quotation should begin with the word "We" in line 10.

AGRICULTURE IN THE UNIVERSITY COLLEGE OF THE GOLD COAST

By Prof. JOHN PHILLIPS

THE Cocoa Marketing Board of the Gold Coast, with the approval of the Government, has made available to the University College of the Gold Coast the sum of £1 million for the purpose of establishing and endowing an Agricultural Research Station in the Forest Region. Of this amount, the sum of £750,000 has been allocated for investment for staffing and other recurrent expenditure likely to be associated with the proposed Station, while the sum of £250,000 is to be available over the course of the next four years for purposes of capital development.

At a ceremony at the Agricultural Research Station of the Department of Agriculture of the College, at Nungua, near Accra, a cheque for £750,000 and one for £40,000 as the first contribution toward capital needs were presented by the chairman of the Cocoa Marketing Board to the Principal of the University College on February 28.

Briefly, the objectives of the proposed centre, which is to be established in an area of forest on soils considered to be typical of a large area of the forest region, include: (1) Provision of educational facilities for students of agriculture—undergraduate and senior. (2) The investigation of problems in the management of forest soil, including the possibilities of improving on existing practices in 'shifting cultivation' or 'bush fallowing' and the enhanced production of food and commodity crops both annual and perennial. (Among the commodity crops would be cocoa, coffee, cola, citrus, banana, pineapple—and by some special arrangement relating to site, aspects of oil palm production.) (3) Through studies both at and beyond the centre, the gathering of information relating to the economics of production of selected commodity and other crops, with emphasis on cocoa. (4) Study of problems of production, within the forest region, of poultry, pigs and sheep in certain circumstances. (5) Application of special techniques in the removal of woody growth and the cultivation of forest soil—bearing in mind the dangers of extensive and prolonged exposure of these soils to insolation and heavy and consistent rainfall. (6) The organization of a centre on which professional advisory service of a non-routine nature relating to forest agriculture could be based. (7) Establishment of a centre at which scientific and other research workers concerned in the problems of forest agriculture could work, on invitation, from time to time.

The proposed Station is a logical successor to the first research centre established by the University College in 1952 at Nungua, on the Accra Plains, for students of agriculture and for research into the classification and development of soils; crop production under irrigation and on rain-fed land; animal production and pasture management; aspects of soil and water conservation; mechanization of agriculture and agricultural management and economy. The progress at this Station has been sufficiently encouraging to attract the interest of the authorities to an extension of the University College's activities to the most important economic region in the country, that of the mixed evergreen forests.

The University College is in special relationship with the University of London in respect of academic standards, examinations and the conferment of degrees. At the present there are eleven men reading agriculture in the first, three in the second and three in the final year of the agricultural course proper. Special scholarships for men reading agriculture at the College are offered by the Cocoa Marketing Board and the Agricultural Development Corporation of the Gold Coast. A wide range of research by members of the staff is in progress.

THE ART OF SCIENCE

PROF. L. C. BEADLE'S inaugural address, "The Art of Science", which he delivered on October 28, 1954, at Makerere University College of East Africa, Kampala, Uganda, on taking up the chair of biology there, and which has now been published*, is a brilliant exposition of the thesis that every educated person should know something of the history of science and of the nature of creative research. No summary can do justice to an address which abounds in humour, in sense and frank avowals of the author's convictions, but which can scarcely be quoted without distorting the balance of his argument. He starts by insisting that the inclusion of a subject in the curriculum of a university cannot be justified solely on grounds of utility and that no one can fully understand the nature of science without some knowledge of its history. He pauses in his survey of the history of science to observe that the medieval conception of science as a finite body of established facts is exactly what science is not, and to comment that so far there has been a sufficient number of practising scientists in the teaching profession to frustrate the attempts made during the present century to revive the conception through the invention of examinations. Turning to the biological sciences, he points out that the main creative act in biological research is the decision as to what the problem is, and then the posing of the right questions; he does not believe that the biologists can entirely avoid considering the problem of mind and body. If, however, the great progress now being made, with the aid of new techniques, in the physiology of brain and nervous system, on one hand, and in the study of animal behaviour, on the other, leads to the two streams meeting at any point, there should be results of great practical value, and the combined streams might be deep enough for the psychologists and philosophers to navigate.

In dealing finally with the question, "What is the art of science?", Prof. Beadle remarks that the first and greatest exponents of the scientific method,

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* The Art of Science: an Inaugural Address delivered at Makerere University College of East Africa, Kampala, Uganda, on October 28th, 1954. By Prof. L. C. Beadle. Pp. iii+32. (London: Oxford University Press, 1955.) 3s. 6d. net.

Bacon and Descartes, though themselves creative thinkers, apparently misunderstood the true nature of creative work. Both seem to have missed the point that scientific discovery is primarily a matter of intuition, that is to say, it is an art. The most essential feature of a creative scientific thinker, Prof. Beadle insists, is his power of imagination and intuition; and knowledge and experience, such as can be got from formal education, are the background from which spring those imaginative flights which are the essence of scientific discovery. He suggests that the greatest single need for the scientific development of Uganda is that the young children should be encouraged, more than they are, to play and experiment. It is the task of the schools to preserve the experimental and imaginative outlook and to protect it against the pernicious influence of examination syllabuses; and it is the task of the universities, the demands of which determine so much the teaching syllabuses in schools, to frame their demands so as to encourage the schools to teach real science, and also to send them teachers who really understand what science is.

EFFECT AT GROUND-LEVEL OF GAS FROM A CHIMNEY-STACK

THE determination of the maximum concentration at ground-level of gas emitted from an industrial chimney-stack is an important problem in the application of meteorology to health. Sutton[1] showed that the concentration at ground-level downwind from the chimney of gas at the same temperature as the surrounding air drifting out of the top rises to a maximum with distance from the chimney and then falls off. He gave a formula for the maximum concentration in terms of wind speed, height of chimney, the atmospheric turbulence coefficients and the atmospheric stability. Usually, the gas is hotter than the surrounding air and has an appreciable vertical speed at the top of the chimney. Both factors cause the gas plume to have a vertical component of speed for some distance from the chimney. The centre line of the plume gradually bends over to become horizontal along the wind at a great distance from the stack.

Recently, Dr. A. C. Best[2] has examined, with the view of helping the stack designer, the relative merits of the following three formulæ for finding the maximum concentration at ground-level of gas from a heated elevated source: (*a*) an extension of Sutton's 'cold' gas formula; (*b*) a theoretical one due to Bosanquet, Carey and Halton[3]; and (*c*) an empirical one, suggested in the United States at the Atomic Energy Station, Oak Ridge[4]. Sutton's 'cold' gas formula is applied to the 'hot' gas problem by replacing the chimney by one at a height greater by a length proportional to u^{-3}, where u is the wind speed. Dr. Best shows that the other two formulæ are equivalent to treating the problem in the same way but with additional heights, for (*b*) proportional to u^{-2} (approximately), and for (*c*) to u^{-1}. He calculates the maximum values of concentration of gas at ground-level for various realistic values of wind speed, height and diameter of chimney, and rate of heat output by the chimney relative to the surrounding air, for example, speed of efflux 5 and 15 m./sec., diameter 5 and 10 m., heights 50, 100 and 200 m., and heat output 10^5–10^9 cal./sec.

Formulæ (*a*) and (*b*) give values with ratios mostly nearly unity and with a maximum of 1·66, and formulæ (*b*) and (*c*) give ratios twenty-five of which were less than 2, thirty-eight less than 3, and with the greatest ratios 4·3, 5·6 and 6·4 occurring only for the somewhat abnormally great stack height of 200 m. The results apply only to occasions of a small fall of temperature with height. An inversion above the chimney would make the concentration at ground-level markedly greater. Formula (*c*), which is

$$\text{maximum concentration (mgm./m.}^3) = \frac{9 \times 10^6 . Q}{h(14\,vd + H)},$$

where Q is strength of source in lb./sec., h height of stack (ft.), v speed of efflux (ft./sec.), d diameter of stack (ft.), and H rate of heat output relative to the surrounding air (B.Th.U.), gave the greatest values for the worst conditions of low height, small speed of efflux and low heat output. For this reason, and also because it is the simplest to use, Dr. Best suggests the Oak Ridge formula is the most suitable one for the stack designer.

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[1] Sutton, O. G., "Micrometeorology", p. 292 (London, New York and Toronto: McGraw-Hill, 1953).

[2] Best, A. C., *Met. Mag.*, **84**, 297 (1955).

[3] Bosanquet, C. H., Carey, W. F., and Halton, E. M., *Proc. Inst. Mech. Eng.*, **162**, 355 (1950).

[4] Rep. U.S. Atomic Energy Comm., Oak Ridge, Tenn., No. *ORO*-99 (1953); formula also quoted in Rep. Comm. on Air Pollution (Cmd. 9322), (London: H.M.S.O., 1954).

NEW NATURE RESERVES IN ENGLAND

THE Nature Conservancy has recently established two new nature reserves—Fyfield Down, Wiltshire, and Westleton Heath, Suffolk—and in addition has acquired further land for the existing nature reserve of Yarner Wood, Devon.

Fyfield Down is one of the finest remaining tracts of unreclaimed high chalk downland in England and is probably the richest in sarsen stones, locally known as 'grey wethers', from their resemblance when seen in the distance to a flock of sheep. It is probable that the great 20-ft. sarsen stones in the circle at Avebury (weighing about 60–70 tons) were brought there from Fyfield Down nearly four thousand years ago to form the oldest important structure in Britain and one unique in Europe. Being close to Avebury, the new reserve is within one of the principal areas inhabited by prehistoric man, and the Celtic field system is one of the largest in England. There is a tumulus to the south of the fields and two others along the western boundary formed by the Ridge Way, which at this point crosses another ancient track known as the Herepath. There are also remains of an ancient village along the 700 ft. contour, the highest point on the reserve being about 830 ft. The sarsens are large blocks of sandstone apparently derived from a bed of sand which covered the site in Eocene times. Their distribution is considered to be natural, none having been erected as standing stones. They produce an effect of great botanical interest, being accompanied by pockets of acid soils, on which grow acid-loving plants such as sheep's sorrel. This is in contrast to the ordinary lime-loving plants of downland; meadow saxifrage (*Saxifraga granulata*) is abundant in the reserve. The vegetation indicates an exceptionally high humidity, and bluebells grow in the open. A varied moss flora grows on the stones. The grassland of the reserve will continue to be grazed by sheep (rabbits having been virtually eliminated by myxomatosis), and the gallops will continue to be used for training racehorses. More than sixty breeding species of birds have recently been listed at Fyfield Down, including the wheatear, grasshopper warbler and six species of tits; the hen harrier, buzzard, peregrine, quail, hoopoe, and short-eared and long-eared owls have also been observed. The present Declaration by the Nature Conservancy covers an area of approximately 610 acres, about three miles west of Marlborough, which has been leased to the Conservancy by Mr. G. E. Todd, of Manton House. Permits will be necessary for those who wish to collect specimens of animals or plants, or to visit parts of the reserve away from the footpaths. Applications for such purposes should be addressed to the Regional Officer for the South, Nature Conservancy, Furzebrook Research Station, Wareham, Dorset.

Westleton Heath straddles the road between Westleton and Dunwich. Part of this heath is already included in the Minsmere bird reserve managed by the Royal Society for the Protection of birds, and the Conservancy's acquisition of 117 acres on the eastern side safeguards the remainder up to the boundary of the Forestry Commission's Dunwich Forest, which lies between it and the sea. The heath is well known for its birds, including the stonechat, woodlark, red-backed shrike, stone-curlew, lesser redpoll and nightjar. It also has great importance as one of the few good surviving examples of the characteristic and formerly extensive East Suffolk heathlands, most of which have recently been reclaimed for agriculture or afforestation, or have been absorbed by the needs of defence. The dry sandy and shingly soil is of low fertility and is underlaid by the Westleton Beds, sands and gravel of mid-Glacial (Pleistocene) age laid down under marine conditions. It is clothed largely in heather and is crossed or bounded by roads and footpaths to which the public are asked to keep in order to reduce the fire risk and to avoid disturbing the wild life. Inquiries and applications for permits should be addressed to the Regional Officer for East Anglia, Nature Conservancy, 6 Upper King Street, Norwich, Norfolk.

Yarner Wood, near Bovey Tracey, was bought by the Nature Conservancy and declared a reserve in May 1952. A part of the wood was burnt by incendiary bombs during the air raid on Exeter in 1942, and in this section the fire killed about two-thirds of the standing trees and left others badly damaged. It was followed by a dense growth of heather, bilberry and bracken, and a plan was adopted early last year whereby part of the wood was set aside for scientific investigations into different methods of regenerating woodland, for encouraging colonization by insectivorous birds and for population studies of small mammals by the University of Exeter. Otherwise the reserve is being managed to re-establish woodland of the type which is believed originally to have been there. In order to protect and diversify the reserve, an additional twenty-eight acres adjoining the reserve and the *B*.3344 road from Bovey Tracey to Manaton have been bought by the Conservancy. Included in this addition are an interesting small alder wood and bog containing such plants as the royal fern (*Osmunda regalis*). The acquisition includes Yarrow Lodge, which is being converted to accommodate members of the Conservancy's staff working in the reserve, access to which is by permit only and must be strictly limited in order to avoid interference with the programme of scientific research. Inquiries should be addressed to the Regional Officer for the South-West, Nature Conservancy, Furzebrook Research Station, Wareham, Dorset.

BOOKS IN SHORT SUPPLY

To the specialist bookseller, the supply and prices of books which are no longer in print is a pressing problem to which there is no easy answer. In an address to the Society for the Bibliography of Natural History, C. Kirke Swann explained how the bookseller has to know the comparative scarcity of books as well as their importance to the student or collector (*J. Soc. Bibliography of Nat. Hist.*, 3, Pt. 3; January 1956). It is surprising to learn that, of those books which have been published during the past fifty years and are seemingly necessary to the student of natural history, about two-thirds of them are out of print. Demand greatly exceeds supply for such well-known books as Goodrich, "Structure and Development of the Vertebrates"; Fraenkel and Gunn, "Orientation of Animals"; Flower and Lydekker, "Introduction to the Study of Mammals"; Noble, "Biology of Amphibia"; Eltringham, "Histological Methods"; Ellis, "British Snails"; Scott, "Studies in Fossil Botany"; Seward, "Fossil Plants"; Hutchinson, "Families of Flowering Plants"; West and Fritsch, "British Freshwater Algae", and many others.

There are several reasons for this scarcity. Some editions were comparatively small and there have been no reprints; copies have been worn out through use, to say nothing of destruction and damage during two great wars; an increased interest in the subject; and comparative lack of new books to replace many of the older standard works.

The situation could be met by reprinting, but here there are several difficulties. Printing to-day is not cheap, especially if there are illustrations to be considered. Another important factor is the number of copies required. Two hundred copies or so of a number of the books would probably satisfy the demand. Reprinting in such comparatively small numbers is not economic unless the price is correspondingly high. It would often result in the prices of reprints being far higher than the present market price of the originals. Some books are rapidly becoming irreplaceable.

In discussing some of the older books the position is rather different. Editions, compared with modern books, were often very small, and in some cases extremely so, ranging from about four or five hundred copies down to less than a dozen. Another factor is the high prices at which many of the books were published, particularly if the present value of the pound, compared with, say, the year 1830, is borne in mind. Many of these older books have almost disappeared from the market and are only to be found in libraries, from which they are seldom, if ever, likely to emerge. Though quite a large number of these are now only of historical interest, they are eagerly sought after by the collector.

A NEW METHOD OF ANALYSING IONOSPHERIC MOVEMENT RECORDS

By Dr. G. L. ROGERS
Department of Physics, Victoria University College, Wellington, New Zealand

IN 1948, Gabor[1] proposed a system of microscopy by reconstructed wave-fronts which is, in effect, a two-stage image-forming process using Fresnel diffraction[2], with the option of changing wave-length half-way. Hitherto the process has been used in conversions from a short wave-length, for example, electron optical[3] or X-ray[4], up to visible light. There is no reason, however, why the method should not be used to scale down a wave-length, and this allows the optical examination of any radio wave pattern which is generated by Fresnel diffraction[5] from a sufficiently small object in an otherwise coherent main beam. The following phenomena suggest themselves as capable of investigation by this technique:

(1) Occultation of a radio-star by a sample of $F2$ region consisting of relatively small patches in an otherwise clear moving ionospheric sky[6].

(2) Ionospheric movement records when the ionosphere is largely a smooth reflector with small imperfections moving across it.

(3) Records obtained when a sensibly smooth reflector has absorbing or phase-contrast patches moving below it; for example, sporadic E below F_1, or meteor trails below E.

(4) The need for a small object in an otherwise coherent beam may be removed, by supplying a 'coherent beam' artificially from elsewhere, after the Gabor and Goss[7] 'round the square' interferometer. In the case of radio signals, this is relatively easy, as a signal can be taken from the transmitter's master oscillator, suitably attenuated, and fed into the receiver, where it combines with the downcoming signal in accordance with the well-known 'coherent demodulator' technique[8]. In this case, the signal passed direct from the transmitter may conveniently be two or three times the strength of the maximum reflected signal, so that the phase of the sum-term never departs too far from that of the larger signal. Alternatively, the analogy with the Gabor and Goss interferometer may be made complete by replacing the optical 'quadrature prism' by an analogous radio network consisting of two 'coherent demodulator' receivers, one working directly from the transmitter's master oscillator, the other from this signal after passing through a 90° phase-shifting network[9]. The outputs from *both* receivers must be recorded, and may later be combined optically in a Gabor and Goss interferometer. This later technique removes all restriction on the degree of roughness in the ionosphere which may be investigated.

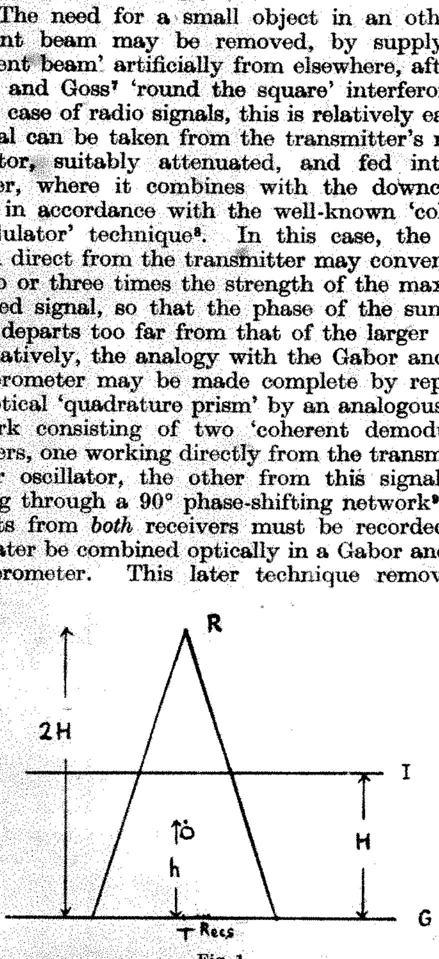

Fig. 1

A preliminary investigation of this technique has now been undertaken. The radio arrangement is shown in Fig. 1. Here we take the ionosphere provisionally as a good reflector, a point we can check later by reconstructing an 'image' of it. The reflexion R of the transmitter T in the ionosphere, I, may be regarded as a point source of coherent radiation diverging from R, and giving rise to a diffraction pattern of the object O, which will travel over the ground as the projection of O's motion. It is shown elsewhere[2] that this diffraction pattern is characterized by a 'focal length', f_r, given by:

$$f_r = \frac{2Hh}{2H-h} \tag{1}$$

When the record is converted into a variable-density photographic plate[10], it is found to have a visual focal length, f_v, in a visual wave-length λ_v, given by

$$f_v = \left(\frac{\lambda_r}{\lambda_v}\right)\left(\frac{d}{T.v_g}\right)^2\left(\frac{2Hh}{2H-h}\right) \tag{2}$$

where λ_r is the radio wave-length, d the distance on the photographic plate corresponding to the time marks on the records, T the time interval between these marks, and v_g the velocity of the diffraction pattern over the ground. The actual velocity of the object, at height h, is

$$v_h = (2H-h)\, v_g/2H$$

To test the method, use was made of existing Dominion Physical Laboratory records, obtained on 2·404 Mc./s. (approximately 125 metres) with a pulse length of about 70 µsec. and a receiver gate of 150 µsec. at 100 pulses per sec. from three aerials arranged according to the Mitra[5] pattern at a spacing of 100 yd. The signals were separated, and each was converted into an equivalent variable-density track[10]. These tracks were then mounted in register and rephotographed, the north aerial track being repeated top and bottom to assist in getting a vertical line. The resultant hologram (Fig. 2a), which was just over 1 mm. wide and about 6–8 mm. high in all, was put on to the optical bench and a number of values of f_v were found visually, and confirmed by photography. The photographs show a black line developed in the 'image' of each track: each line is in an ideal case a one-dimensional image of the object O. Owing to the time delay in passing over the different aerials, these reconstructed black lines are laterally displaced from track to track, and the corresponding time-interval may be deduced by measuring the shift. v_g may then be deduced at once, using the analysis of Mitra's paper[5]. A particularly good example is shown in Fig. 2b and less obvious cases in Figs. 2c and d. It is believed the latter may be an 'image' of the ionosphere itself, but the evidence is not fully conclusive.

Attempts to deduce v_g are subject to some uncertainty, because of the small scale of the hologram necessary to get a reasonably small f_v. Thus Fig. 2a was originally at a scale of about 12µ per sec. A better plate-measuring microscope than available

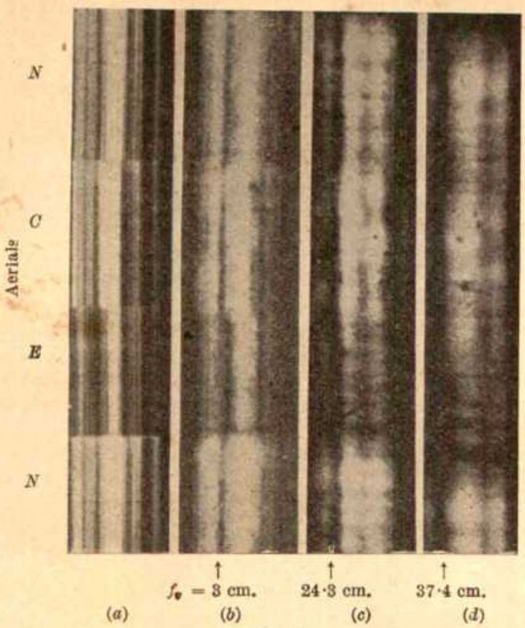

Fig. 2

here might have improved matters, and the use of a longer recorded track would also have assisted, by increasing the resolving power, and reducing the line-width. Case 2*b* is the most accurate; it corresponds to an object moving at 10–15 metres/sec. at a height of 100–300 metres. It is thus abundantly clear that objects far below the ionosphere can make significant contributions to ionospheric movement records.

It will be seen from equation (2) that if v_g is obtainable, everything is known but h; and hence the height of the object may be deduced. Unfortunately, the expression contains a term in v_g^2, and is thus subject to considerable uncertainties. It has, however, an important advantage over traditional methods of analysis in that h is otherwise quite indeterminate.

Fig. 2 also brings out an important point, namely, that most ionospheric movement records are composite, and give information relating to quite different levels. So far as is known, diffraction microscopy constitutes the only method of analysis which gives even partial height discrimination.

In routine use, direct recording of the three signals as variable-density tracks is essential, as the labour of conversion[10] from present variable-area tracks is prohibitive on a large scale. No very great linearity in the recording system is required. Experiments on such direct recording are being considered. On the optical side, methods are being developed to enable the effective visual foci and lateral shifts to be measured rapidly.

For those interested in the mathematics of correlation, it may be noted that 'reconstruction' in a diffraction microscopy apparatus is equivalent to correlating the observed radio diffraction pattern with a wave which is a diametral section through a Newton's ring system, the scale of the latter being varied by moving up or down the optical bench. A sharp peak is expected on the correllogram when the scale of the Newton's ring wave corresponds to one of the visually determined 'image' planes. At the same time, the effects of other phenomena, at different heights, are weakened, and hence the movement velocity obtained by diffraction microscopy is expected to be more reliable than that obtained by other means. The usefulness of this technique will thus be apparent.

I am indebted to the Director of the Dominion Physical Laboratory for permission to use ionospheric movement records obtained by Mr. G. J. Burtt and his staff, also to Prof. G. A. Peddie of this Department for help and encouragement.

[Sept. 26

Note added December 9. Since the above was written, a Dakota aircraft has been sent up on an ionospherically quiet day and a one-dimensional 'image' of it has been recovered by diffraction from one of the aerial records obtained. This confirms a tentative identification of the 100–300 metre object as probably a light aircraft.

[1] Gabor, D., *Nature*, **161**, 777 (1948); *Proc. Roy. Soc.*, A, **197**, 454 (1949); *Proc. Phys. Soc.*, B, **64**, 449 (1951).

[2] Rogers, G. L., *Proc. Roy. Soc. Edin.*, A, **63**, 193 (1952).

[3] Haine and Dyson, *Nature*, **166**, 315 (1950). Haine and Mulray, *J. Opt. Soc. Amer.*, **42**, 763 (1952).

[4] Baez, A. V., *Nature*, **169**, 963 (1952).

[5] Mitra, *J. Inst. Elect. Eng.*, **96**, III, 441 (1949).

[6] Hewish, *Proc. Roy. Soc.*, A., **214**, 494 (1952). Maxwell, A., and Little, C. G., *Nature*, **169**, 746 (1952).

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LOCOMOTION OF WORMS

A VERY little naked-eye observation shows that both the usual text-book account of the locomotion of worms (largely based on the work of Friedländer[1]) and the more recent papers by Gray[2] and Gray and Lissmann[3] are inadequate descriptions of how a worm moves.

My interest in the subject was first aroused by the accidental observation, in 1931, that a worm could move on the vertical surface of a sheet of polished tin. I have several times since then seen a worm moving upwards on a vertical surface of glass, such as the side of a beaker. So far as I am aware, no mention of this ability has appeared in the scientific literature, but an account of a worm crawling up a window-pane was given some years ago by an anonymous correspondent in *The Times*[4]. It is clear that such movement cannot be explained by the usual description.

I have observed worms moving on various surfaces, smooth and rough, dry and wet, and in glass and plastic tubes and in other forms of artificial burrows. The species were not determined, but there seems to be no great difference between *Lumbricus* and *Allolobophora*, and as there have certainly been several species and probably other genera among my material, it is probable that locomotion is similar in all the Lumbricidae. The chief points of amplification or correction of the published accounts are the following.

(1) The segments which are moving forwards are often raised a little above the surface; this lifting is increased and unnatural when the worm is on some-

thing such as absorbent paper, which tends to dry it, but may also be seen at other times. From the physical point of view, raising the body must assist locomotion by reducing the resistance to forward motion while increasing that to backward slip.

(2) In spite of (1), there is often much backward slip on a smooth surface, such as glass, and even on quite rough paper. This is especially noticeable when the tail elongates; it then moves backwards, and only in the subsequent contraction of the longitudinal muscles does it move forwards. Slip is also seen (and heard) when the anterior segments shorten and move backwards.

(3) The contraction waves often do not pass more than half-way down the body; if they do not go to the end, the tail is dragged passively forward.

(4) The chætæ are probably of little assistance in locomotion on a surface. So far as I have observed, they are never extruded unless the longitudinal muscles of their segment contract, but it is quite possible for this contraction to occur without extrusion of the chætæ, and if segments remain contracted the chætæ may be gradually withdrawn. In one preparation of the anterior eight segments of a worm, the chætæ several times remained erect after the longitudinal muscles had extended. In extrusion, the chætæ of the anterior part of the body are directed slightly backwards, those of the middle segments are directed radially, with some irregularity, and those of the last twelve or so segments are directed strongly forward. These posterior chætæ are longer than the others. In normal locomotion only the chætæ of the first dozen or so segments are extruded.

(5) Large 'steps' can be taken by the worm on a smooth surface such as glass only if the extreme anterior end is first placed in contact with the surface, and I now have good visual evidence that this end is acting as a sucker. If the worm is observed from below, one can see that the extreme anterior end is pressed against the glass, the peristomium is pressed around it in a ring, and then the central parts of the anterior end are withdrawn from contact with the glass. I have not been able to see any action of the pharynx in this process, as described by Dr. Roots in the following communication, and I think that it is the whole prostomium which is withdrawn. Whatever the exact mechanism, the resulting decrease in pressure anchors the worm, and if the opposing resistance becomes too great, the sucker can be seen to leave the glass with a jerk. If a worm is moving on a stretched 'Cellophane' sheet, it can be seen to suck this inwards as it touches down. This is especially obvious when it is taking big steps. That worms could drag stones and other flat objects by suction was known to Darwin[5], but he did not know that the same method was used by the worm to drag its own body.

(6) When the worm is strongly stimulated at the anterior end, and sometimes when that end is without support, there is backward locomotion of a generally similar type to the normal. The tail end is strongly flattened and the posterior chætæ thrust out; as has been said under (4), these point forwards. It is doubtful if backward locomotion on the surface is ever of much importance in Nature, but it is this reflex which anchors the worm in its burrow and makes it so difficult to pull out. It is not a matter of overcoming a frictional resistance, as described by Chapman[6], but of breaking a system of interlocked structures. Either the soil, or the chætæ, or the worm, must break, and usually it is the last.

(7) I suspect that both the anus and the cut surface of a worm may on occasion act as suckers, but I have no certain evidence that they do.

(8) Fluid sometimes leaks from the dorsal pores, both spontaneously and as a response to prodding. This to some extent discounts the theoretical discussion of Chapman[6].

(9) Movement along a tube is carried out largely by a technique similar to that known to rock-climbers as 'backing up', and it is reasonable to suppose that movement in a burrow or in loose soil is similar. For the initial stages of burrowing, where alone anything can be seen, this has been described by Darwin[5] and Newell[7], and I have confirmed their observations.

(10) When a worm in a tube meets a plug made of soil, it generally tries to get through by the technique just described. If it fails, it extrudes the pharynx to a length of two or three segments and sucks in a mouthful of soil, and continues until a hole is made. Sometimes, presumably when in subjective terms it is hungry, without waiting to try to force its way through, it begins sucking as soon as the prostomium touches the soil, but I have never seen a worm pause to eat soil once its anterior end had emerged beyond the plug. I have once or twice seen the pharynx everted before contact with the soil, but only when the prostomium is very near it. This suggests that the worm is reacting to the sensation of smell. Occasionally a little soil is sucked into the mouth without eversion of the pharynx.

(11) In a tube which is only slightly wider than the maximum diameter of the worm, the animal can completely reverse itself by going through a hairpin curve.

(12) When the worm is in a tube, it has a strong tendency to become quiescent; in this state it does not move, and even strong stimuli induce nothing but contraction of the longitudinal muscles, with no locomotion.

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The absence of an eversible pharynx is given by at least one well-known text-book as a character which distinguishes the Oligochaeta from the Polychaeta; but the eversion of the pharynx can readily be observed in some of the Lumbricidae. It is strange that Darwin, who made extensive observations on earthworms, does not record this fact.

While observing earthworms in soil between vertical glass plates, I noticed that in *Lumbricus terrestris* and *Allolobophora terrestris* forma *longa*, the pharynx is everted during the preliminary testing of the soil before burrowing, and when the worm is eating its way through compact soil. The pharynx is also repeatedly everted on to leaves before they

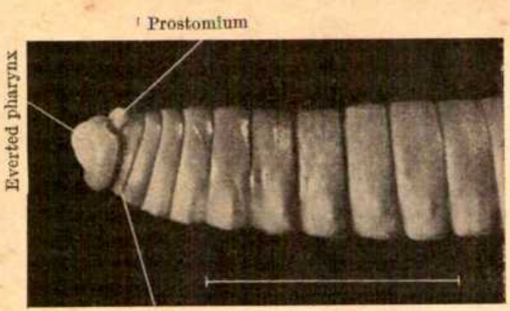

Fig. 1. *Allolobophora terrestris* f. *longa* with pharynx everted

are dragged to the burrow. Darwin[1] records that leaves taken from burrows (and in one case leaves still attached to the plant) are found to have been moistened by an alkaline secretion. It is possible that the secretion may be deposited by the everted pharynx; alternatively, the pharynx may be 'tasting' the leaves. The everted pharynx is shown in Fig. 1, which is a photograph of the anterior end of a specimen of *Allolobophora terrestris* f. *longa* which was fixed while the pharynx was everted.

The pharynx may also function as a sucker, as described by Darwin[2] but without record of its being used for the movement of the worm itself. Anyone who has put some small earthworms into a beaker and left them uncovered knows that after a time they will be found on the bench. Obviously movement up a vertical glass surface cannot be brought about by the mechanism usually described, and the method used is as follows. The anterior end (about nine to twelve segments) is extended upwards, the peristomium and the ventral portion of the prostomium are pressed against the glass, and at the same time the buccal mass and pharynx are pushed forwards and then withdrawn so that suction is developed. Often the pharynx is extruded before contact is made with the glass, so that it is the first to touch the glass. The extended segments then contract, a wave of contraction passes backwards and the body of the worm is dragged upwards. Downward slip is retarded by viscous forces, or in very small worms is prevented altogether by surface tension. Except for the most anterior segments, the ventral surface remains in contact with the glass. I have seen this method of movement in *Allolobophora caliginosa*, *Dendrobaena subrubicunda*, *Eisenia foetida* and *Lumbricus rubellus*.

I have not seen the prostomium used in the way described by Mr. Yapp in the preceding communication, but as the morphology of the anterior end varies from species to species, the method used may also vary in detail while the principle of suction remains the same.

Observations of worms in narrow vivaria have also confirmed that the method described for the initial stages of burrowing[3] (alternate attenuation and expansion of the anterior end) is also used during movement within the burrow and through loose soil.

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PHYTOPLANKTON AND HYDROGRAPHY OF THE PACIFIC PART OF THE ANTARCTIC OCEAN

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THE Norwegian South-Sea Expedition (the *Brategg* Expedition), visiting the Pacific section of the Antarctic Ocean in the summer season 1947–48, collected quantitative phytoplankton samples from seven to eight depths at about sixty stations. From the upper 50 m. net samples were also taken. The samples from the stations along the 120th West meridian have been worked up: stations 33–44, between lat. 57° 22′ and 68° 13′ S., taken January 26–31; station 17, lat. 62° 02′ S., taken December 30. The quantitative samples were analysed by the sedimentation method.

At these stations the hydrographic data demonstrate a marked difference in the upper 200 m. between the sub-Antarctic and the Antarctic zones. The surface layers were in both zones about 50 m. deep; in the sub-Antarctic zone the temperature was 3°–5° C., increasing from south to north, the salinity was 34·0 per mille, σ_t was 26·9–27·1; in the Antarctic zone the temperature was between $-1°$ and $+1°$C., the salinity 33·4 per mille and σ_t was 26·8–26·9. Below the sub-Antarctic surface layer, the Antarctic intermediate water was characterized by having a temperature minimum located somewhat deeper than the water masses sampled for phytoplankton. Below the Antarctic surface layer the winter-water was found to be colder, saltier and heavier than the upper layer (temperature $-1°$ to $-2°$ C., salinity 34·0 per mille and σ_t 27·4). This winter-water was found between 50 m. and 100 m. The Antarctic Convergence was in December located at about lat. 62° S., and in January at about lat. 61° S. This shift influenced the hydrographical conditions at the two stations worked at the same position: thus station 17 in December belonged to the sub-Antarctic zone, whereas station 38 in January lay in the Antarctic zone.

These hydrographic features are reflected in the distribution of the phytoplankton. The Antarctic zone was far richer than the sub-Antarctic in the total number of cells per litre at each station, and especially so for the diatoms. As a rule, a station in the Antarctic zone had about ten times as many cells as a station in the sub-Antarctic zone. Within the two zones the fluctuations were very small and the increase from the sub-Antarctic to the Antarctic zone at the Antarctic Convergence was most conspicuous (see stations 37 and 38 in Fig. 1).

The vertical distribution differed in the two zones (Fig. 1). In the sub-Antarctic zone, with its com-

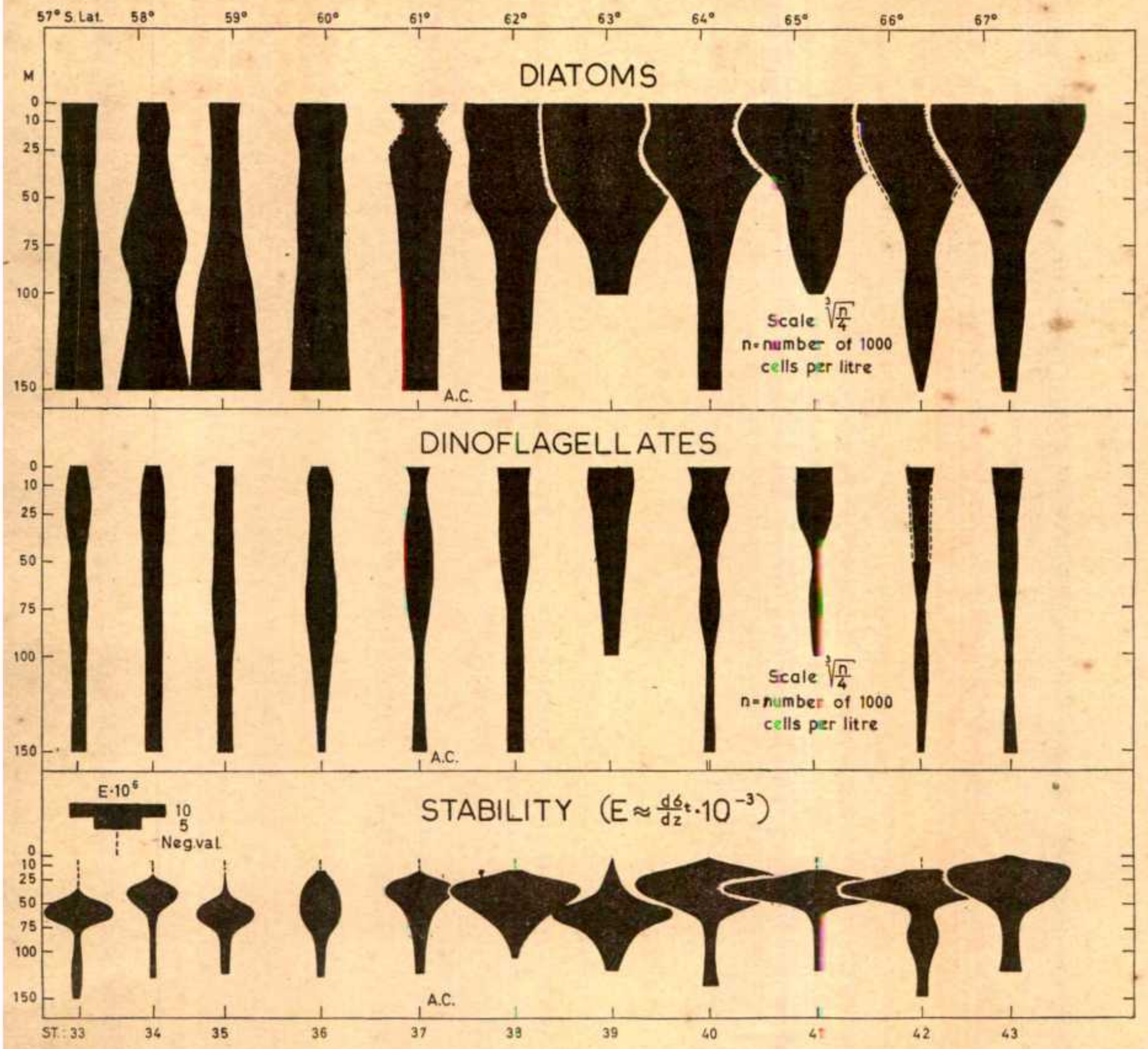

Fig. 1. Vertical distribution of the phytoplankton. AC, Antarctic Convergence. Depths (ordinates) are plotted against positions and stations

paratively low stability, the distribution with depth was approximately even, although at some stations populations were larger at 100 m. and 150 m. than at 0 m., mainly due to the abundance at the lower levels of resting spores of the diatom *Chaetoceros neglectus*. In the Antarctic zone, with its pronounced stability, the large phytoplankton populations were confined to a surface layer of 25–50 m.

In some of the species the Antarctic Convergence acts as a boundary in their horizontal distribution. This is exemplified by the following species.

Coccolithus huxleyi (Lohmann) Kamptner, the only coccolithophorid recorded from the Antarctic ocean, occurred only in the sub-Antarctic zone, at stations close to the Antarctic Convergence.

Thalassionema nitzschioides Grunow is an example of a diatom from the sub-Antarctic zone the numbers of which decreased from December to January. The prevalence in the deeper layer in January also indicates that the vegetation period of this diatom was then at its close.

Nitzschia closterioides n. sp. is an example of a diatom from the Antarctic zone which was not entirely restricted to this zone. The populations in the sub-Antarctic zone were, however, rather small compared with the Antarctic zone, even at the beginning of the season (station 17).

Peridinium applanatum Mangin, the only dinoflagellate recorded in relatively great numbers, was strictly confined to the Antarctic zone.

Chaetoceros neglectus Karsten cannot be characterized as belonging to either the Antarctic or the sub-Antarctic zone. In January no cells were recorded from the sub-Antarctic zone, whereas in the Antarctic zone the populations were rather large. In December, however, the cell numbers in the sub-Antarctic zone were as large as in the Antarctic zone a month later. The increase seems to have started to the north in the sub-Antarctic zone at the beginning of the season, and in January the maximum occurred in the middle of the Antarctic zone, at station 41. This impression of a north to south sequence in the increase of the population is also corroborated by the occurrence of resting spores in the deeper layer of the sub-Antarctic zone in January, and by the fact that numbers of this species showed a sudden increase, not at the Antarctic Convergence, but to the south of this region.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

New Determinations of the Velocity of Light

IN 1953 the Ordnance Survey was asked by the U.S. Army Map Service to test its Bergstrand *AGA* geodimeter. This was done by using it to re-measure the two bases of the recently completed primary re-triangulation of the United Kingdom[1]. From these measurements it was possible to deduce a new value for the velocity of light *in vacuo*. Recently, the Ordnance Survey has received the account of a fresh determination by R. Schöldström[2] on the Öland base line in Sweden which gives a value which agrees very closely with that deduced from our results. The comparison between the generally accepted value determined by Bergstrand in 1950[3] and the three recent determinations is as follows:

Bergstrand, Öland base 1950 (5,402 metres): 299,793·1 ± 0·2 km./s.

Ordnance Survey, Ridge Way base 1953 (11,261 metres): 299,792·4 ± 0·11 km./s.

Ordnance Survey, Caithness base 1953 (24,829 metres): 299,792·2 ± 0·13 km./s.

Schöldström, Öland base 1955 (5,402 metres): 299,792·4 ± 0·4 km./s.

Both bases used for the Ordnance Survey determination had earlier been measured by 'Invar' tape in catenary: the Ridge Way base twice, in 1937 and 1951, and the Caithness base once in 1952[4]. The two measurements of the Ridge Way base carried out at different times, using different tapes and under very different conditions, differed by 1 in 1,700,000. The forward and back measurements of the Caithness base differed by 1 in 1,270,000. The tape-measured lengths of both bases are therefore very accurate. Of the two the Ridge Way length is probably the more accurate. It is the weighted mean of two independent measurements, and the base was sited more favourably than at Caithness, where part of the line traversed difficult boggy ground.

The Ridge Way base in Wiltshire runs from White Horse Hill (altitude 858·1 ft.) to Liddington Castle (altitude 914·7 ft.) and for the greater part of this distance the light path is 150–250 ft. clear of the ground. The Caithness base runs from Warth Hill (altitude 408·7 ft.) to Spital Hill (altitude 581·6 ft.) and the height of the light path above ground varies from 0 to about 500 ft. Temperature, barometric pressure and relative humidity were observed at the terminals and the means of the two terminal values used to correct each geodimeter observation. The observations were carried out in variable weather over a number of nights at each base.

A filter was used passing light with a group wavelength (Λ) of 5580 A. The formula used for obtaining the refractive index μ_G of the wave group in ambient conditions was:

$$\mu_G = 1 + \frac{\mu_g - 1}{1 + \alpha t} \times \frac{p}{760} - \frac{0{\cdot}000000055e}{1 + \alpha t}$$

in which t is temperature in degrees centigrade, p is atmospheric pressure in mm. of mercury, e is vapour pressure in mm. of mercury, α is the coefficient of expansion (0·00367), and μ_g is the group refractive index of dry air at 0° C., 760 mm. pressure and 0·03 per cent of carbon dioxide calculated using the formula

$$\mu = 1 + \left(2{,}876{\cdot}4 + \frac{16{\cdot}288}{\Lambda^2} + \frac{0{\cdot}136}{\Lambda^4}\right) 10^{-7}$$

for monochromatic light[5].

Two modulating frequencies (f_1 and f_2) were used, the mean of the observations on both frequencies constituting one complete measurement. The frequencies of the two oscillators had been determined by the U.S. authorities before the dispatch of the instrument and were checked by the National Physical Laboratory. The comparisons were as follows:

f_1	U.S.	June 1953	9,999,944 c./s.
	N.P.L.	Aug. 7, 1953	9,999,932 c./s.
	N.P.L.	Oct. 12, 1953	9,999,945 c./s.
f_2	U.S.	June 1953	10,099,854 c./s.
	N.P.L.	Aug. 7, 1953	10,099,855 c./s.
	N.P.L.	Oct. 12, 1953	10,099,853 c./s.

For the computations the American figures were accepted.

The constant of the geodimeter was also verified at the National Physical Laboratory by a direct method using the 50-m. mural base normally employed for standardizing geodetic surveying tapes. The value obtained confirmed that obtained by the makers of the geodimeter, who use a different method.

Table 1 gives a summary of the important data relating to the determinations of the velocity of light by means of the geodimeter at the two bases in the United Kingdom. The rejected observations were those taken under unfavourable conditions (for example, unpractised observer, very still air).

Because of the probable greater accuracy of the Ridge Way base-length and the greater variation in height of the Caithness light-path, the Ridge Way value, 299,792·4 km./sec., is the more reliable.

It is clear from Schöldström's account that his determination is also a very strong one. In arriving at his error limits, he has taken into account the uncertainty due to errors in his accepted values for temperature, pressure, humidity, colour and frequency. The limits given for the Ordnance Survey values are simply the mean square errors deduced

Table 1

Period 1953	Line: geodimeter station first	Length from base measurement (air distance)	No. of obs.	Root mean square errors		Remarks
				Single observation	Mean	
July 5–29	White Horse Hill Liddington Castle	11,260·677 ± 0·003 m.	14	0·010 m.	0·003 m.	3 observations rejected
Aug. 13–24 Sept. 20 to Oct. 5	Warth Hill Spital Hill	24,828·626 ± 0·010 m.	16	0·030 m.	0·007 m.	Of the 23 observations, 7 were rejected, 3 from the first visit and the remainder from the second

from internal evidence and are not therefore strictly comparable.

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Electron Microscopy and Radioautography as Coupled Techniques in Tracer Experiments

CONSIDERABLE progress has already been made towards high resolution in radioautography, and good results have been obtained by various workers with the Ilford peeling film technique of Pelc[1], the *NTB* stripping method of Boyd[2] and the 'wet-process' system of Gomberg[3]. Lately, I have shown[4] that, by using thick layers of nuclear emulsions (300μ), and avoiding background effects by placing the specimens in a coal mine at a depth of 600 metres[5], it is possible to follow the β-particle tracks to their origin and obtain a one-micron resolution.

Films of the sensitive emulsion may be made thin enough to allow observation in the electron microscope, thus adding greatly to the resolution. The process is as follows. Microscope slides, specially selected for freedom from radioactive contamination, were covered with a layer of collodion or 'Formvar'. In the experiment described here, the specimens were nuclei extracted from tumour tissues and labelled *in vitro* with cobalt-60 (β-ray, 0·3 MeV.). They were placed on the collodion and covered with a thin layer of Ilford *G5* nuclear emulsion, obtained by melting the gel at 55° C., as in the usual procedure, and diluting it with water to the proper consistency. The slides, after drying, were placed for exposure in a thick-walled lead box. As a proportion only of the β-particles are likely to be emitted in the plane of the sensitive layer, the necessary exposures are longer than in the thick-layer method previously employed.

The slides were developed in Ilford *P.Q.* Universal developer, cleared in hypo within 20 sec. and fixed for 2 min. After washing, the double layer of collodion-gelatine was lifted from the slides without difficulty and mounted in the electron microscope. The accompanying electron micrograph (Fig. 1) shows the tracks emitted by four single nuclei at a magnification of 2,000 (reduced from the original magnification of 6,000).

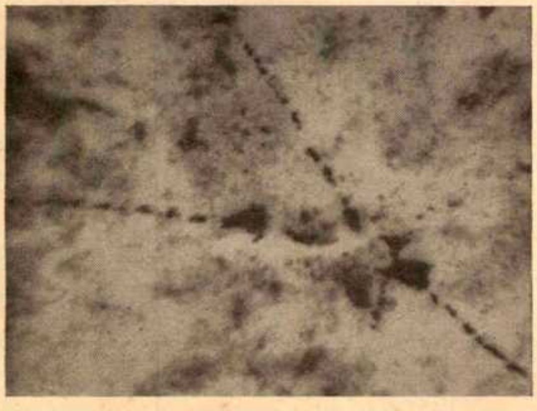

Fig. 1. Electron micrograph of β-ray tracks emitted by tumour nuclei labelled with radioactive cobalt-60. × 2,000

This new technique, successful for the particles of cobalt-60, of energy 0·3 MeV., is likely to be of great value in the case of the soft radiation of carbon-14, as the grains of the tracks are close enough to allow a very high magnification.

So far the method has been applied to isolated cells and cell nuclei, but it is hoped to extend it to ultra-thin tissue sections.

I am indebted to Prof. J. Sayers, of the Electron Physics Department, University of Birmingham, for facilities, and I wish to acknowledge the skilled technical help of Mr. C. C. Newton. This work was done under a grant from the British Empire Cancer Campaign, London.

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Zinc-deficiency of *Hevea brasiliensis* as a Predisposing Factor to *Oidium* Infection

INFECTION of the *Hevea* rubber tree by *Oidium heveae* is common in Malaya but is not regarded as a major pathological problem; in Ceylon, however, the fungus can produce serious loss of crop yields and the problem is of economic importance[1]. *Oidium heveae* is most prominent in Malaya at the time of refoliation after 'wintering' of the trees, when it may cause a secondary leaf-fall. It is only at this time that *Oidium* is found on leaves exposed to full sun. Throughout the year it may be found on young plants but only when these are shaded, and then never sufficiently seriously to cause defoliation. A small number of poorly developed colonies of *Oidium heveae* are usual on the leaves of plants grown in our plant-house[2] as the glass and framework of the house provide light shade. During the study of the micronutrient-deficiency symptoms of *Hevea brasiliensis* grown in sand culture within this house, a striking relationship between the susceptibility to severe *Oidium heveae* attack and the zinc status of the plants was noticed. This relationship was not noted for the copper- or molybdenum-deficient plants grown simultaneously and in the same environmental conditions as the zinc-deficient plants. Our observations were thus made on plants grown under glass and were derived from one experiment only; the results, however, were so well marked that their significance should be quickly tested and evaluated in countries where *Oidium heveae* attack is of major concern.

'Selfed' seeds of clone Tjirandji 1 were sown in sand which had been rigorously purified by boiling with hydrochloric – oxalic acid mixture, and which was contained in 'Pyrex' glass vessels. Two types of nutrient, all nitrate nitrogen or part nitrate- part ammonium-nitrogen, were supplied to the seedlings;

but as this did not influence the main result described below, it will not be mentioned further. The nutrients were freed from zinc by subjecting them to phosphate adsorption followed by dithizone extraction, essentially as described by Hewitt[3], whose procedure was also employed for the purification of the ferric citrate. Zinc was supplied in the 'complete' nutrient solution at a concentration of 0·065 part per million; this was the only factor wherein the 'complete' cultures differed from the zinc-deficient cultures. Water which had been purified by passing through ion-exchange resins was used throughout.

Three months after sowing, severe symptoms of zinc deficiency occurred; these included rosetting, production of narrow, strap-like, young leaves with wavy margins, chlorosis and malformation of young laminæ, death of growing points, production of numerous lateral shoots and severe stunting (Fig. 1). That these symptoms were truly those of zinc deficiency was proved by the recovery of the affected plants when supplied with 'complete' nutrient. Plants which had received the 'complete' nutrient solution throughout the experiment grew rapidly and well and remained comparatively free from disease; but from the sixth month onward, the zinc-deficient plants became severely infected with *Oidium heveae*. The heavy infection was confined to those parts of the plant formed in the absence of a sufficiency of zinc.

Abnormally large and heavily sporing colonies of *Oidium heveae* were found on the laminæ (Fig. 2); the fungus also completely enveloped the growing tip of the severely deficient plants and some of the newly formed leaves fell. The 'complete' nutrient plants, grown adjacent to the zinc-deficient plants, showed only the odd, feebly developed colony usual on all plants in the plant house.

An analysis of plants sampled six and a half months after sowing showed that the 'complete' nutrient plants contained eight to ten times as much zinc per plant as the zinc-deficient ones.

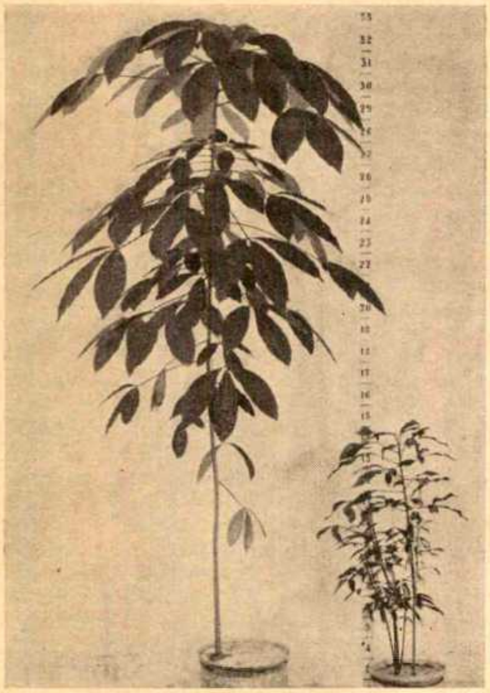

Fig. 1. Complete nutrient plant (left); zinc-deficient plants (right). One scale division equivalent to three inches. Eleven-month old seedlings

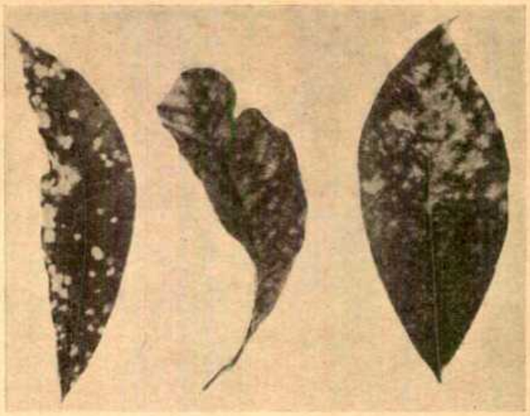

Fig. 2. Zinc-deficient laminæ heavily infected with *Oidium heveae*. Top surface, two laminæ on left; bottom surface, lamina on right. ⅗ nat. size

It seems likely that without a sufficiency of zinc the rubber plant is unable to produce enough of a certain metabolite which confers some degree of resistance to *Oidium heveae* attack. We plan to repeat our experiment in order to determine whether substances other than zinc can confer resistance. In the meantime, it appears possible that in some areas the prevalence of *Oidium heveae* may be accounted for by a lack of zinc available to the plants.

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Dec. 23.

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Reduction–Oxidation Level of Soils

SEVERAL attempts have been made to determine the redox potentials of soils by inserting a suitably treated platinum electrode into the soil suspension and measuring the e.m.f. against a reference electrode; but from a strictly physico-chemical point of view one cannot speak about well-established redox potentials in soils, which are derived from experimental data. To avoid these difficulties, the use of the empirical term 'redox level' is suggested, thereby giving an expression for the mean reducing or oxidizing activities in dry soil samples.

If a soil is treated with a solution containing the reversible redox system potassium ferrocyanide and ferricyanide, the e.m.f. of a platinum electrode measured against a reference (calomel) electrode in the soil suspension will be different from the potential in the pure solution. These differences, ΔE mV., may be correlated with the reducing or oxidizing properties of the soil. By treating the same soil with solutions containing potassium ferro- and ferricyanides in different ratios, all buffered with 1 M ammonium acetate, and plotting ΔE found against the E values of the pure solutions, one gets an S-shaped curve, which intersects the E-axis in the point E'. This point corresponds to a solution that does not change its redox potential in contact with

Table 1

Soil	E' (mV.)	Total Mn (p.p.m.)	*p*H in 1 *N* KCl quinhydrone	*p*H′
1	389	45	5·1	5·08
2	486	123	4·8	4·06
3	456	152	5·0	4·73
4	483	165	6·8	6·82
5	508	328	4·3	3·70
6	511	395	5·3	5·32
7	566	695	5·5	5·53

the soil; thus it may be regarded as an expression for the redox level of the soil.

In seven totally different Danish soils the following measurements have been carried out: 10 gm. air-dried soil was shaken for 1 hr. at room temperature with 50 ml. of ferrous-ferric-cyanide solutions, all buffered with 1 *M* ammonium acetate. The concentration of potassium ferro- and ferri-cyanide varied between 10^{-4} and 10^{-2} mole/l., and the E values measured were all referred to the normal hydrogen electrode. Total manganese was determined by ignition of the soil and subsequent treatment with hot hydrogen peroxide solution containing nitric acid. Manganese was determined colorimetrically as potassium permanganate in the filtrate. Table 1 and Fig. 1 show a linear correlation between the total manganese content and the values of E', indicating that with increasing content of total manganese the redox level increases proportionally.

The values of ΔE were quite reproducible, but they could be caused by either absorption or precipitation of the iron-cyanide ions in the soil suspensions instead of merely by redox processes as indicated by:

$$\mathrm{Fe(CN)_6^{----}} \rightleftarrows \mathrm{Fe(CN)_6^{---}} + e^-.$$

In the strongly buffered solution containing acetate and iron cyanide ions in a ratio of at least 100 : 1, extensive absorption of the iron cyanide ions is not likely to occur. Several heavy metals might precipitate the iron cyanide ions, but in the presence of, for example, 3·75 p.p.m. zinc, the maximum precipitation cannot exceed 0·1 per cent of the total in the case of ferrocyanide, which would cause an increase of 3 mV. in the e.m.f. measured. This difference is only about of the same order of magnitude as the experimental error. For soils rich in iron, one would expect precipitation of ferro- and ferri-cyanide compounds, but tests have shown that in the strong acetate medium iron ions are blocked as acetate complexes.

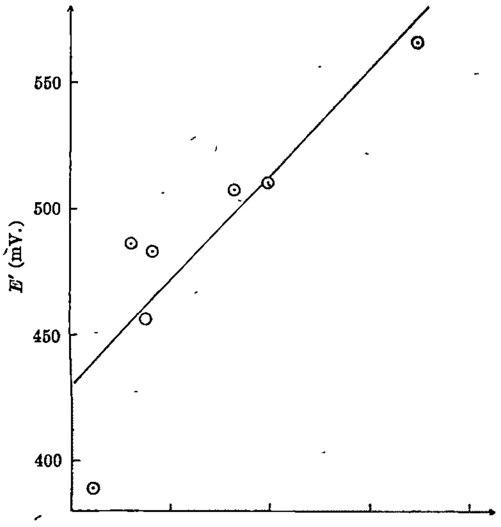

Fig. 1

A soil very rich in iron oxides was found to give $\Delta E = 0$ for a ratio of ferri- to ferro-cyanide of 13·8. This soil was shaken with solutions containing iron cyanides in this ratio, the total concentration of which was varied by ten-fold dilution, while the ammonium acetate concentration was kept constant at 1 *M*. This experiment showed that ΔE still remained close to zero, that is, E' is independent of the dilution.

The same principle has been used in connexion with *p*H measurements in soils. 10-gm. portions of the seven soils were shaken with 100 ml. of 1 *M* potassium chloride solutions buffered with citric acid and disodium hydrogen phosphate in a total concentration of about 0·01 mole/l. These solutions had a *p*H ranging from 2·8 to 7·3. After 1 hr., the *p*H of the suspensions was determined by glass-electrode measurements, and the differences (ΔpH) between the *p*H of the suspensions and those of the pure buffer solutions were plotted against the *p*H of the buffer solutions. Here again an *S*-shaped curve was formed, and the intersection with the *p*H-axis at the point *p*H′ indicated a buffer solution of such a composition that it did not change its *p*H by contact with the soil. Therefore *p*H′ is identified as the *p*H of the soil, here measured with quinhydrone in 1 *N* potassium chloride soil suspension, and as shown in Table 1 this is true for four of the seven soils having a *p*H greater than 5. The discrepancies are probably due to complex formation with trivalent metals, for example, ferric or aluminium ions.

By these methods it might be possible to study the concept of redox capacity as well as buffer capacity, and they enable the study of problems such as the ageing of the soil during storage or changes in exchangeable manganese during transfer of the soil from natural conditions to the laboratory. Investigations are being continued and a more detailed publication will appear.

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Occurrence and Nature of an Amœba Excystment Factor produced by *Aerobacter* sp.

ALTHOUGH an excystment factor potentiating the emergence of trophozoites from their resting cysts in Protozoa has long been postulated, there has so far been no convincing experimental evidence of its existence. A critical appraisal of previous work[1-4] has revealed that the factor has variously been attributed to hypo- and hyper-tonicity of the medium, low oxygen tension, change of *p*H, reducing agents, presence of enriched nutrient media, change of temperature, etc. Earlier workers in this field do not appear to have adequately recognized the risk of extraneous infection inherent to such experiments, particularly when nutritionally rich and highly susceptible media, such as 'Difco' yeast extract, are examined for the presence of this factor[5]. Unless absolutely aseptic conditions are maintained in the course of experiments, the results will remain open to doubt.

Crump[1] showed that excystment in *Amœba* Z, (*Didascalus thorntoni*; Singh[6]) took place without the presence of bacteria, while *Amœba* 4 (*Schizopyrenus russelli*; Singh[6]) excysted only in the presence of certain bacteria (*Aerobacter* sp. and 4036). She suggested that the two species of bacteria produce in the medium some material that induces excystment in *S. russelli*. In view of Crump's[1] findings, it was of interest to secure an experimental proof of its occurrence and elucidate the nature of the factor produced by *Aerobacter* sp., Strain 1912; Singh[7]. As bacteria and amœbæ live in close association in human and animal intestines, a detailed study of amœba excystment factor or factors, produced by *Aerobacter* and other intestinal bacteria, would be of considerable significance for a more effective approach to the problem of amœbic dysentery.

Large numbers of mature cysts of *S. russelli* (see Singh[6] for culture methods) produced on *Aerobacter* sp. on non-nutrient agar (2·5 per cent agar, 0·5 per cent sodium chloride; *p*H 6·8–7·0) were treated with a mixture of penicillin (4 units/c.c.) and streptomycin (4 μgm./c.c.) solution for about 24 hr. at room temperature (25°–26° C.). They were washed by centrifugation with 0·85 per cent sodium chloride and tested for their sterility on nutrient agar slopes and for viability by inoculating them in the presence of *Aerobacter* sp. on non-nutrient agar. The sterilized cysts, thus treated, excysted readily in the presence of living bacteria, although on non-nutrient agar alone there was scarcely any excystment. These cysts have been used in all the subsequent experiments.

Aerobacter sp. five days old grown in nutrient broth at 37° C. was washed twice on the centrifuge with ice-cold saline, in which it was finally dispersed as a uniform suspension. Aliquots of the suspension, heated at 100° C. in a vigorously boiling water-bath for different periods, were tested for their capacity to induce the excystment of sterilized cysts. The bacteria were spread on non-nutrient agar plates and inoculated with large numbers of cysts. In the presence of even the 5-min. heat-treated bacteria, on rare occasions, only a few active amœbæ could be seen after 24–48 hr. incubation at 25° C., but they did not multiply. After three days, when washed resting cells of *Aerobacter* sp., preserved at 5° C. for 72 hr., were added, the great majority of the cysts excysted within 24 hr., showing that the excystment factor produced by *Aerobacter* sp. is highly thermolabile.

When placed on non-nutrient agar with *p*H adjusted at different levels (2·2, 3·0, 4·0, 5·0, 6·0, 7·0 and 8·0), the cysts did not show any sign of excystment, even after a period of 48–72 hr.; but when *Aerobacter* sp. was provided, excystment occurred generally and was independent of *p*H. Excystment, however, occurred more readily in the *p*H range 5–8.

Addition of reducing substances like cystine, cysteine, glutathione, thioglycollic acid and ascorbic acid to the non-nutrient agar did not induce excystment unless *Aerobacter* sp. was added.

Collodion cups (25 mm. diameter and 12 mm. height) were cast from a 6 per cent solution of collodion in ether–ethanol mixture (Merck) and sterilized in distilled water by autoclaving for 15 min. at 15 lb./sq. in. A layer of non-nutrient agar was poured in the sterile cups, which were placed on the surface of a papain-digest meat-agar plate heavily seeded with *Aerobacter* sp. Plenty of cysts were inoculated on the non-nutrient agar surface in the cups and incubated at 25° C. In the control experiments, the nutrient agar was not seeded. The majority of cysts excysted within 24 hr. in experiments in which *Aerobacter* sp. was inoculated in nutrient agar and allowed to multiply actively. After 48–72 hr. the amœbæ either encysted or died due to the lack of food. In control experiments only a few active amœbæ could be seen. This experiment clearly shows that *Aerobacter* sp. produces some substance that passes through a collodion membrane and into non-nutrient agar and causes the excystment of the amœbal cysts.

The experiment was repeated by reversing the relative positions of the seeded nutrient and non-nutrient agars—the seeded nutrient agar being placed in the collodion cup and the cysts on the surface of non-nutrient agar. In yet another series of experiments, the seeded nutrient agar in the cup was replaced by nutrient broth inoculated with *Aerobacter* sp. It was found that the factor was elaborated by *Aerobacter* sp., growing in the nutrient agar or broth as the case may be, and diffused through the collodion membrane into the non-nutrient agar, where its presence was revealed by the ready excystment of the amœbal cysts when placed on it. The factor could not be found in the unseeded controls.

It would appear that an excystment factor is produced by the actively proliferating culture of *Aerobacter* sp., which is capable of diffusing easily and rapidly through a collodion membrane into the agar gel. The factor is thermolabile and does not appear to be related to either *p*H or to any of the reducing substances tried by us, although both these factors may be expected either to condition the cysts to the action of the excystment factor or augment its potency. Work on the isolation and further characterization of the factor is now in progress.

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Utilization of Xanthin by Mould Fungi

The utilization of purines by fungi as the sole source of nitrogen in their nutritive media has been reported in the literature only in a few cases[1–3]. No work concerning the utilization of xanthin by mould fungi appears to have been published.

One of us (E. D. M. T.) has already shown[4] that many fungal species representing all the fungal groups were able to grow luxuriantly in a medium containing uric acid as the only source of nitrogen. It was also possible to demonstrate the presence of the uricase enzyme in those fungi.

The experiments reported here carried out on xanthin have revealed, as Table 1 shows, that many mould fungi representing the different systematic groups are able to utilize xanthin as the only source of nitrogen.

Table 1. GROWTH OF DIFFERENT MOULD FUNGI ON CZAPEK–DOX-XANTHIN MEDIUM

Fungal group	Growth
Phycomycetes :	
Mucor fragilis	medium
Ascomycetes :	
Aspergillus niger	good
A. fumigatus	medium
Penicillium chrisogenum	medium
Fungi imperfecti :	
Fusarium semitectum, *U*1	good
,, ,, *U*4	luxuriant
,, ,, *U*9	medium
,, ,, *U*11	luxuriant
,, ,, *U*12	luxuriant
,, ,, *U*14	luxuriant
,, ,, *U*16	luxuriant
,, *niveum*	medium
,, *sambucinum*, *U*7	good
,, ,,	good
,, *oxysporum*, *U*6	luxuriant
,, ,, *U*10	medium
,, ,, *U*15	good
,, *moniliforme*, *U*2	good
,, ,, *U*13	good
,, *equiseti*	luxuriant
Alternaria tenuis, *U*18	good
,, ,, *U*30	luxuriant
,, ,, *U*47	luxuriant
,, ,, *U*48	good
,, ,,	trace—weak
,, *porri*	weak
Cladosporium cladosporioides	weak

The basic medium utilized was Czapek–Dox. The sodium nitrate of this medium was replaced by nitrogen-equivalent amounts of xanthin. The salts used in preparation of the medium were *A.R.* grade. The cultures were made in 50-c.c. Erlenmeyer flasks each containing 15 c.c. of the sterilized medium; five flasks were made for each individual fungus. All the flasks were inoculated with the same standard inoculum; the inoculated flasks were incubated at 28° C. for eight days, after which the dry weight of the mycelial mats was recorded.

Preliminary enzymatic studies have revealed the presence of xanthin-dehydrogenase enzyme in some of the fungi examined.

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Inhibition of L-Asparaginase in Extracts of *Mycobacterium phlei* by D-Asparagine

THE concept that substances related chemically to a metabolite might interfere with the normal function of that metabolite or displace it from the site of attachment to the appropriate enzyme[1] is now well established. Accordingly, an unnatural stereoisomer of a metabolite could also be regarded as a potential antimetabolite; but it was surprising to find that only a few unnatural amino-acids did, in fact, interfere with the growth-promoting effects of their natural antipodes. Thus, D-leucine[2] and D-tryptophan[3] interfere with the growth-promoting effects of the corresponding L-isomers in lactobacilli, and D-glutamic acid was found partially to inhibit the activity of the L-glutamic acid decarboxylase obtained from *E. coli*[4].

In the course of studies on the asparaginase activity in cell-free extracts of *Mycobacterium phlei*, we found that L-asparagine, but not the D-isomer, was attacked by this enzyme. Moreover, D-asparagine was found to inhibit the enzymatic deamidation of the L-isomer.

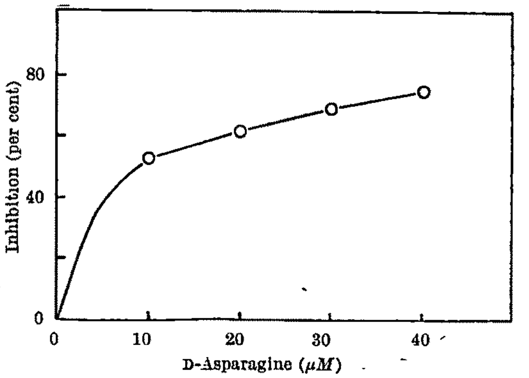

Fig 1 Inhibition of L-asparaginase activity by increasing concentrations of D-asparagine. Total volume: 1 ml., containing L-asparagine, 10 *μM*; D-asparagine, varying from 0 to 40 *μM* (Nutritional Biochemical Corp., U.S.A.). Bacterial extract, 2·5 mgm. protein; phosphate buffer *p*H 8·2, *M*/150. Incubation, 90 min. at 37° C.

The organism (*M. phlei* 271 from the culture collection of this Department) was grown in Roux bottles on nutrient agar supplemented with 0·1 per cent 'Tween-80' (polyoxyethylene sorbitan mono-oleate, Atlas Powder Co., U.S.A.). After incubation at 35° C., for three to four days, the bacteria were washed three times with distilled water, centrifuged and concentrated to about 2–3 gm./20 ml. of wet weight.

The thick suspension was disintegrated by a Raytheon 9*KC* sonic vibrator for 25 min. The supernatant, from which the debris was removed by high-speed centrifugation (at about 20,000 *g* for 20 min.), was dialysed against running water for 13–15 hr. The whole procedure was carried out in the cold room. The protein content of the dialysate was determined by Mehl's biuret method[5]. The asparaginase activity of the extract was estimated from the ammonia formed (by the Conway microdiffusion method) and from the amount of aspartic acid produced (by quantitative paper chromatography, after Giri *et al.*[6]).

Fig. 1 shows the effect of increasing amounts of D-asparagine on the inhibition of the L-asparaginase activity; at an inhibitor/substrate ratio of 4 : 1, an inhibition of 75 per cent was obtained. In order to establish the nature of the inhibition the reaction

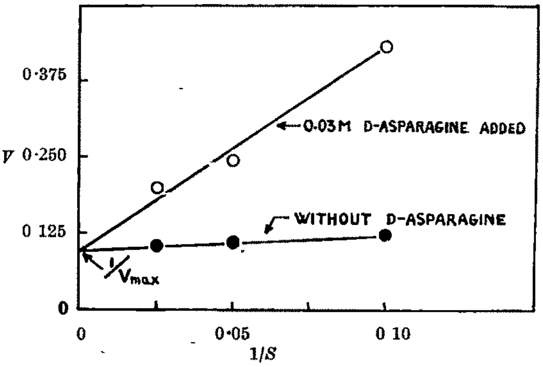

Fig. 2. Effect of substrate concentration on inhibition of asparaginase activity by D-asparagine. The same arrangement as in Fig. 1, except for concentrations of substrate and inhibitor. L-asparagine concentrations were 10, 20 and 40 *μM* respectively; D-asparagine, 0 and 30 *μM* respectively. *V*, reaction velocity, *μ*mole of ammonia produced in 90 min. *S*, substrate concentration in *μM*

velocity was measured at various concentrations of the substrate (L-asparagine) in the presence and in the absence of the inhibitor (D-asparagine). The results presented in Fig. 2 (after Lineweaver and Burk[7]) show that D-asparagine inhibits competitively the L-asparaginase activity of *M. phlei.*

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Effect of Sialoadenectomy on Thyroid Activity

THE rapid appearance of iodide in saliva following administration of iodide iodine-131 has been demonstrated[1], and its measurement has proved useful in the evaluation of the thyroid status of clinical cases[2]. Recently, an experiment has been reported[3] which suggested that the salivary glands may play an important part in thyroid metabolism, involving the removal of iodine-131 diiodotyrosine from the peripheral circulation. Dehalogenation processes by characteristic enzymes in the salivary gland tissue have been observed[4].

Our present preliminary observations indicate that the salivary glands play an important part in regulating the activity of the thyroids of the mouse and the rat. We employed adult male mice (N.I.H.) weighing 25 ± 1 gm. throughout. Animals were housed in conventional cages in a room the temperature of which was maintained at 25 ± 3° C. The daily ration consisted of commercial mixed grains and water, *ad libitum.* Submaxillary, parotid and sublingual glands were removed under aseptic conditions seven to ten days prior to measurements of thyroid activity. Sham-operated controls were employed throughout. In each experiment sham controls and sialoadenectomized animals were given equal periods of post-surgical rest. Carrier-free iodine-131 as iodide and carrier-free phosphorus-32 as phosphate were administered intraperitoneally in the doses indicated in the tables. Experimental groups contained at least ten and not more than twelve animals. Thyroids were removed, weighed on a microbalance to the nearest 0·01 mgm., and plated for radiological assay as described previously[5]. Radio assays of iodine-131 were performed with the aid of an end-window Geiger–Muller counter and scaler; phosphorus-32 was assayed with the aid of a scintillation counter sensitive to β-particles and a Dumont photomultiplier tube. Assays were pre-set for count to give a statistical error less than 1 per cent. Results are expressed as counts per min./mgm. tissue or as a percentage of control-animal values.

The results in Table 1 shows that sialoadenectomy, performed on mice, increased the uptake of iodine-131 by the thyroid in the first four hours following administration of radioactive iodide. The iodine-131 content of the mouse thyroids, measured 24 hr. later, indicates a delayed turnover of iodine-131 in the sialoadenectomized animals as compared to that in the control groups. Repeated experiments substantiate the initial observations. Sialoadenectomy also produced similar changes in the rate of iodine-131 metabolism in the thyroids of rats. 24-hr. thyroid iodine-131 levels are always less than those found in sham-operated control rats (Table 2).

Table 1. EFFECT OF SIALOADENECTOMY ON UPTAKE OF IODINE-131 BY MOUSE THYROID FOLLOWING INJECTION OF 5 μC. IODINE-131 PER 25 GM. BODY-WEIGHT

Group	Average 4-hr. uptake (counts per min./mgm.)	(Per cent)	Average 24-hr. uptake (counts per min./mgm.)	(Per cent)
Sham controls	1,350 ± 147*	100	4,958 ± 133*	100
Sialoadenectomized	1,736 ± 234	129	1,932 ± 373	39

* Standard error of the mean.

Table 2. EFFECT OF SIALOADENECTOMY ON THYROID ACTIVITY OF RATS 24-hr. uptake, 20 μc. iodine-131 per 100 gm. body-weight

Group	Average counts per min./mgm.	Per cent
Controls	824 ± 33*	100
Experimental	555 ± 54	67·3

* Standard error of the mean.

To test the probable changes of the levels of thyroid-stimulating hormone in animals deprived of their salivary glands, resort was made of the titre of the hormone indicated by phosphorus-32 uptake by the thyroid glands[6]. The results indicated in Table 3 are the preliminary observations following uptake of phosphorus-32 for 1 hr. by mouse thyroids in control and sialoadenectomized animals. Administration (intraperitoneal) of 5 μgm. of the hormone restored the phosphorus-32 activity of the thyroids of desalivated mice to normal levels (Table 3).

Table 3. TITRE OF THYROID-STIMULATING HORMONE AND EFFECT OF INJECTED HORMONE MEASURED BY PHOSPHORUS-32. UPTAKE OF PHOSPHORUS-32 BY MOUSE THYROIDS 1 HR AFTER INJECTION OF 50 μC RADIOACTIVE PHOSPHATE

Group	Average counts per min./mgm.	Per cent
Controls	366 ± 25	100
Sialoadenectomized	227 ± 29	62
Controls + 5 μgm hormone 1 hr prior to phosphorus-32	433 ± 63	118
Sialoadenectomized + 5 μgm. hormone 1 hr. prior to phosphorus-32	416 ± 160	114

The observations recorded here indicate that the salivary glands play an important part in the regulation of the activity of the thyroid gland, probably via control of the production and/or the utilization of thyroid-stimulating hormone. The influence on the titre of the hormone is apparent since the desalivated mice in these studies showed uptakes of phosphorus-32 by the thyroid that were consistently lower (30–38 per cent) than that observed in intact control animals. Further, the phosphorus-32 uptake-response of sialoadenectomized mice to a single 5-μgm. dose of thyroid-stimulating hormone showed a gain of 84 per cent above their base values, whereas control animals exhibited a gain of only 18 per cent above their base values.

The thyroids of sialoadenectomized mice incorporate iodine-131 more rapidly than those of control animals in the 4-hr. test period, but they also appear to utilize thyroid iodine-131 at a subnormal rate as indicated by the iodine-131 content of the thyroids after 24 hr. The initially higher uptake of radioactive iodine in the sialoadenectomized mice may be due to the loss of the normal iodide spillway into the saliva[1] which could lead to higher concentrations in the circulating fluids with consequent increase in iodine-131 trapped by the thyroid. The reduced levels of thyroid iodine-131 and the low titre of thyroid-stimulating hormone indicated by uptake of phosphorus-32 are not difficult to explain in view of our preliminary studies on the rate of disappearance of thyroid iodine-131. The uptake of iodine-131 in sialoadenectomized mice is maximal at 6–8 hr. and the iodine-131 disappears from the thyroid quite slowly or not at all in the 24–48 hr. interval, indicating reduced titre of thyroid-stimulating hormone.

The increased sensitivity of thyroid-stimulating hormone (Table 3) suggests that some regulating mechanism is impaired when salivary glands are removed from the mouse. Whether the effects produced are due to a hormonal or enzymatic regulator presumably present in salivary glands is not yet known.

We acknowledge the technical assistance and co-operation of Florence Fries. The thyroid-stimulating hormone was kindly given by Dr. S. Steelman of the Armour Laboratories. This study was sponsored by a grant from the National Cancer Institute.

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Effect of Vitamin D on the Phosphôrus Content of Rachitic Rat Cartilage

EARLIER investigations[1] in these Laboratories had indicated that vitamin D influenced carbohydrate metabolism in calcifying cartilage of the albino rat. Since carbohydrate and phosphorus metabolism are closely interlinked, the present investigation was undertaken with the view of determining the influence of vitamin D on the phosphorus content of rachitic rat cartilage.

Healthy albino rats four weeks old were distributed in seven groups; the first six groups contained ten rats in each, while the last one contained twenty animals. All the animals were fed a modified rachitogenic diet[2] for twenty-one days. At the end of this period, animals in group I were killed, their tibial epiphyseal cartilages quickly removed and placed individually in tubes and dried at 90° C. Animals in groups II–VII were fed a single dose of vitamin D (4,000 I.U.). Exactly 24 hr. after vitamin D administration, rats in group II were killed and their tibial cartilages removed and dried. The animals in the remaining groups were killed at intervals of 24 hr. The dried cartilage of each rat was weighed and its total phosphorus content determined colorimetrically after wet ashing. The results are presented in Table 1.

It will be seen that the administration of vitamin D caused a gradual increase in the total phosphorus content of the cartilage. At 96 hr. after vitamin D administration, the phosphorus content of the cartilage was maximum, being about twice that contained in the cartilage of the untreated rachitic animal.

It is not clear at this stage why the phosphorus content of cartilage decreases after 96 hr. It may be mentioned, however, that this fall coincides with (*a*) the maximum increase in calcifying capacity *in vitro* shown by the cartilage of the animals treated with vitamin D, and (*b*) the commencement of calcification *in vivo*, both of which have been demonstrated by Dikshit and Patwardhan[3] to occur at 96 hr. after administration of vitamin D.

Table 1. TOTAL PHOSPHORUS IN CARTILAGE FROM RACHITIC RATS AND RATS GIVEN VITAMIN D

Group No.	Hr after vitamin D	No. of observations	μgm. phosphorus/ mgm. dry cartilage
I	0	10	9 78 ± 1·72
II	24	10	11 00 ± 1 15
III	48	10	14 13 ± 1 71
IV	72	10	13 14 ± 1·49
V	96	10	20·94 ± 2·37
VI	120	10	17·21 ± 2·38
VII	144	20	12 21 ± 1 41

The results reported here indicate that the phosphorus content of rachitic cartilage increases due to the influence of vitamin D preparatory to the onset of calcification. Further work is in progress to determine the effect of vitamin D on the various phosphorus compounds in the healing cartilage.

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Dominant Lethality induced by X-Rays in Haploid and Diploid *Saccharomyces cerevisiae*

IN a previous paper[1], evidence was presented for the presence of dominant lethals in X-irradiated haploid yeast cells. Diploid yeast zygotes formed by the conjugation of one irradiated and one unirradiated haploid cell were found to exhibit signs of radiation damage, including swelling, delay in division and death. The damage responsible for inactivation of these half-irradiated zygotes was defined operationally as dominant lethal damage. The present communication describes a continuation of these experiments in which diploid cells homozygous for mating type were employed along with the two haploid cultures previously used. These diploid cells will conjugate with haploid or diploid cells of opposite mating type when placed in direct contact, thus permitting a similar determination of the frequency of dominant lethals in diploid cells. This was of interest because previous studies of the survival of X-irradiated yeast cells of higher ploidy[2] suggested that the frequency of this type of damage might increase with increasing ploidy.

The diploid cells arose spontaneously in the haploid cultures and were isolated with a micromanipulator. The amounts of deoxyribonucleic acid, ribonucleic acid and dry weight per cell for the haploid and diploid cultures were all approximately in the ratio 1 : 2, confirming the expected ploidy of these cultures[3]. The cells used in the experiments were harvested from 24-hr. streak cultures on yeast extract – dextrose agar plates (½ per cent yeast extract, 1 per cent dextrose), suspended in buffer and maintained at 4° C. until used. Viability was nearly 100 per cent. Single, non-budding cells were isolated with a micromanipulator and paired with similar cells of the opposite mating type as described previously[1]. The medium used for conjugation and growth of the cells after irradiation was yeast extract – dextrose agar (see above) and incubation was at 30° C. Conjugation usually occurred within four to five hours. The frequency of conjugations averaged about 90 per cent and was relatively uninfluenced by irradiation of the parent cells. For each of the following crosses: haploid × haploid (oo), haploid × diploid (oO), diploid × haploid (Oo) and diploid × diploid (OO), one, or the other, or both of the parental cells was irradiated with X-rays (the symbol on the left represents a cell of the α-mating type, that on the right the a-mating type; o represents a haploid cell, O a diploid cell. A filled-in circle is used to indicate that the cell was irradiated before pairing). Zygote viability was determined from about 80–100 pairs of cells at a number of dose points (3–7) for each of the twelve possible combinations. The viability of the haploid and diploid cells for vegetative division was determined in a similar manner by the isolation of about a hundred single, non-budding cells for each dose-point studied. The criterion of viability was the ability of the zygote or cell to develop into a colony containing more than forty cells.

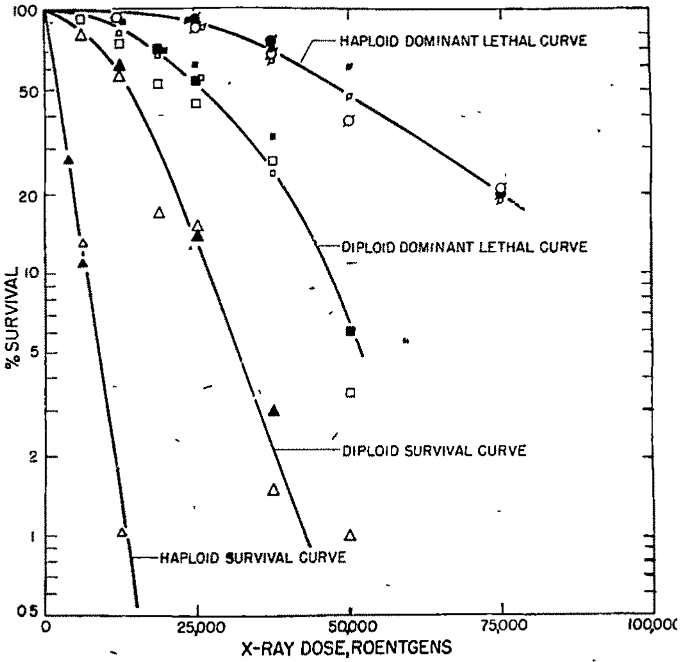

Fig. 1. Haploid dominant lethal curve: ϕ, •o; ɸ, o•; ϕ. •O; ɸ, O•. Diploid dominant lethal curve: □, ●○; ■, ○●; □, ●o; ■, o●. Diploid survival curve: △, ● – $\alpha\alpha$ diploid; ▲, ● – aa diploid. Haploid survival curve: △, • – α haploid; ▲, • – a haploid

In agreement with a number of previous studies, the diploid cells of both mating types were found to be less sensitive to X-ray inactivation than the haploid cells. However, the frequency of dominant lethals induced in the diploid cells was considerably greater than in the haploid cells. The results of these experiments are summarized in Fig. 1. Within the accuracy of the experiments, the yield of dominant lethals for either haploid or diploid cells was the same for irradiation of either mating type and in addition was independent of the ploidy of the unirradiated parental cell; that is, •o ≡ o• ≡ •◯ ≡ ◯• and ●◯ ≡ ◯● ≡ ●o ≡ o●. Furthermore, there is an approximate dose reduction factor of 2 between the haploid and diploid dominant lethal curves, suggesting that the amount of dominant lethal damage depends on the product of ploidy and dose.

Examination of the results from all crosses where one or both of the parental cells had been irradiated revealed that for a given value of the parameter $p_1D_1 + p_2D_2$ (where p_1 and p_2 are the ploidies of the parental cells and D_1 and D_2 are the respective doses received), the viability of all zygotes except haploid × haploid (••) was approximately the same. A typical example of this relation is presented in Table 1. Agreement of the results in terms of this parameter would be consistent with the assumption that dominant lethal damage was most important in inactivation of triploid and tetraploid zygotes which had been formed by two irradiated cells. That the haploid × haploid cross (••) did not fit was considered to be due to the expression of some recessive lethal damage.

Table 1

Cross	p_1	p_2	D_1 (krep)	D_2 (krep)	$p_1D_1+p_2D_2$	Fraction of viable zygotes
●•	2	1	16·7	16 7	50 0	0 49 ± 0·05
●•	2	1	12 5	25 0	50 0	0·54 ± 0 05
●●	2	2	12 5	12·5	50 0	0 52 ± 0 05
●●	2	2	18 75	6 25	50·0	0·46 ± 0 05
●○	2	2	25 0	0	50 0	0·44 ± 0 07
• ○	1	2	50 0	0	50·0	0·47 ± 0·06
• •	1	1	25·0	25·0	50 0	0·17 ± 0 04

The dependence of dominant lethals on the product of ploidy and dose would be consistent with this damage arising from inviable recombinations of broken chromosome ends—the frequency of breaks would most probably increase with both these variables. However, many critical cellular components of yeast cells are known to increase in integral fashion with ploidy[3], and similar reasoning might be applied to identify the damage with these components. The present experiments do not permit a definite characterization of the dominant lethal damage; they do, however, show that the frequency of this damage increases with the ploidy of the irradiated cell.

A more complete account of this work, including experimental details as well as additional studies with vegetative cells of different ploidies, will appear in a later publication.

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Amino-acid Composition of Hæmoglobin E

In 1955, some of us published the results of the determination of the amino-acid composition of hæmoglobins A, B (also known as S), C and F [1-3]. In that work we used a modification of the column hromatographic method of Stein and Moore. We were recently able to study a family of which some members are carriers of hæmoglobin E. We took advantage of this opportunity to determine the amino-acid composition of this hæmoglobin by the use of the method mentioned in the previous publication[1].

The family came from Indonesia; the father (1) is of mixed British–Javanese extraction (see Fig. 1). He was somewhat anæmic (hæmoglobin 12 gm./100 m. blood). His hæmoglobin was found to contain 1 per cent of fœtal hæmoglobin, which could be emonstrated by three methods available to us alkaline denaturation, electrophoresis and chromatoraphy[4]). The presence of about 11 per cent of hæmoglobin F, together with the hæmatological findings, places this otherwise healthy man in the roup of the Cooley trait (thalassæmia minor).

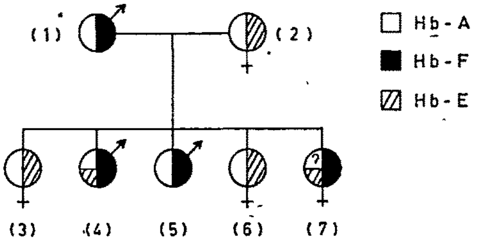

Fig. 1. Pedigree of the family studied

The mother (2) is of mixed Indonesian–Chinese xtraction (from which part of China her mother ame is unknown); her Indonesian father's family ame from Northern Celebes. In the blood of this healthy woman an abnormal hæmoglobin was detected and shown by paper electrophoresis to be hæmoglobin E [5-7]. The percentage of this hæmoglobin E was 38 per cent. Of the five children of this marriage, numbers 3 and 6 had hæmoglobin A and E in their blood, the percentage of hæmoglobin E being respectively 27 and 44 per cent. The blood of one child (5) showed a small percentage of fœtal æmoglobin (6 per cent), as did the father's blood. Another child (4), a boy of five years, the only member of the family with a severe anæmia, showed he clinical picture of a moderately severe Cooley's anæmia. His blood contained nearly 41 per cent of œtal hæmoglobin, 38 per cent of hæmoglobin E and 21 per cent of normal hæmoglobin. The youngest hild (7) is now seven months of age. Her blood still ontains 71 per cent of fœtal hæmoglobin. In a normal child of that age only traces of fœtal hæmoglobin can be detected. Besides this fœtal hæmoglobin, hæmoglobins E and perhaps A could be detected. Similar families with thalassæmia minor and hæmoglobin E trait in their ancestry and with members whose hæmoglobin was a mixture of hæmoglobins E and F have been described previously[5,7].

As we were unable to separate quantitatively hæmoglobins A and E, we had to use mixtures of both hæmoglobins for our amino-acid determinations. We used the hæmoglobin of cases 2, 3 and 6 containing, respectively, 38, 27 and 44 per cent hæmoglobin E.

Table 1. Amino-acid Composition of 48-hr. Hydrolysates of Different Hæmoglobin Samples
(The values are given as gm. per 100 gm. protein)

Amino-acid	Hæmoglobin A	Patient 2 (38 per cent hæmoglobin E)	Fraction patient 4 (65 per cent hæmoglobin E)
Aspartic	10·5	10·3	10·35
Threonine	5·5	5·45	5·7
Serine	4·45	4·75	4·45
Glutamic	7·25	7·8	7·0
Proline	4·95	4·65	4·9
Glycine	4·55	4·75	4·45
Alanine	9·95	10·3	9·95
Cystine	1·0	1·05	1·15
Valine	10·9	10·8	11·0
*iso*Leucine	0·35	0·4	0·35
Leucine	15·15	14·9	14·3
Tyrosine	3·85	4·15	3·75
Phenylalanine	7·85	7·6	7·85
Lysine	9·9	9·8	9·95
Histidine	8·3	8·25	8·25
Arginine	3·35	3·65	3·25

The hæmoglobin of patient 4 was then re-tested after the hæmoglobin F had been removed by means of column chromatography. After this procedure, the hæmoglobin E content was 65 per cent, the remainder being hæmoglobin A. The analysis was done as previously described[1]. In Table 1 the results for cases 2 and 4 are given. Those of cases 3 and 6 are in agreement with the two mentioned here.

These results make it likely that the amino-acid composition of hæmoglobin E is the same as that of normal hæmoglobin. The same is the case for hæmoglobin B. The N-terminal residues of hæmoglobin E are the same as those of the hæmoglobins A, C and B, namely, five valine groups[8]. These findings make it probable that man can synthesize different hæmoglobins which have the same amino-acid composition and the same N-terminal residues, but differ in some physical properties. The occurrence of each of these hæmoglobins is dependent on the existence of one abnormal gene.

Protein synthesis seems to occur under the direct influence of one or more genes. Therefore it is possible that these relatively small differences in structure between hæmoglobins A, E and B which are caused by the presence of one abnormal gene can provide us with some information about the mode of action of these genes in the synthesis of hæmoglobin. Two different possibilities arise: first, the indistinguishable amino-acid composition and the identical N-terminal residues point to an identical sequence of the amino-acids in the polypeptide chains in these different hæmoglobins. If this is true, the differences between these hæmoglobins must be the result of differences in folding of the polypeptide chains and of differences in bonds between these chains. In this case one might conceive that one group of genes is responsible for the synthesis of the polypeptide chains and that a separate gene or a small group of genes regulates the folding of those chains and the bonds between them. This would make protein synthesis in at least two phases likely.

A second possibility is that there are in fact differences in the amino-acid sequences in the polypeptide chains and that these differences are the cause of the differences between hæmoglobins A, E and B. Consequently a different folding of the polypeptide chains must be assumed in the different hæmoglobins. Hæmoglobin C differs from hæmoglobins A, E and B in lysine content. This points to the possibility that the gene responsible for the formation of hæmoglobin C influences the synthesis of the polypeptide chains. In view of the great differences in amino-acid composition between hæmoglobins A and F, one must assume that the synthesis of these two proteins is regulated by quite different groups of genes.

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Staining of Wool by Bacterial Pigments

Staining of the fleece by bacterial pigments has been described[1], and a number of colours have been attributed to a variety of organisms. Recent investigations on the staining of Corriedale fleeces during periods of wet weather have shown that several stains similar to some of those described in previous work can be caused by the oxidation or reduction products of the pigment pyocyanine, produced by a single species *Pseudomonas aeruginosa* (Schroeter) Migula.

Growth and pigment production by the organism are dependent upon the rate of drying of the fleece from saturation[2]. At saturation, the *p*H of basal fleece of the susceptible type is 5·6–6·0, and this *p*H has been found to be the optimal for rapid production of pyocyanine in culture. Under such conditions of wetness and *p*H the fibres are stained green. However, after prolonged wetting, colour banding occurs in the fleece, and brown and red bands appear in succession above a green band. Upon drying, banding disappears and a yellowish-brown or green colour results.

P. aeruginosa was isolated as a nearly pure culture from wool showing green staining; and after purification it was grown in a synthetic culture medium containing phosphate, sulphate, magnesium and ferric ions with glycerol and urea. Growth for twelve days at 22° C. gave maximum production of pyocyanine, at which stage the cultures were passed through a Seitz filter. Extraction of the filtrate with chloroform yielded a coloured solution which was later separat into pyocyanine (blue), hemipyocyanine (yellow) a pyorubrin (red) by elution through an alumi column. The aqueous layer also retained pigmen and these fluoresced in ultra-violet light. Separati of pyocyanine is also achieved by converting it its red salt when the chloroform extract is shak with 1 per cent hydrochloric acid. The salt is tak up into the aqueous layer, and hemipyocyanine a pyorubrin remain in the chloroform layer.

Reduction of aqueous pyocyanine solution ov the entire *p*H range results in the breakdown pyocyanine in different ways according to the init *p*H of the solution. At *p*H 5·6 and above, breakdo of the blue solution is direct to the leuco-base. B tween *p*H 5·6 and 4·8, when the colour of the soluti is violet, the breakdown is by two steps, to green a then to the leuco-base. Below *p*H 4·8 when the sol tion is red, reduction is by three steps, yellow to gre and finally to the leuco-base. Pigment solutions *p*H 4·8–5·6 are easily reduced to green, whereas *p*H's below 3·5 the stepwise reduction is more di cult. These results are in accord with those Friedheim and Michaelis[3] except that these auth make no reference to the yellow reduction produ which has been found to be the first step in t reduction of pyocyanine in the lower *p*H ranges.

Of all the pigments isolated, only hemipyocyani and pyocyanine have been found to stain wool fibr The colour produced in the fibres was dependent up the *p*H of the stain solution. Table 1 shows t results of such tests.

When pigment is absorbed into the fibre from alkaline dye solution, the change in colour from bl to the leuco-base shows that reduction of the py cyanine molecule has occurred. However, oxidat to the blue colour occurs upon washing. Staini between *p*H 5·8 and 5 results in a decrease of bl and an increase of green in the fibre. The gre coloration is, however, formed in the fibres in soluti and subsequent oxidation does not change it. Th it appears that over this particular small range *p*H values reduction of the oxidized pyocyan molecule has occurred, causing the green reducti product to be formed. The dyestuff produced rema within the fibre on washing in warm distilled wa and in 1 per cent hydrochloric acid, but the lat converts the green coloration to a red colour simi to that produced in fibres dyed in solutions bel *p*H 3·0 : this change is reversible. Thus it appe possible that the red band at distal staple leve formed after prolonged wetting of the fleece, is caus by acidic degradation products of the tip[4]. Neit the green- nor the red-dyed wool can be changed blue.

It appears that the pyocyanine molecule is retain within the fibre but not due to bonding, wher

Table 1. Clean Scoured Wool stained with Pure Pyocyanine in 0·1 *M* Phthalate Buffer at 37° C. for 48 hr.

*p*H of dye solution	Colour of dye solution	Colour of stained wool		Wool washed in distilled water (80° C.)	Wool washed in 1 per cent hydrochloric acid (warm)
		In dye solution	After washing in distilled water (20° C.)		
8·4 and above	Blue	Colourless	Blue	All absorbed pyocanine removed from fibres	All pigment removed as red ac salt
7·4	Blue	Colourless	Blue	,,	,,
5·8	Blue	Green	Blue-green	Pyocyanine partly removed but green remains in fibres	Pyocyanine removed as acid sal green pigment turns red an remains in fibre
5·0	Violet	Green	Green	No pigment removed into solution	No acid salt removed but gree pigment turns red
3·0	Red	Yellowish-brown	Yellowish-brown	,,	,,
2·0	Red	Red	Red	,,	,,

e green and red pigments, as shown by the stability nd loss of indicator reaction at alkaline *p*H values, ppear to be bonded to the fibre. It is likely that e combination of an amino-group and the dye olecule will result in the formation of an aminohenazine compound having dyestuff properties.

We wish to thank Prof. J. A. R. Miles, of the edical School, Otago University, for confirming our entification of the bacterium.

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Protein Denaturation in Heavy Water

The increasing availability of deuterium oxide esulting from developments in nuclear energy renders t opportune to reopen the general question of the ffects of deuteration on biological activity. Numerous nvestigations have utilized deuterium as a tracer. here are few quantitative studies, however, which elp provide a basis for an understanding of the rofound consequences of extensive deuteration on iving organisms. To this end, we have now carried ut experiments on the denaturation of ovalbumin n 99·6 per cent heavy water.

The denaturation of ovalbumin by highly conentrated urea solutions has been described in detail y Simpson and Kauzmann[1] and affords a reasonably ontrolled system adapted to comparative kinetic tudies in heavy water and water. Following closely he experimental procedures and methods of analysing he data described by Simpson and Kauzmann, we ave made polarimetric measurements of the deaturation of ovalbumin in heavy-water solutions which are 7–8 molar in deuterourea. Under these onditions a markedly slower rate of denaturation s observed in heavy water as compared to water.

The polarimetric measurements were performed in 99·6 per cent heavy water in water-jacketed polarimeter tubes 2 dm. long; the temperature was maintained at 30·0° C. ± 0·2° C. A Rudolf high-precision model 80 polarimeter equipped with a monochromator supplying light of wave-length 5893 A. was employed. Reagent grade urea was exchanged with 99·6 per cent heavy water four times yielding a product urea-d_4, which gave by Kjeldahl determination N, 43·5 per cent (calculated for ND_2COND_2, N, 43·7 per cent). Stock solutions of ovalbumin in heavy water were prepared by dissolving four-times crystallized ovalbumin (obtained from Pentex Inc., Kankakee, Illinois) in 99·6 per cent heavy water and centrifuging the solution for two hours at 31,000 *g*. Morowitz and Chapman[2] have shown that all exchangeable hydrogens in a globular protein are replaced by deuterium atoms within 20 min. from the time of dissolution in heavy water. Protein concentration was determined in the solutions by dry weight and spectrophotometrically, using for ovalbumin E (1%, 1 cm.) = 7·5 at 279 mμ. In order to provide a valid basis for the comparison of our heavy-water measurements with observations in ordinary water, it is essential that the same preparation of crystallized ovalbumin be used for the kinetic measurements in both solvents.

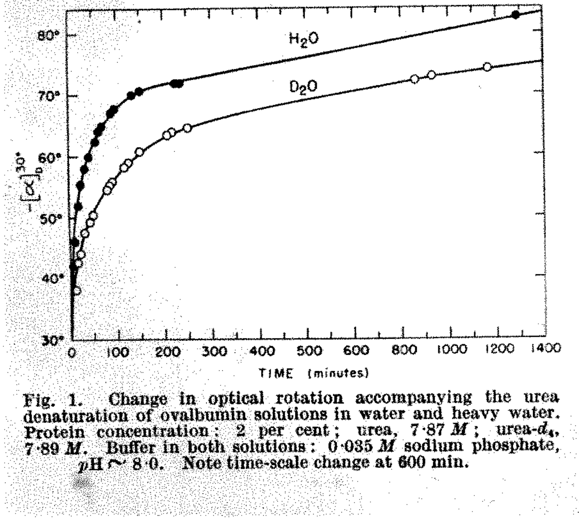

Fig. 1. Change in optical rotation accompanying the urea denaturation of ovalbumin solutions in water and heavy water. Protein concentration: 2 per cent; urea, 7·87 *M*; urea-d_4, 7·89 *M*. Buffer in both solutions: 0·035 *M* sodium phosphate, *p*H ~ 8·0. Note time-scale change at 600 min.

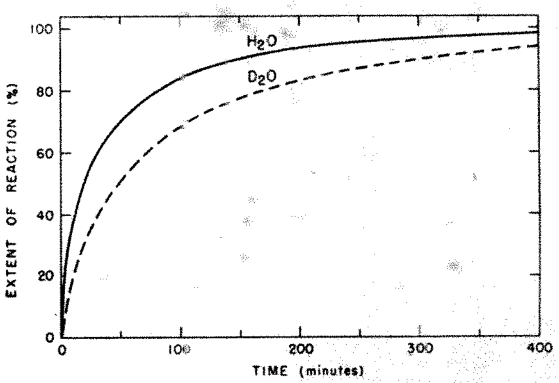

Fig. 2. Comparison of rates of denaturation in water and heavy water. Extent of reaction (initial fast reaction) is calculated at each point by the relationship:

$$\% \text{ reaction completed} = \frac{[\alpha] \text{ observed} - [\alpha] \text{ initial}}{[\alpha] \text{ final} - [\alpha] \text{ initial}}$$

In Fig. 1 are presented the specific rotations $[\alpha]_D^{30°\text{C.}}$ for both water and heavy-water solutions. Neither the kinetic data obtained by Simpson and Kauzmann in water nor the data given here for heavy water are capable of representation by a simple first- or second-order graph. The analytical procedure developed by Simpson and Kauzmann has been applied to Fig. 1, yielding for the heavy-water data $-[\alpha_f] = 70°$, and for water, $-[\alpha_f] = 75°$. These final optical rotation values can be used to construct Fig. 2, from which the characteristic half-times of reaction can be determined: in heavy water, $t_{1/2} = 50$ min.; in water, $t_{1/2} = 18$ min. It thus appears that the rate of denaturation in heavy water is only about one-third that in ordinary water.

A surprising observation in the course of this work is the finding that the specific rotations $[\alpha]_D^{30°\text{C}}$ of ovalbumin in pure water and heavy water are practically identical. For ovalbumin in heavy water we find $-[\alpha]_D^{30°\text{C}} = 29·7 \pm 0·6°$, for water, $30·0 \pm 0·3°$ C.; Simpson and Kauzmann give 30·0° for the specific rotation of ovalbumin in water. The substitution of deuterium for hydrogen thus does not lead to equilibrium structural alterations by the criterion of optical rotation.

On the basis of the results described here it cannot be decided whether the marked slowing down in the rate of denaturation in the protein–urea–heavy water system is due to alterations in the interaction between the protein and the solvent, the protein and the urea, or the solvent and the urea. However, all these interactions involve hydrogen bonding, and it would appear plausible to attribute the change in rate to small differences in the strength of the hydrogen bonds when hydrogen is replaced by deuterium. Thus, if the replacement of hydrogen by deuterium in hydrogen bonds existing between the protein and solvent leads to slightly more stable bonds, because of zero-point energy considerations, then multiplying the slight stabilization per bond by many bonds may produce the observed slowing down. In any event, it would appear that further studies in deuterated systems may contribute to a clearer understanding of the role of hydrogen bonding in maintaining protein configuration.

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Assay of Possible Carcinogenic Hydrocarbons from Cigarette Smoke

Recently, Cooper and Lindsey[1] and Seelkopf[2] described the identification and assay of the carcinogen 3,4-benzpyrene and other polycyclic hydrocarbons in a neutral aromatic fraction of cigarette smoke. These investigators, in the attempt to reconstruct conditions complying with those present in normal human cigarette smoking, smoked cigarettes in an automatic fashion which effected strictly regular intermittent puffing.

The present communication describes a similar investigation of cigarette smoke under conditions of smoking and collection of smoke products which differed from those used by Cooper and Lindsey and by Seelkopf. The time taken to smoke a cigarette of average weight 1·1 gm. to a butt of approximately 1·4 cm. was varied between 7 and 12 min.; 2–4 sec. draws were made during the course of smoking. It was assumed that varying the tempo of smoking as indicated coincided more with reality than regular and 'average' smoking. The smoke products were collected in acetone chilled to − 70° C. 500 cigarettes, used in the present operation, yielded 15·0 gm. of smoke products.

A neutral aromatic fraction was prepared and fractionated by adsorption chromatography using alumina, silica gel and 'Florisil'. The chromatographic analysis was followed by inspection of columns and eluates under a filtered ultra-violet light, and eluates were screened by fluorescence spectrography. Ultra-violet absorption spectrophotometry was carried out for qualitative and quantitative determination of polycyclic hydrocarbons as an adjunct to fluorescence spectrography. In all determinations cyclohexane was used as solvent.

Table 1. Absorption Maxima (mμ)

3,4-Benzpyrene	403		385		37
Fluorescence spectrum IV	401	394	384	380	37
,, ,, VI	404·5	390	387		37

The range of polycyclic hydrocarbons present was found to be essentially the same as that demonstrated by Cooper and Lindsey[1b], pyrene being present in greatest concentration. In addition, other hydrocarbons were detected. Azulene, postulated by th London workers as likely to be present, was indicated in an initial eluate by its spectrum in the near ultra-violet and visible range. The presence of 1,2-benzanthracene, detected by fluorescence spectrography was substantiated by its ultra-violet absorption spectrum, giving an inflexion point at 384·5 mμ and peaks at 299, 288 and 276 mμ. It was present to the extent of 1 μgm. approximately. 3,4-Benzpyrene, th presence of which was established by both fluorescence spectrography and ultra-violet absorption spectrophotometry, was estimated at 7·4 μgm. by peak-heigh measurement against a standard 3,4-benzpyrene at 385 mμ. This concentration of 3,4-benzpyrene agrees with that estimated by Seelkopf. A rechromatography of the 3,4-benzpyrene fraction on activated alumina revealed the presence of two further components in low concentration, which had a blue-violet fluorescence in ultra-violet light and which were more strongly adsorbed than the 3,4-benzpyrene; thei fluorescence spectra are shown in Fig. 1. One spectrum IV, exhibits a slight hypsochromic shift with apparently increased fine structure, whereas the other, spectrum VI, shows a slight bathochromic shift relative to the 3,4-benzpyrene spectrum, such as may be brought about when a position of low free valence is substituted by an alkyl group (*vide* Schoental and Scott[3]). The absorption data in Table 1 demonstrate that the apparent shift of the shortest fluorescence band is paralleled by the shift in the longest absorption band, an approximate mirror-image relationship existing between the fluorescence and absorption spectra[3,4].

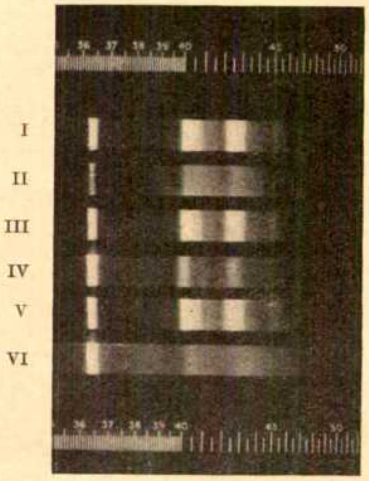

Fig. 1. Fluorescence spectra of three compounds isolated from cigarette smoke

No.	Spectrum	Exposure time (min.)
I	Standard 3,4-benzpyrene (0·1 mgm. per 100 ml.)	3
II	3,4-Benzpyrene derived from cigarette smoke	3
III	Standard 3,4-benzpyrene	3
IV	Unidentified *A*	8
V	Standard 3,4-benzpyrene	3
VI	Unidentified *B*	15

All samples are in cyclohexane

The quantitative estimation of the 3,4-benzpyrene nd 1,2-benzanthracene is regarded as having semiuantitative significance. The latter compound, hich satisfies the frontier electron density index for arcinogenicity of Nagata *et al.*[5], is shown by Steiner[6] o be of 'medium' carcinogenic potency. The conurrent action of the 1,2-benzanthracene, 3,4-benzyrene and the two compounds, the spectra of which esemble that of benzpyrene, on the animal body is ifficult to assess. A wide range of effects, from inibition through summation to synergism, is coneivable (*vide* Steiner[6]).

I am grateful to Dr. P. R. Peacock, director of esearch, and Mr. J. G. Chalmers, for helpful advice, nd to Mr. S. Breslin for printing and mounting of pectra. Further details, including temperatures ecorded during the smoking, will appear elsewhere.

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Cancer Research Department,
oyal Beatson Memorial Hospital,
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Nov. 30.

Cooper, R. L., and Lindsey, A. J., (*a*) *Brit. J. Cancer*, **8**, 296 (1954); (*b*) **9**, 304 (1955).
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Influence of a Magnetic Field on Thermal Convection Patterns

THERMAL instability during the chemical silvering f glass produces Bénard convection patterns in the eposited silver layer. An unstable condition prouced by cooling the silver solution to about 10° C., ouring it over the top surface of glass plates at 5° C. arranged horizontally, so as to produce a layer bout 3 mm. thick, gave silver patterns as shown in ig. 1. A very unusual and pronounced difference ccurred in the details of the shapes of the convection atterns when formed in the presence of a magnetic ield.

When the glass was cooled to the same temperture as the silvering solution and heated from elow at two points by the poles of an electro-agnet at room temperature, a different type of conection occurred in these locally heated areas. The onvection lines centred toward he heated regions, as shown in ig. 2 for two directions of the agnet current, the magnet posiion unchanged. The shape of the onvection lines disclosed an unsual effect, namely, a characteristic ifference between the patterns over he north and south poles. The adiating lines at the north pole isclose little curvature and stream oward a common focus at the entre, whereas at the south pole he lines have greater curvature and o not meet at a common centre.

When an alternating current 60 ~) was applied to the electroagnet, the convection patterns ppeared the same over both pole ieces.

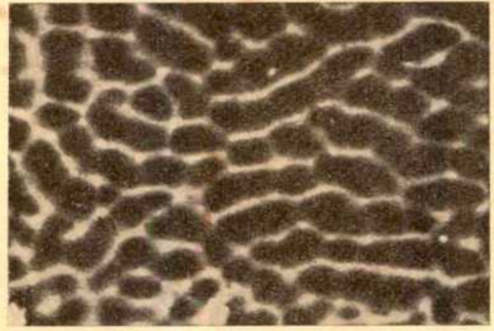

Fig. 1. Bénard cell patterns on silvered glass surface. × 2

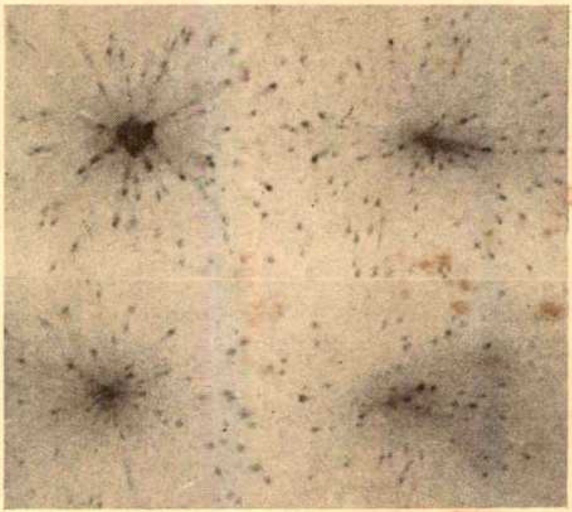

Fig. 2. Convection lines around poles of electro-magnet; 2,000 gauss field. × 3. Upper, north pole left, south pole right; lower, south pole left, north pole right

Patterns using a permanent magnet with large circular pole faces are shown in Fig. 3. The north pole lines are straighter and converge toward a central spot, whereas the lines at the south pole form at the periphery of the heated area and have greater curvature. There is a provocative similarity between these patterns and sunspot patterns. Especially interesting are sunspots that have mutual line patterns as shown by Alfven[1]. The magnetic field itself may

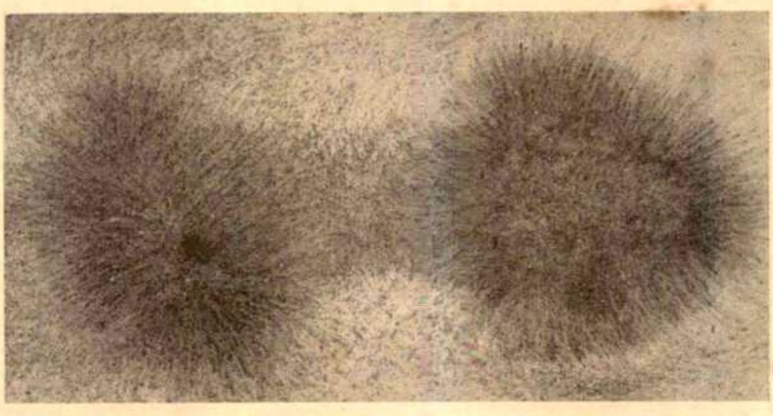

Fig. 3. Permanent magnet, north pole left, south pole right; 1,400 gauss field; pole faces 4 cm. diameter. × 0·6

have an inhibitive effect on the formation of the Bénard convection, as was recently demonstrated by Nakagawa[2]. Chandrasekhar[3] also points out that with motions at right angles to the magnetic field, the 'closing in' of the lines to produce the usual Bénard cell patterns becomes increasingly difficult. He also mentions that the lines around sunspots (photographed in hydrogen radiation) may be due to the inhibitive effect of their magnetic fields.

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Toledo 5, Ohio. Oct. 17.

[1] *Sci. Amer.*, **186**, No. 5, 26 (1952).
[2] *Nature*, **175**, 118 (1955).
[3] *Phil. Mag.*, **43**, 501 (1952).

Relation between the Initial Instantaneous Extension in Creep and the Yield Stress and Coefficient of Work-hardening in Polycrystalline Metals

In the course of work on the creep of polycrystalline lead (99·99 per cent) under constant stress in the range 20–105° C., a full account of which is being prepared, it was found possible to measure the initial instantaneous extension with reasonable accuracy at the lower end of the temperature scale. At higher temperatures the period of low strain-rate, which intervened between the termination of the initial extension and the onset of the transient creep, diminished and the accuracy of measurement suffered in consequence. Nevertheless, as can be seen from Fig. 1, it was possible to establish that the tensile stress σ was related to the initial tensile strain ε by the work-hardening law characteristic of polycrystalline metals of cubic symmetry :

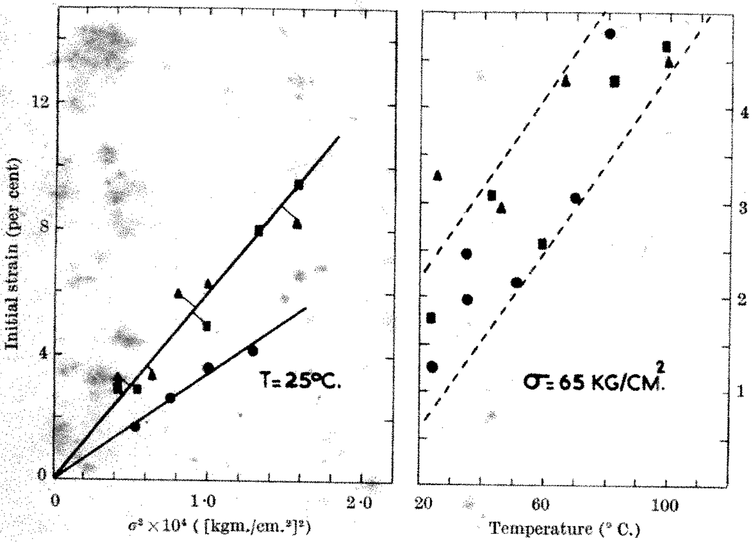

Fig. 1. Mean grain diameter : ●, 0·11 mm. ; ▲ 0·06 mm. ; ■, 0·04 mm.

$$\sigma^2/\varepsilon = \chi(T)$$

where $\chi(T)$ is the temperature-dependent coefficient of work-hardening.

Jacquet's electron-micrographic evidence[1] of the formation of dislocation 'pile-ups' at grain boundaries of slightly deformed alpha-brass, but particularly th uniformity of the spacing between adjacent pile-up suggested that the hardening of the brass was c the interaction type, treated theoretically by Mott which also leads to a parabolic strain-hardening law An attempt was therefore made to apply this theor of interaction-hardening to the results obtained i the present work.

If, to conform with the method of testing, th shear stress is replaced by $\frac{1}{2}\sigma$, and the tensile strai is put equal to the shear strain, Mott's theory give

$$\chi = G^2bn/\pi^2L$$

where $2L$ is the mean grain diameter, b the inte atomic spacing in the slip direction, G the shea modulus and n the number of dislocation in th pile-up. According to Mott,

$$n \simeq (2\pi L/Gb)\,\tau_y$$

where τ_y is the yield stress in shear of the undeforme metal. Since, judging from Jacquet's results, n doe not appear to be significantly dependent on L fo grain-sizes as used by him, and also in the work her discussed, it follows that τ_y should be approximatel inversely proportional to the grain-size. Furthe from the above relations,

$$\chi \simeq (2/\pi)\,G\tau_y$$

which is independent of n. Now, very slow cree in polycrystalline lead is observed at tensile stresses[3] o about 30 kgm./cm.², so that τ_y is less than 15 kgm. cm.² at 25° C., but must be greater than 3 kgm./cm.² which is the yield stress in shear for single crystals o high purity[4]. Therefore, taking $\tau_y = 10$ kgm./cm. and $G = 5 \times 10^4$ kgm./cm.², the last equatio yields $\chi = 3{\cdot}2 \times 10^5$ kgm./cm.² which is in satisfactory agreemen with the values obtained from th slopes of the lines in the left-han figure : $2{\cdot}8 \times 10^5$ kgm./cm.² fo $2L = 0{\cdot}11$ mm., and $1{\cdot}7 \times 10$ kgm./cm.² for specimens with grai diameters $2L = 0{\cdot}04$ and $0{\cdot}06$ mm Owing to poor resolution of th experimental results in the last two cases, separate χ-values wer not determined for these grain sizes. It is apparent, however that the ratio of grain sizes is close to the corresponding ratio of χ^{-1}-values. The value of n which is required to satisfy these results is of the order of 100 at 25° C., which is comparable with the mean value of the number of dislocations per pile-up as shown in Jacquet's micrographs. The comparatively high temperature-dependence of χ, indicated by the results in Fig. 1 (right), is of about the same magnitude as that of the yield stress in shear of lead single crystals in the same temperature-range[4].

Paul Feltham

Department of Metallurgy,
University, Leeds, 2. Dec. 5.

[1] Jacquet, P. A., *Acta Met.*, **2**, 752 and 770 (1954).
[2] Mott, N. F., *Phil. Mag.*, **43**, 1115 (1952) ; **44**, 742 (1953).
[3] Tyte, L. C., *Proc. Phys. Soc.*, **51**, 203 (1939).
[4] Neurath, P. W., and Koehler, J. S., *J. App. Phys.*, **18**, 79 (1951).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Wednesday, April 4

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. L. Clegg: "Fuel and Power Surveys".*

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 6.15 p.m.—Scientific Papers.

Society for Analytical Chemistry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. R. Hill: "The Determination of 4-Chloro-2-methylphenoxyacetic Acid in MCPA by a Differential Refractometric Method"; Mr. F. Franks: "Paper Chromatography with Continuous Change in Solvent Composition. Part 1. Separation of Fatty Acids. Part 2: Separation of Surface Active Agents".

Thursday, April 5

Institution of Electrical Engineers (in conjunction with the British Nuclear Energy Conference, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. A. B. Gillespie: "The Control and Instrumentation of a Nuclear Reactor"; Mr. R. J. Cox and Mr. J. Walker: "The Control of Nuclear Reactors"; Mr. W. Abson and Mr. F. Wade: "Reactor Control Ionization Chambers"; Mr. G. E. Lockett: "Some Design Aspects of Nuclear Reactor Control Mechanisms".

Thursday, April 5—Friday, April 6

Institute of Physics, Education Group (at 47 Belgrave Square, London, S.W.1), at 10 a.m. daily—Conference on "The Teaching of Atomic and Nuclear Physics".

Society of Chemical Industry, Fine Chemicals Group (in the Auditorium, The Wellcome Building, 183–193 Euston Road, London, N.W.1)—Symposium on "Hypotensive Drugs and the Control of Vascular Tone in Hypertension".

Friday, April 6

Institution of Mechanical Engineers, Internal Combustion Engine Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. B. R. Feilden, Mr. J. D. Thorn and Mr. M. J. Kemper: "A Standard Gas Turbine to Burn a Variety of Fuels".

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion on "The Importance of Visual Aids in the Teaching of Advanced Radio and Electronic Engineering", opened by Mr. R. H. Garner.

Saturday, April 7

United Kingdom Committee for the World Health Organization of the United Nations (in the Beveridge Hall, Senate House, London University, Malet Street, W.C.1), at 2.30 p.m.—Meeting to celebrate "World Health Day". Principal Speakers: Sir Russell Brain, Bt., and Sir Andrew Davidson.

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. J. Foley, Mr. E. White and Mr. R. Wilkins: "Power Supplies and Telemetry for Instrument-Carrying Artificial Satellites".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist, Senior Grade (with a first- or second-class honours degree) in the Pathological Department—The Secretary, Liverpool Radium Institute, 1 Myrtle Street, Liverpool 7 (April 7).

Lecturer or Assistant Lecturer in Applied Mathematics—The Registrar, The University, Leeds 2 (April 9).

Demonstrator (with a good honours degree in physiology or biochemistry) in Physiology—The Registrar, The University, Manchester 13 (April 10).

Research Engineers (with a good honours degree or corporate membership of one of the principal Engineering Institutes), for the development of plant manufacturing smokeless and metallurgical fuels—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting SS/236 (April 11).

Assistant Statistician (with a pass degree, diploma, or equivalent qualification, and preferably with a knowledge of both mathematics and horticulture (or botany)), for the examination and analysis of experimental data—The Secretary, East Malling Research Station, near Maidstone, Kent (April 14).

Lecturer in Physics—The Registrar, The University, Reading (April 14).

Lecturer (honours graduate in physics or chemistry) in Textile Chemistry—The Registrar, College of Technology, Manchester 1 (April 14).

Assistant Lecturer in Zoology—The Registrar, The University, Manchester (April 16).

Lecturer (with a good honours degree) in Chemical Engineering—The Registrar, King's College, Strand, London, W.C.2 (April 16).

Mathematician or Aerodynamicist (with a first- or second-class honours degree or equivalent, and preferably with a knowledge of airworthiness requirements and operating regulations) at the Ministry of Supply Headquarters in London, to assess the suitability of civil aircraft projects for commercial operations, including estimation of aircraft performance and economics of operation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.99/6A (April 16).

Research Fellow in Economic Statistics—The Registrar, The University, Manchester 13 (April 16).

Lecturer (with a good honours degree in electrical engineering or physics) in Electrical Engineering with special reference to Electronics—The Registrar, King's College, Strand, London, W.C.2 (April 18).

Laboratory Superintendent for Pharmacology and Veterinary Physiology, and a Technician in Pathology, at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 20)

Assistant Lecturer or Lecturer (preferably with qualifications in applied mathematics) in Mathematics—The Registrar, Trinity College, Dublin (April 21).

Lecturer (Grade II) in Mathematics at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 23).

Lecturer (with teaching experience, and preferably a good honours degree in geography) in Education—The Secretary, The University, 38 North Bailey, Durham (April 28).

Lecturer or Senior Lecturer in Genetics—The Registrar, The University, Liverpool (April 30).

Lecturers in Experimental Physics—The Secretary of University Court, The University, Glasgow (April 30).

Professor of Experimental Physics at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 30).

Senior Lecturer in Pharmacology at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

Research Physicist (with Ph.D. or equivalent in physics and experience in cryogenic research) in the Division of Physics, National Standards Laboratory, Commonwealth Scientific and Industrial Research Organization, Sydney, New South Wales, Australia, for experimental research in the Division's cryogenic group—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 770/116 (May 1).

Reader in Clinical Pathology at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 2).

Reader or Senior Lecturer in Applied Mathematics at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 7)

Lecturer (preferably with experience in the theory of machines and/or strength of materials) in Mechanical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, May 15).

Assistant (preferably with experience in plant pathology) to the Mycologist at Cambridge, and an Assistant Regional Trials Officer (preferably with practical experience in crop production), at Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Biochemical Technician in the Physiology Department of the Medical School, to take charge of the preparation of materials for biochemical classes for medical, dental and science students, and to assist if required in research work of a biochemical nature—Prof. A. A. Harper, Department of Physiology, The Medical School, King's College, Newcastle-upon-Tyne 1.

Biochemist (with a Ph.D. or its equivalent from a recognized university, and preferably a knowledge of manometric and tracer techniques) to study nutrition and metabolism of marine bacteria and various problems concerned with the biochemistry of fish—The Acting Director, Fisheries Research Board of Canada, Technological Station, Vancouver 2, B.C., Canada.

Chair of Civil Engineering—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

Chemical Engineer (with a Master's or Bachelor's degree in chemical engineering, and preferably some research experience) to initiate engineering research on problems concerned with the processing of fish, and to assist in engineering work already in progress—The Acting Director, Fisheries Research Board of Canada, Technological Station, Vancouver 2, B.C., Canada.

Computor (woman, with good mathematical qualifications), to assist with scientific research in the Physics Department—The Assistant Secretary, University College London, Gower Street, London, W.C.1.

Crop Ecologist (with either (*a*) a good honours degree in botany, with postgraduate training in agriculture or agricultural botany, and a sound grasp of statistics, particularly those concerning crop sampling; or (*b*) a degree in mathematics with experience of statistical techniques and some knowledge of, and interest in, biometry or botany) in the Department of Soil and Land-Use Survey, Gold Coast, to collect yield data for various crops grown on different soils—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.79/13/03.

Electrical Engineers and Physicists (with a first- or second-class honours degree in electrical engineering or physics with a bias towards electronics, and preferably with experience of airborne radar systems) at a Ministry of Supply Establishment in Norfolk, for development and adaptation of radio equipment, pulse techniques, including aerials, power supplies and displays—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.105/6A/BN.

Laboratory Technician in Physics—The Clerk to the Governors, Mid-Essex Technical College, Market Road, Chelmsford.

LABORATORY TECHNICIAN (with appropriate qualifications, and preferably some training in biochemistry) IN THE CLINICAL PATHOLOGICAL LABORATORY—The Secretary, The National Hospital, Queen Square, London, W C.1.

LECTURER (specializing in palæontology–stratigraphy) IN GEOLOGY, and a LECTURER (specializing in petrology–mineralogy) IN GEOLOGY—The Acting Dean, College of Arts and Science, Baghdad, Iraq.

ORGANIC CHEMIST (Scientific Officer grade) (with at least a second-class honours degree with not less than a year's experience of research in organic chemistry, and preferably with an interest in the chemistry of natural products and/or microbiology) at the Colonial Microbiological Research Institute, Trinidad, to conduct research into chemical problems arising in the course of the Institute's programme, involving work on antibiotics and other products of micro-organisms, fermentation of the cocoa bean, plant polyphenols, etc.—The Director of Recruitment, Colonial Office, London, S.W 1, quoting BCD.208/209/04.

ORGANIC CHEMIST (with a degree in chemistry or biochemistry and postgraduate laboratory or research experience) AT THE LOW TEMPERATURE RESEARCH STATION, Cambridge, to work on the chromatographic analysis of potatoes in relation to blackening—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

PHYSICIST (with a good degree or equivalent, and a good knowledge of classical physics, with electronics) for work on problems of tension control of the yarns in lace manufacture; and a CHEMIST (with a good degree or equivalent in chemistry, and preferably some knowledge of textile chemistry) for work on problems of dimensional stability of lace fabrics—The Director, Lace Research Association, Glaisdale Drive West, Bilborough, Nottingham.

PHYSICISTS or CHEMISTS (with an honours degree) for work which covers a wide range of problems connected with the manufacture and use of ceramic materials—The Director of Research, British Ceramic Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

SENIOR LECTURER IN PHYSIOLOGY AND PHARMACOLOGY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR LECTURER (with high academic qualifications, and able to teach physical chemistry up to B.Sc. special chemistry degree standard and also able to direct research) IN PHYSICAL CHEMISTRY—The Registrar, College of Technology and Commerce, The Newarke, Leicester

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 27 (N.S.). No. 2 (December 22nd, 1955): Whiting (*Gadus merlangus* L.) in Irish Waters. By Hazel W. Elkin Pp. 17–34. 5*s*. No. 3 (December 22nd, 1955). The Granites of the Western Mourne Mountains, County Down. By C. H. Emeleus. Pp. 35–50+plates 1 and 2. 5*s*. (Dublin: Royal Dublin Society, 1955.) [181

Books for Young People. Group 1: Under Eleven, Annotated and Classified. Compiled by the North-Western Branch of the Library Association under the editorship of Hilda M. McGill. New edition, completely revised. Pp. 103. (London: Library Association, 1955.) 12*s*. (9*s*. to L A members.) [181

Department of Scientific and Industrial Research. Forthcoming International Scientific and Technical Conferences. List No. 18 (January 1956). Pp. i+38. (London: Department of Scientific and Industrial Research, 1956.) [181

Royal Society for the Prevention of Accidents. Danger!—Office Staff at Work. Pp. 16. (London: Royal Society for the Prevention of Accidents, 1956.) 6*d* [181

A Brief History of the Cambridge University Press. Pp. iii+26+3 plates. (Cambridge: At the University Press, 1955.) [181

Sperry Gyroscope Co., Ltd. Sperry Synchros (Publication No. 652) Amendment No. 3. (Brentford, Mddx.: Sperry Gyroscope Co., Ltd., 1955.) [181

Republic of Ireland. Department of Agriculture: Fisheries Branch. Report on the Sea and Inland Fisheries for the year 1954, incorporating Statistics of the Capture of Salmon, Sea Trout and Eels. Pp 47. (Dublin Government Publications Sale Office, 1955.) 2*s*. 6*d*. [201

Association of Universities of the British Commonwealth. Report of the Executive Council, together with the Accounts of the Association for the year 1st August, 1954, to 31st July, 1955. Pp. 25. (London: Association of Universities of the British Commonwealth, 1955.) [201

Child Psychology. By Dr. Edna Balint. (Reader's Guides, Second Series, No. 4.) Pp. 24. (Cambridge: At the University Press, 1956. Published for the National Book League.) 2*s*. 6*d*. net. [201

Brompton Hospital Reports: a Collection of Papers by Members of the Staffs of the Hospitals for Diseases of the Chest (Brompton Hospital, London Chest Hospital) and of the Institute of Diseases of the Chest. Vol. 23, 1954. (London: Brompton Hospital, 1955.) 15*s*. [201

Other Countries

Geological Survey Department, Tanganyika. Bulletin No. 26: The Geology and Ecology of the Nachingwea Region. a reconnaissance survey of Topography, Soils, Vegetation and Geology in the Southern Province of Tanganyika. By Dr. D. R. Grantham, with contributions by R. D. Pilson. Pp. viii+33+3 plates+2 maps. (Dar-es-Salaam: Government Printer, 1955.) Shs. 7/50. [191

Records of the Queen Victoria Museum, Launceston. New Series, No. 3. The Occurrence in Tasmania of *Lactoria Diaphana* (Bloch and Schneider, 1801.) By Heather L. Jones. The Appearance of *Acridotheres tristis* Linne, in Northern Tasmania. By Heather L. Jones. Pp. 4. (Launceston: Museum Committee, Launceston City Council, 1955.) [191

Bulletin of the American Museum of Natural History. Vol. 107. Article 3. A Review and Revision of the Marlins, Genus *Makaira*, By Francesca R. Lamonte. Pp 319–358+plates 4–12. (New York American Museum of Natural History, 1955.) 1 dollar. [19

Report of Her Majesty's Astronomer at the Cape of Good Hop to the Secretary of the Admiralty for the year 1954. Pp. 10. (Observatory: The Observatory, 1955.) [19

Report of the President of the Carnegie Institution of Washingto for the year ending June 30, 1955. Pp. 9. (Washington, D.C.: Carnegie Institution of Washington, 1955.) [19

Researches of the National Museum, Bloemfontein. Vol 1, Part 7 A Revision of the Scaloposauridae with special reference to Kinetis in this Family. By A. W. Crompton Pp. 149–184 Vol. 1, Part 8 Fossil Proboscidian Teeth and Ulna from Virginia, O F.S. By A. J. I Meiring. Pp. 185–202. (Bloemfontein: National Museum, 1955.) [19

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NATURE

No. 4510 SATURDAY, APRIL 7, 1956 Vol. 177

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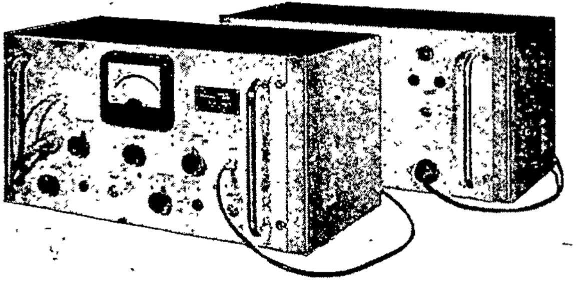

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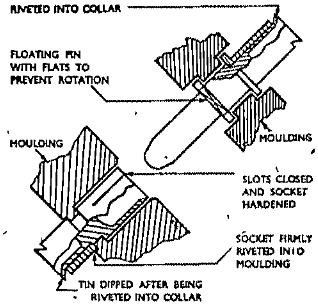
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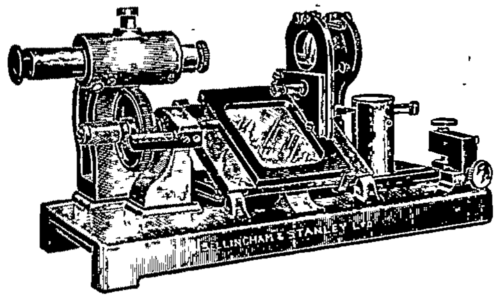

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SCIENCE AND TECHNOLOGY IN DEFENCE

THE recently issued Statement on Defence* is largely a progress report on what has been done in Britain to translate into a defence programme the policy outlined in last year's White Paper. Although during the summer of 1955 there was reason for hoping for a genuine relaxation in international tensions and for the growth of tolerance and understanding between the nations of the free world and those under Communist control, this hope has been disappointed. It remains necessary for the Western democracies to maintain their defensive strength until such time as a true understanding of Western policies can make its impact on the Soviet people.

The appreciation of the economic factors given in the White Paper is realistic and does at least point to the fundamental question: How much can Britain afford to spend on defence? It is not simply the effect of high expenditure on defence on the general level of taxation. Production for defence falls in the main upon the metal and metal-using industries, which supply about half the exports of Britain and are of great importance in re-equipping British industry, thus playing a vital part in strengthening the balance of payments. Moreover, the maintenance of British forces overseas involves a heavy direct charge on the balance of payments.

It is something to find at last frank acknowledgment that the claims of defence research must be balanced against the competing claims on the limited resources of scientific man-power, quite apart from the fact that the size of the Services themselves inevitably affects the man-power available for civil industry. This may be due to the fact that the Services have been able to recruit only about one-half the graduates they need; but it may be also due to the growing realization that the new defence policy laid down last year, and in particular the concentration on improved weapons, makes a strong research and development effort essential. The Government has come within sight of realizing the fundamental importance of science in the defence effort of Britain and, in particular, of directing the limited resources wisely. It is admitted that there have been signs that the research and development have been overloaded and resources dissipated instead of being concentrated on a limited number of projects of the highest strategic importance. The whole programme is now being thoroughly re-examined in order to ensure a proper balance between the resources available and the projects to which the highest priority should be attached.

It is on the selection of those projects and in its analysis of the strategic factors that the White Paper is weakest and most open to criticism; and strategic weakness could frustrate the purpose of the review of the future development of the Services on which the Government has been engaged. Admittedly, at a time of rapid technical advances, a point will be reached beyond which it is impossible to plan because any conclusions will be based on guesswork. Nevertheless, even when the Government confines its review to probable developments over the next seven years, unsound strategic objectives can defeat the purpose of a review designed to provide the Services with reasonably long-term plans on which their production, training and building programmes can be based, to ensure that the reduction in man-power to about seven hundred thousand proposed by March 1958 is achieved with the least military risk, and that the cost of defence in terms of man-power, materials or money does not overload the economy.

Before considering the strategic aspect, this research and development programme may be examined more closely. The financial provision for research and development in 1956–57 has been increased to provide for new weapons of greater complexity and higher quality; expenditure on production and research is now estimated at £787,580,000 gross, against appropriations-in-aid of American aid receipts amounting to £224,930,000. This figure includes the cost of development work undertaken by industry under contract, and the purchase of stores and equipment for research and development establishments, and is £58,170,000 less than in 1955–56, or 37·5 per cent of the £1,498,700,000 net, compared with 41·5 per cent of the £1,494,200,000 net in 1955–56. The White Paper, in stating that the financial provision for research and development has been increased, gives little idea, however, where the increase has been made; and in the debate in the House of Commons on February 28, Sir Walter Monckton, Minister of Defence, merely gave the total figure as about £200 million. Development of some of the more conventional weapons has been cut out or reduced, though some research and development are continuing on them; but it is clearly the new and technically very complex projects, particularly those associated with the deterrent aspect, which are making increasingly heavy demands on the resources of Great Britain.

The White Paper claims that the whole programme is being kept under review with the dual aims of maintaining the right balance between the newer and the older kinds of development projects, and of ensuring that the effort which is being devoted to defence research and development is deployed to the best advantage. It is also recognized that, within the programme as a whole, the effort on research as distinct from development must be maintained, and that the future effectiveness of the British Armed Forces depends primarily on the wise direction and quality of the research effort. Moreover, apart from the need for maintaining specific research aimed at solving immediate problems, long-term research is of increasing importance as techniques become more complicated.

Admittedly the balance between research and development costs and expenditure on the Armed

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* Statement of Defence, 1956. (Cmd. 9691.) Pp. 32 (London: H.M. Stationery Office, 1956.) 1s. 3d. net.

Forces in general is very delicate; and investment in research and development is bound to be heavy with the rapid advance in science and technology. Nevertheless, the indications of the extent of that effort given in the White Paper do suggest some doubts as to whether, over the past few years, the right projects have been selected and whether that effort is still being too widely diffused. Work on the development of a variety of nuclear weapons, for example, continues to expand, and in relation to home defence the importance of continuing and expanding research into the problems of nuclear warfare, and into the most effective and practical methods of dealing with them, is stressed. Many factors of fundamental importance remain obscure, and the danger of misdirected effort here is admitted. Again, particular emphasis is placed on the development of the ballistic rocket and on the *V* bomber aircraft as a deterrent to aggression. Progress is being made in the development of guided missiles for each of the Services, and increasing effort is being devoted to the solution of the problems of flight at high supersonic speeds, including the problems of take-off from, and landing on, existing airfields and aircraft carriers. Two experimental high-speed submarines should be completed next year, and considerable advances have been made in increasing the range of submarine detection and in associated weapons, while the first guided-weapons trial ship should be in operation next summer.

These are only some of the research and development projects indicated by the White Paper; but they illustrate sufficiently the way in which strategic considerations determine the shape of the research and development effort in Britain. Still more, they indicate the importance of the right selection of objectives; and although reference is made to the continuance of close co-operation with the United States, particularly on guided weapons, they raise also the question whether, in deciding the magnitude and nature of research and development, sufficient regard has been paid not merely to resources but also to the possibilities of co-operation with other countries of the Western alliance. The two main criticisms of the British defence policy and programme are, in fact, whether the thinking about priorities has been sufficiently fundamental and whether, in selecting projects, account has been taken not simply of the right priorities but also of the full possibilities of specialization in arms and functions among the countries of the Western alliance. In particular, may not some of the British research and development projects be wastefully duplicating American work?

Before considering such criticisms, however, it is as well to look at the strategic considerations as presented in the White Paper. First, it is suggested that the primary objective must be to prevent war by the maintenance of the Allied deterrent. We have also to be prepared for the continuance of the 'cold' war—the constant and world-wide threat of Communist penetration short of direct military aggression. Equally, we have to be prepared for the outbreak of localized conflicts on a scale short of world war; nor can the possible use of nuclear weapons in such limited wars be ignored.

Accordingly, the forces required to support present British strategy have a fourfold role to fulfil. They must contribute to the Allied deterrent, commensurate, it is suggested, with Britain's standing as a world power. They must play their part in the 'cold' war. They must be capable of dealing with outbreaks of limited war, should they occur. They must also be capable of playing their part effectively in a world war, should it break out, and this involves full co-operation with the civilian authorities and an organization for home defence which can be readily expanded or adapted as changes in the international situation or the development of new weapons may require.

Sir Walter Monckton, in opening the debate in the House of Commons on February 28, acknowledged the importance of getting the priorities right. The resources available for defence will be stretched to the utmost in meeting even essential needs, and to attempt to do more would impose an intolerable strain on the national economy and thus defeat its own ends. Sir Walter said Britain has never been able to do all that is required for full insurance: something has always had to be left out, and the real question is what is the calculated risk to be taken.

All this was common ground among speakers in the debate. Differences of opinion arose over the nature of the calculated risks, and it is not easy for anyone, denied the full knowledge which the Government alone possesses, to pronounce on the soundness of the particular projects on which the Government has decided to concentrate the limited resources of the nation. Indeed, even with that full knowledge, in an era of rapid technical advance there is, as Sir Walter admitted, an element of guesswork in the Government's own decisions.

In spite of this, however, a certain amount of evidence was advanced during a debate, which generally reached a high level, to suggest that during the past ten years the selection of priorities has not been sound, even when it is remembered that in some fields the choice has not rested entirely with Britain. The debate, however, was valuable not so much for suggesting, subject to the limitation already noted, what the correct priorities might be, as for stressing, first, the need to raise defence above political party issues and to ensure some continuity in the office of Minister of Defence: and, secondly, for indicating some of the factors which should determine the choice of objectives.

One criticism advanced of the Government's defence policy is whether sufficient attention is being given to the possibilities of co-operation or specialization of function with the other countries of the Western alliance. Of this, Sir Walter Monckton observed that there is a continual exchange of information and co-operation in other ways between the United States and Britain, and indeed that there are mutually benefiting arrangements with the United States for the exchange of military information of all sorts, including special arrangements for collaboration in the vital field of guided missiles. He thinks, however, that in practice there are definite limits to the extent to which the British research and development effort and that of the United States can be made to coalesce. Apart from the dollar difficulty, there are sometimes practical difficulties in making equipment of American design in Britain and incorporating it in British ships, aircraft, etc. British policy, Sir Walter suggested, should be to make the fullest use of the collaboration agreement we have with the United States and other countries to avoid duplication of research and development, but it is also necessary to continue with research and development ourselves over a wide range of projects. Sir Walter admitted that we shall have to be more selective in re-equipping our Forces. Mr. R. R. Stokes's comment here is significant: "We cannot go on behaving in a nuclear age as if nothing much had happened. We need new thinking".

That is particularly true in regard to the policy of graduated deterrence which has been urged on the Government and which was advocated by Prof. P. M. S. Blackett in a lecture at Trinity College, Cambridge, on February 24, when he made some outspoken criticisms of the confusion of thought in planning defence policy. Prof. Blackett said that, while the White Paper contains some sound proposals, it does not reflect the doubts and criticisms which are now being raised, not only as to civil defence but also as to defence policy in general. He thinks that the present confusion arises from the failure of those planning defence to adapt themselves to the change in the comparative strength in nuclear weapons of the East and West since 1950, and urged that some clear definition of the circumstances in which the nations are prepared to use atomic weapons and some definite distinction between their strategic and tactical use are greatly needed.

Sir Walter referred briefly to this matter at the close of his speech, but no more than to indicate that the Government is thinking again as to the possibility of distinguishing between tactical and strategic weapons. Indeed, so far from advocating adoption of a policy of graduated deterrence, he thinks there are solid grounds for believing that, even if the policy is right in itself, it is unlikely to be adopted by other parties to the agreement. Sir Walter leans towards a comprehensive scheme of disarmament, but in doing so he largely shied away from the questions and decisions which should determine the projects on which our resources should be concentrated for effective defence.

Apart, however, from this question of the right choice of projects, there is also the question of the general deployment of scientific and technical resources in Britain. It is admitted in the White Paper, and was recognized in the debates of February 28 and 29, that defence research and development effort make heavy demands on industry in Britain as well as on scientific and technical man-power. The public is not, however, given anything like the information in the White Paper or elsewhere for an outside judgment to be formed as to whether or not that effort is in danger of distorting the national economy or the balance of scientific and technical effort. Concern has sometimes been expressed, for example, as to the effect on the balance of research of the efforts in nuclear physics and the development of nuclear energy, not merely for weapons but equally for peaceful purposes; but there is at present no means of judging how effective a safeguard the organization of defence research in Britain under the Defence Research Policy Committee can provide against such distortion.

It would be reassuring, moreover, if the White Paper had touched on the bearing of technical education in Britain both on recruitment to the Services and on the equipment of the Services to fulfil their function. This, too, is an aspect of the general man-power situation of the country; for defence requirements have to be considered in relation to scientific and technical education, just as they have in relation to scientific and industrial research. Nor will these needs be met effectively except as part of an adequate educational policy for the nation as a whole, which takes full account of particular shortages such as that of science teachers and seeks to meet them by realistic and fundamental measures rather than by expedients which merely create difficulties and undesirable repercussions elsewhere. Any expansion of scientific and technological man-power in Britain, and even in technical man-power, is a long-term process; as Prof. Blackett remarked, defects in an educational system are not quickly repaired, nor is there any easy recovery from false economies in research in the past.

Accordingly, it is important not merely that these resources should be distributed wisely, but also that the best possible use should be made of them where they are deployed, that skilled and highly trained men should not be employed where those less trained would be equally effective, and that neither professional inhibitions nor restrictive practices on the part of employers or trade unions should hinder the development of the nation's full productive capacity. It is these factors which, as much as anything, will determine whether Britain can continue to devote to defence purposes some two-thirds of its expenditure on scientific research (on Mr. John Strachey's estimate); and they give a point to Mr. G. Brown's plea for a further look at the way in which defence research is organized departmentally—the Minister of Supply's assurance that there is little duplication in research was rather bald. There is the additional point that, in the field of defence as elsewhere, the effectiveness of applied research depends on the way it is administered and the degree of understanding of research methods and people, as well as of the problems to be solved, shown by those responsible for that administration. It is always possible to learn from others, and there are more than a few points, for example, in the papers presented last September in the United States at the ninth annual conference on the administration of research at the North Western University Technological Institute, which deserve consideration in this connexion; particularly relevant is Mr. R. A. Morgan's discussion of research relationships between government and the university, in which defence research was specifically considered.

More even than last year, the latest Statement on Defence puts the whole question of defence and defence research in its proper economic as well as its strategic or political context. The implications are not always pursued or examined and the priorities may be challenged. Though the Government can perhaps be charged with attempting too much and spreading the nation's resources too widely, the first duty of the scientist or technologist is not to attempt to point out what those priorities should be ; rather he should stress the relation of the defence effort, and especially that on research and development, to the economic effort generally, and put in perspective the implications of this for the nation's industrial and scientific research effort as a whole, for its technological and scientific man-power and for its educational system.

IMPACT OF SCIENCE ON RELIGION

Modern Science and Christian Beliefs

By Dr. Arthur F. Smethurst. Pp. xx+300. (London: James Nisbet and Co., Ltd., 1955.) 21*s*. net.

DR. A. F. SMETHURST has set before himself an ambitious aim. He surveys the whole range of natural science and considers its bearing on Christian belief with the object of enabling any educated reader to form a reasonable opinion on the subject. He has succeeded in a surprising degree and has written a book which is always lucid and readable ; it should help to enlighten many Christians on the present state of scientific thought and perhaps, too, some scientists on modern Christian theology. It is difficult to review such a book, because few could claim so wide a knowledge of the various branches of science, together with the equipment of a theologian, as that possessed by the author—and certainly I am not one of the few.

It is inevitable that not all the sections of the book should be of equal interest, and it will be possible here only to indicate its scope and to direct attention to some controversial points. Dr. Smethurst deals with the inherent limits of scientific knowledge on lines which are familiar, laying stress on the fact that individuality and value seem to be excluded from its investigations. He argues that the Christian belief in God prepared the way for the rise of natural science. In this, he agrees with many other eminent thinkers; but one may, perhaps, hesitate to hold that the belief was an indispensable preparation without which science could not have come into existence. It is always rash to dogmatize on what could or could not have happened, had circumstances been other than they were ; and it is enough for Dr. Smethurst's case to state, what is obviously true, that the Christian belief in God was, in fact, one of the conditions in which science came into being. Dr. Smethurst contends forcibly, and surely reasonably enough, that recent advances in physics and astronomy, so far from tending to make theism less easy to accept, have had the opposite effect, and the theistic view finds more support from modern cosmology than it could ever have from the scientific theories of the end of the nineteenth century. When the reader comes to the chapters on biology and psychology he is in the thick of the conflict.

Dr. Smethurst may be congratulated on his firm repudiation of fundamentalism in all its forms and his clear statement of the general evidence for the fact of evolution. He argues that evolution bears the marks of divine purpose and cannot be interpreted adequately unless we see in it the work of creative Spirit. But the problem of evil cannot be ignored, and the author does not evade the issue. In this connexion he has a good word to say for the devil—not, one hastens to add, as a character, but as a hypothesis. His view might be described as a relative and temporary dualism. Support can, of course, be adduced for this conception from the New Testament, and it has *prima facie* an apparent agreement with the facts of experience. Dr. Smethurst is well aware of the philosophical and theological difficulties which would have to be met, but no doubt lack of space prevents him from going deeply into them. No author can be blamed for not producing a final solution of the crux of theism—the problem of evil—but a further development of Dr. Smethurst's thesis would have been welcome.

The chapter on psychology is one of the best in the book, characterized by fair and balanced presentation of the chief theories. Freud's contribution is recognized and duly appraised, while the criticism of his view on the nature of religion is definite and well-argued. The value of the book is considerably enhanced by four long appendixes on logical positivism, dialectical materialism, existentialism and the problem of the communication of the Gospel in a scientific age. It is to be hoped that Dr. Smethurst's book will be read by many Christian fundamentalists and by many 'dyed in the wool' agnostics. Both classes of readers will find much to think about.

W. R. MATTHEWS

RADIOACTIVE TRACER TECHNIQUES IN BIOLOGY

Radioisotopes in Biology and Agriculture

Principles and Practice. By C. L. Comar. Pp. xiii+481. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 67*s*. 6*d*.

THE success of radioactive tracer techniques has nowhere been more spectacular than in the biological sciences. The application of radioisotopic techniques to biology and physiology has already resulted in far-reaching advances and continues to develop so rapidly that some knowledge of the possibilities and limitations of tracer methods is now essential to every worker in these sciences. The publication of this informative and factual book, written primarily for the biological student and investigator, is therefore particularly welcome.

The author gives a clear and comprehensive survey of the present situation with regard to radioactive tracer techniques in biology. An excellent balance between principles and practice is maintained throughout, and comprehensive references on all aspects of the subject are quoted. The book will be of particular value to the research worker who wishes to apply tracer methods to his own problem. Its major weakness lies in the omission of an adequate account of the elements of radioactivity physics, and the newcomer to the subject will need to turn to elementary text-books of physics for a correct understanding of these fundamental principles without which he will not be fully equipped to undertake tracer investigations.

The book opens with an excellent account of the general principles on which different types of tracer studies are based, with examples drawn from a wide variety of biological investigations, and includes a particularly valuable treatment of the kinetics of biological systems as studied by radioisotopic methods. The limitations imposed by chemical effects, radiochemical impurities, radiation effects and isotopic effects are clearly defined. Then follows a practical account of the measures necessary to protect personnel against radiation, including suggested working rules for use in radiochemical laboratories. It is unfortunate that the book was written too early for the inclusion of a summary of the 1955 Recommendations of the International Commission on Radiological Protection, and it is to be hoped that this omission will be made good in future editions.

A useful chapter outlines plans for typical laboratories for radioactive work and gives much practical information regarding methods of administration of active materials to both animals and plants and methods of sample collection. The section devoted to techniques for the radioactive assay of biological samples is less successful owing to the inadequacy of the physical treatment. While the author cannot be criticized for not giving a detailed discussion of the scalers and other electronic equipment used in assay work, the omission of a satisfactory description of the fundamental properties of the Geiger–Müller counter, scintillation counter and ionization chamber and of the mechanism of radioactive decay is difficult to justify.

A detailed summary of the properties of selected radioisotopes is given, with examples of investigations illustrating the procedures, equipment and precautions necessary for their use. The data presented for each isotope include the specific activity available, the minimum detectable activity using different assay methods, and figures relating to radiation protection. While they form a useful guide, these data should be accepted with some reserve in view of the present rapid improvement in technique. The specific activities listed are those obtainable from the Oak Ridge reactor in the United States, and do not necessarily apply to preparations obtained from other sources. It may also be noted that the protection data are in some cases at variance with the latest Recommendations of the International Commission on Radiological Protection. A select bibliography accompanies the information relating to each isotope.

The final chapters discuss the allied techniques of autoradiography, paper chromatography, ion exchange and activation analysis which play so important a part in tracer studies. These chapters are all excellent. Their scope is much wider than the limited field of radioactive tracer methods, and they give a clear and concise introduction to these fascinating techniques.

The general format and production maintain the high standard expected from the publishers. This book, while not to be regarded as a standard work of reference, will form a valuable addition to the library of the biological research worker.

E. H. Belcher

HANDBOOK OF ORGANIC COMPOUNDS

Organic Solvents

Physical Properties and Methods of Purification. On the basis of the First Edition by Arnold Weissberger and Eric S. Proskauer. Completely revised Second Edition by John A. Riddick and Emory E. Toops, Jr. (Technique of Organic Chemistry—Vol. 7. Edited by Arnold Weissberger.) Pp. vii+552. (New York: Interscience Publishers, Inc.; London: Interscience Books, Ltd., 1955.) 8.50 dollars.

THE statement on the dust cover claims that this volume provides "a guide and reference book for everyone engaged in synthetic organic work, in the study of reaction mechanisms, and in the study of non-aqueous solutions and titrations". This provides a better description of the contents of the book than the main title, since the volume does not, in fact, record the solvent properties of any compound.

The physical properties and numerical values tabulated can be grouped into four main types: values useful for the identification of pure substances and as criteria of purity (for example, boiling points, melting points, etc.); values useful in connexion with physico-chemical measurements (for example, ebullioscopic constants, etc.); properties useful for the study of solute systems (for example, electrical conductivities, spectra, etc.; no spectra are shown, however, but references are given to sources); and properties important for the handling and storing of solvents (for example, flash points and toxicities). The various constants are listed under the names of the compounds; but there are also tables of boiling points, freezing points, dielectric constants and dipole moments with the properties arranged in order of increasing magnitude. A chapter is devoted to a discussion of criteria of purity, drying techniques and determination of water. A large section consisting of 163 pages which describes various purification procedures for each compound is followed by a bibliography, a list of 2,169 references to the literature and an index.

The occurrence of *cis*- and *trans*-isomers of certain cyclic compounds has given the compilers of this volume a great deal of trouble. Thus, although it is stated on p. 314 that "Decahydronaphthalene from different sources will show considerable variation in composition of the *cis*- and *trans*-isomers", the results of very precise measurements made on unspecified mixtures of isomers are presented on p. 68. Similarly, the properties of 2-, 3- and 4-methylcyclohexanol are tabulated, although there is no indication whether the values quoted refer to the *cis*- or *trans*-isomers or to a mixture of these materials.

The molecular weights given are not now correct to the number of figures quoted, because the 1953 International Atomic Weights were not employed. Thus, the molecular weight of cyclopentane should be 70·135 and not 70·130 as printed. Some of the constants appear to have been recorded with a much greater precision than the experimental results warrant. For example, several flash-points are given to the nearest 0·1 deg. F., whereas this constant is rarely known to within 5 or 10 deg. F. Thus, the flash-point of *n*-heptane is quoted as 20·6° F., whereas values ranging from 25 to 63° F. are given in the pamphlet "Fire-Hazard Properties of certain Flammable Liquids, Gases and Volatile Solids"

(National Fire Protection Association, Boston, 1946), which recommends 25° F. as the selected value. Errors in the structural formula of the following compounds were noted (page numbers in brackets): 3-methylpentane (55); 2,2-dimethylbutane (56); 2,2,3-trimethylpentane (65); *p*-xylene (76); 2-pentanol (99); 3-methyl-1-butanol (101); methylal (130); 4-methyl-2-pentanone (141); *o*-fluorotoluene (181); *m*-fluorotoluene (182); *p*-fluorotoluene (182); pyridine (243); and thiophene (248). The molecular formula for oleic acid (p. 151) is also incorrect.

The difficulties in producing a book of this type are considerable, but this compilation is so useful that it is to be hoped that a further twenty years will not be allowed to elapse before the appearance of the third edition.

CRYSTALLIZATION OF HIGH POLYMERS

Some Aspects of the Crystallization of High Polymers

By G. Schuur. (Communication No. 276.) Pp. 82. (Delft: Rubber-Stichting, 1955.) 5 Dutch florins.

THIS is a small monograph dealing with a topic which is of considerable current interest. The mechanism of crystallization of an amorphous solid to a crystalline substance is not easy to elucidate. When a polymer is being dealt with, the difficulties increase immensely, and mobility is restricted in a way that does not occur with simpler systems. The trouble here is to try to deduce something about the mechanism and structure of the crystallites formed during the process by observations on the rate of formation of the nuclei, the rate of growth of the crystallites, and the optical properties of the crystallites. Thus, there is a limited amount of experimental data that can be obtained in such systems, and the interpretation, therefore, is still open to considerable discussion.

The author is a member of the Rubber-Stichting in Delft, and naturally he has a considerable interest in the crystallization phenomena exhibited by rubber. In addition, however, he discusses work done on polyamides and superesters, which are equally relevant to this topic.

The book is divided into a number of chapters which introduce the subject to anyone who is not particularly familiar with it. First there are general remarks about crystallization and the problem of liquid crystals. Next is a factual description of what has been observed about spherulitic formation in solid high polymers, and then follow three chapters on the more controversial aspects of methods of crystallization, the rate of crystallization, and phenomena of melting in high polymers.

The book is lavishly illustrated with extremely good photographs of typical spherulites and their behaviour in a number of systems, which convey in a much better form than any tabular data the qualitative nature of these phenomena. The book will provide much stimulus to those engaged in similar work and should also be an extremely useful guide to those who want to know in a general sort of way what is happening in this field of polymer chemistry.

H. W. MELVILLE

MICROSCOPY OF CERAMICS AND CEMENTS

Microscopy of Ceramics and Cements, including Glasses, Slags, and Foundry Sands

By Herbert Insley and Prof. Van Derck Fréchette. Pp. xii+286. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 7.50 dollars.

THE use of the polarizing microscope for the study of ceramics and cements has developed considerably in recent years, and a book such as this is welcome. For each group of ceramics, and for refractories and cements, the authors give brief accounts of the raw materials employed and of the behaviour of ceramic materials during firing operations and of cement during hydration. There are short introductory chapters on the microscope and on optical mineralogy, but the authors very rightly refer their readers to standard text-books for further details and also for tabulated and classified data of the optical characters of the minerals and artificial crystalline materials concerned. The characters of the minerals used as raw materials are, however, given in a separate chapter and their thermal behaviour is outlined. Obvious characters by which the materials produced in firing processes may be recognized are described as the occasion arises. The photomicrographs illustrating these descriptions are excellent.

There are two chapters on the preparation of materials for the microscopic examination and on special techniques and, apart from these, there are separate descriptions of methods used for especially difficult materials such as cement clinker, hydrated cements and porcelain enamels on metal. A very high standard of section-cutting must be attained, sections of cement clinker being worked to less than half the thickness of 30μ used for rock sections. Methods of impregnating friable materials and the use of synthetic thermoplastic cements in place of the old-established Canada balsam are described in detail. For the study of some materials too dense to give good results with transmitted light, polished thin sections are prepared and are viewed by reflected or oblique illumination. These are particularly useful for cement clinker, aluminous cements and basic refractories. Delicate etching with very dilute reagents enables the different components to be recognized.

The chapter on glass describes crystalline solids likely to be encountered as 'stones' in the glass. These may be derived from the batch itself, from the refractories in the walls of the pot, or by devitrification. A binocular microscope with oblique illumination can advantageously be used in this work on glasses, and another device, used in the examination of porcelain enamels on metal surfaces, illuminates the specimen through one eyepiece of a binocular, the observer looking through the other.

A criticism may be made that the authors have attempted too much in a small compass; but they have succeeded in giving an up-to-date summary, for each branch of ceramics and cements, and have supplemented every chapter with a fairly full list of references to modern literature on the subject which will direct workers in Britain to most of the recent American work in these fields.

W. CAMPBELL SMITH

Lehrbuch der anorganischen Chemie

Begründet von A. F. Holleman. (34–36, wesentlich umgearbeiterte und erweiterte Auflage.) Bearbeitet von Prof. Egon Wiberg. Pp. xxviii+661. (Berlin: Walter de Gruyter and Company, 1955.) 28 D. marks.

TRANSLATIONS of the late Prof. A. F. Holleman's books on inorganic and organic chemistry have instructed generations of students. They were characterized by clarity and a wise selection of fundamental material. Although as Prof. Egon Wiberg says, his revision bears little relation to the original "Holleman", it preserves the good points of its ancestor.

The text is thoroughly modern, the electronic theory of valency being amply used in it, and the old formulations of inorganic compounds have been replaced by present-day ones. Physico-chemical principles, such as the phase rule and the theory of equilibrium, are freely used. The newer aspects of the subject come at the right places in the text, and difficult topics are dealt with in stages. The theoretical parts of the book are modern and correct. The treatment of the individual elements and compounds is concise yet thorough, and includes more advanced topics of considerable interest, such as the structure of the silicates, the metal carbonyls and the hydrides of boron. The rarer elements find a satisfactory place, and there are brief but good descriptions of industrial processes. There are many tables of physical properties and an excellent index, so that the book is very convenient for reference.

The text is divided into short sections with clear headings, which will facilitate study, and the treatment of each element follows a regular order of occurrence, preparation, physical properties, chemical properties and uses. The nomenclature is based on Stock's scheme, which is becoming more used in all quarters. The illustrations are mostly curves, diagrams of structure and technical apparatus, ordinary preparative laboratory apparatus, even of a specialized type, not finding a place. This book is clear, systematic, sufficiently detailed, and highly informative. It can be warmly recommended.

British Wild Flowers

By Dr. John Hutchinson. Vol. 1: Pp. 492. Vol. 2: Pp. 493–947. (Pelican Books Nos. A.330 and 331.) (Harmondsworth, Mddx.: Penguin Books, Ltd., 1955.) 5s. each volume.

DURING the past few years Dr. John Hutchinson has been occupied in a revision of Bentham and Hooker's monumental "Genera Plantarum", but this enormous task has not prevented him from writing a number of volumes dealing popularly with the British flora. His first three works in the Pelican series were written expressly for those with no knowledge of botany but who wanted to learn the names of the wild plants of the countryside. Undoubtedly these convenient manuals provided a simple and easy introduction to the study of our native plants. They had no systematic arrangement, though plants belonging to the same family were kept together. The latest volumes, which include the contents of the three earlier books with some additional species, correct this unsatisfactory situation, and the sequence of the species described and figured follows the author's system of classification.

The work certainly gives a good general survey of the British flora, though the inclusion of so many adventive species is perhaps unfortunate as there are significant omissions among the native plants and some indigenous genera get rather scant treatment. This is certainly so in the case of aquatic plants. The genus *Callitriche* is entirely omitted, and other groups are poorly represented. Under *Utricularia* it would have been better to refer to the work of Lloyd, who showed convincingly that the bladders were not the static organs they were supposed to be, but ingenious traps which could be set at tension ready to be sprung by contact on sensitive hairs.

The two volumes, in conjunction with C. E. Hubbard's "Grasses" in the same series, can be recommended to amateur field-naturalists needing an authoritative and inexpensive guide to wild flowers in Britain.

Further Outlook

By F. H. Ludlam and R. S. Scorer. Pp. 174+13 plates. (London: Allan Wingate (Publishers), Ltd., 1954.) 15s. net.

IT is the avowed aim of the authors of this interesting and unusual book "not to write a text on the science of meteorology . . . but rather to explain a philosophy of the science of weather study which will enable us to understand its probable future achievements". The result of this laudable purpose is that the essence of the contents is likely to be fully savoured only by the meteorologist, who will be delighted by the novel treatment of certain parts of his subject but occasionally surprised by quite reckless pronouncements. Surely few forecasters would agree with the authors that the geostrophic wind equation is "'the only theoretical result which is constantly put to practical use", or that "no great forecaster has ever written a tract that has found a place amongst the teaching texts of meteorology".

The authors are distinguished for their work in cloud physics and on mountain waves, respectively, and the chapters headed "Exploiting the Atmosphere" and "Weather Control" are those most likely to interest the general reader. The first of these deals with the development of thermals and wave-clouds and with the techniques of soaring flight; there is an intriguing analysis of the dynamic soaring of the albatross. The other is concerned with ways in which weather may be artificially modified, in particular with the physical processes involved in cloud seeding and with the difficulties of assessing whether or not rain-making experiments are effective. The book is illustrated by very fine cloud photographs.

JAMES PATON

Dancers of God

By Nöel Ballif. (Translated from the French by James Cameron.) Pp. 213+32 plates. (London: Sidgwick and Jackson, Ltd., 1955.) 15s. net.

THE author, M. Nöel Ballif, in company with a team of anthropologists and cinema technicians, and with the backing of the Musée de l'Homme, organized an expedition into the forest country of the French Congo to study the pygmies of the region and to make film and sound recordings of their way of life. The book is essentially a travelogue, delightfully written and well translated, and with an interesting account of the daily life of the pygmies with whom they were lucky enough to make friendly contact.

This is in no sense a serious anthropological work, but the description is useful in the same way as are the descriptions of remote peoples by the early voyagers; they give the layman a more vivid picture than a whole book of expert knowledge. An account of hunting with nets and spears is excellent. The book ends with a brief chapter—one might almost call it an appendix—summarizing in five pages the physical anthropology of African pygmy peoples, by Raoul Hartweg, and a list of the anthropological results of the expedition. The book serves to whet our appetite for the more serious and scientific work which will no doubt follow in due course.

Atom Harvest

By Leonard Bertin. Pp. 253+23 photographs. (London: Martin Secker and Warburg, Ltd., 1955.) 20*s.* net.

THIS is a remarkably fine account of a complicated field in which the reader is not asked to worry over-much about scientific or engineering detail at any stage, but nevertheless acquires an accurate broad understanding of the principles involved. Mr. L. Bertin is to be congratulated on accomplishing very adequately on the British side what Mr. Gordon Dean achieved in respect of efforts in the nuclear field in the United States. He considers at some length the history of the thorny questions of collaboration between the two countries, and many readers will be grateful for his forthright way of tackling the subject.

To the general reader interested in a field of paramount importance to the future of the United Kingdom and the Commonwealth, this is a book which can be highly commended. Even the specialist must find within its pages much to interest him, since few can be familiar with all the many facets of the vast programme set forth in it.

In one respect the reviewer found the book fell short of expectation. More consideration should have been given to the present trends in tracer research, and its rich promise for the future of scientific effort in Britain might have been more thoroughly examined. This need not have meant a longer book as the space could have been saved elsewhere without appreciable loss to the reader; for example, the profusion of discussions set forth could have been pruned severely. S. C. CURRAN

Metals Reference Book

By Dr. Colin J. Smithells. Second edition. Vol. 1: Pp. xvi+532+17. Vol. 2: Pp. xv+533–967+17. (London: Butterworths Scientific Publications; New York: Interscience Publishers, Inc., 1955.) £8 8*s.* net the set.

NO one can deny the usefulness of this book, nor the attractiveness of the volumes, although the cost is almost prohibitive for the individual. The aim has been to supply a collection of data relating to metallurgy and metal physics, and to a large extent this has been done in tabular or diagrammatic form.

The scope is wide, in fact so wide in some respects that it encourages an impression that there are omissions. A large part of the subject-matter is fundamental data, such as mathematical formulæ, conversion factors, constants, thermo-chemical data, atomic characteristics, equilibrium diagrams, on crystallography and a considerable range of important physical properties, together with sections on metallography and mechanical properties. On the practical side, the topics include: fuels and refractories, foundry details, lubricants, corrosion, electroplating, and welding. It is the catholic nature of the selection on these aspects that prompts the feeling that comparable subjects have been omitted.

The second edition has involved considerable revision of data, the rewriting of some sections, the addition of more material, and a more elaborate bibliography; resulting in its presentation in two volumes. A commendable point in this connexion is that both volumes contain the index. In all, this can be regarded as an essential reference book for metallurgists and others working with metals.

A. R. BAILEY

A History of the Classification of the Phylum Brachiopoda

By Helen Marguerite Muir-Wood. Pp. vii+124. (London: British Museum (Natural History), 1955.) 20*s.*

THE Brachiopoda are an interesting group with a long fossil history, but their position in relation to other groups is not satisfactorily determined. In the past they have been associated with a number of the major phyla of the invertebrates. Perhaps the smaller group with which they have been linked most frequently is the Bryozoa, but the consensus of opinion now is to regard these as two separate phyla; indeed, some authorities suggest that the Brachiopoda should be subdivided into two phyla, but in this present work Dr. H. M. Wood prefers to regard the Inarticulata and the Articulata as classes. She has gone into the history of all these changes, starting with the first illustration of a member of the group by Conrad Gesner in 1565 but paying particular attention to them since 1785, the crucial date from the point of view of nomenclature.

This useful work is not intended as a definitive classification, but it is a fully documented presentation of the past and present position with regard to their classification. Subsequent workers will be grateful to Dr. Wood for this essential clearance that will enable detailed revision to be started so much more easily. In this, the relevant bibliography, carefully checked, and the full index will be most useful.

British Trade Unionism

Five Studies by P.E.P. New and revised edition. Pp. xi+199. (London: P.E.P. (Political and Economic Planning), 1955.) 16*s.*

THIS new and revised edition appears in a new format, with five studies only, instead of the previous six. Though the framework has been retained and many passages are virtually unchanged, much of the book has been rewritten, and the first study, in particular, with its statistical analysis of the number, size and type of unions in Britain, has been brought up to date. While the book remains a most useful factual handbook, by omitting the sixth study, that of the implications for the trade unions of the changes in post-war Britain, it appears to have lost much of the value which the earlier edition possessed as a stimulus to the fresh thinking about the functions and organization of the trade unions under conditions of full employment. Such issues as the 'closed shop', the unofficial strike, the problems presented by the nationalized industries and the appropriateness of trade-union organization to present-day conditions and their implications, are not brought out in this new edition, which lacks accordingly much of the challenge which the former edition offered.

ROCKET EXPLORATION OF THE UPPER ATMOSPHERE

By Dr. F. E. JONES
Royal Aircraft Establishment, Farnborough

AND

Prof. H. S. W. MASSEY, F.R.S.
University College, London

AT a meeting of the Gassiot Committee of the Royal Society (of which one of us (H. S. W. M.) is chairman and the other a member) held on October 20, 1953, the possible British participation in a programme of observation of conditions in the upper atmosphere by means of rockets was considered. It was concluded that a British programme would be worth while and possible if support were forthcoming from the Ministry of Supply, and in particular the Royal Aircraft Establishment, which would be required to design a suitable rocket and provide firing facilities.

Details of a possible collaboration between the Gassiot Committee and the Royal Aircraft Establishment were discussed at Farnborough on January 29, 1954, and, as a result, the agreement in principle of the then Minister of Supply, Mr. Duncan Sandys, was obtained in March 1954. The final recommendations of the Gassiot Committee were endorsed by the Council of the Royal Society in November 1954, and the participation of the Royal Aircraft Establishment in the experiment was put on a firm footing as a result of the exchange of letters between Sir David Brunt, secretary of the Royal Society, and Sir Owen Wansbrough-Jones, chief scientist, Ministry of Supply, during the period November 1954–February 1955. Treasury support to the extent of £100,000 spread over four years was agreed on June 29, 1955, to be divided into £50,000 to cover the design and provision of rocket vehicles by the Royal Aircraft Establishment and £50,000 to be made available to the Gassiot Committee, through the normal Air Ministry channel, to cover the cost of the experimental investigations. Some details of the arrangements were released to the popular press in August last. The present article gives details of the rocket, now known as the 'Gassiot vehicle', and an outline of the initial experiments to be undertaken with it.

In designing the rocket vehicle, the considerations of ease of manufacture, preparation for firing and total cost per flight have been kept very much in mind. From these considerations the design has been centred on a single-stage uncontrolled rocket propelled by a solid-fuel motor, the problem being to achieve great height at reasonable cost. The advantages of releasing the rocket from a balloon, in a similar manner to the American 'Rockoon', have been considered; but it was concluded that by suitable choice of motor burning-time the loss in performance due to aerodynamic drag in the lower atmosphere could be considerably reduced and the additional expense and complication of a balloon launch avoided. In addition, a delay of half an hour or more required for a balloon to reach altitude before firing the rocket would not be acceptable in some experiments.

Much in the way of final performance of the rocket depends on the burning-time of the motor. A fast-burning motor produces high velocities in the lower atmosphere with resultant excessive drag. A slow-burning motor usually means a reduction of specific impulse and, because of the lower accelerations involved, the dispersion problems in an uncontrolled vehicle increase. The optimum burning-time seems to lie in the region of 30 sec. and this is the value chosen for the Gassiot vehicle.

The outline design of the rocket is shown in Fig. 1. The fins are of an existing design and later versions will not have swept trailing edges. The nose cone, which will house the instrumentation, is made of 14-gauge steel with provision for jettisoning the forward portion at the 10-in. diameter region. Just aft of the nose cone is a portion of the body which houses the telemetry, ancillary instrumentation and power supplies. The total weight of the rocket at launch will be just over 2,500 lb., by far the greater portion of which is fuel. The total payload made up of instrumentation and telemetry equipment for a height of 550,000 ft. is 150 lb.

The launcher is illustrated in Fig. 2. The structure consists of a vertical 'boom'—the launch way—supported at approximately its mid-point in a gymbal system, the gymbal framework forming the apex of a large tripod. The launching angle is variable through ±10° in azimuth and from 75° to 95° in

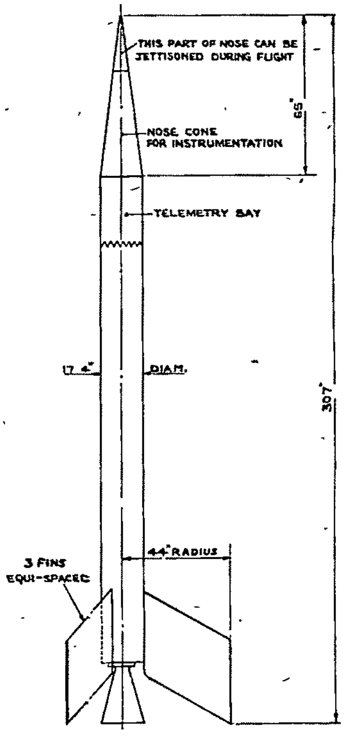

THIS PART OF NOSE CAN BE JETTISONED DURING FLIGHT
NOSE CONE FOR INSTRUMENTATION
65"
TELEMETRY BAY
17.4"
DIAM.
307"
44" RADIUS
3 FINS EQUI-SPACED

Fig. 1. Gassiot rocket vehicle

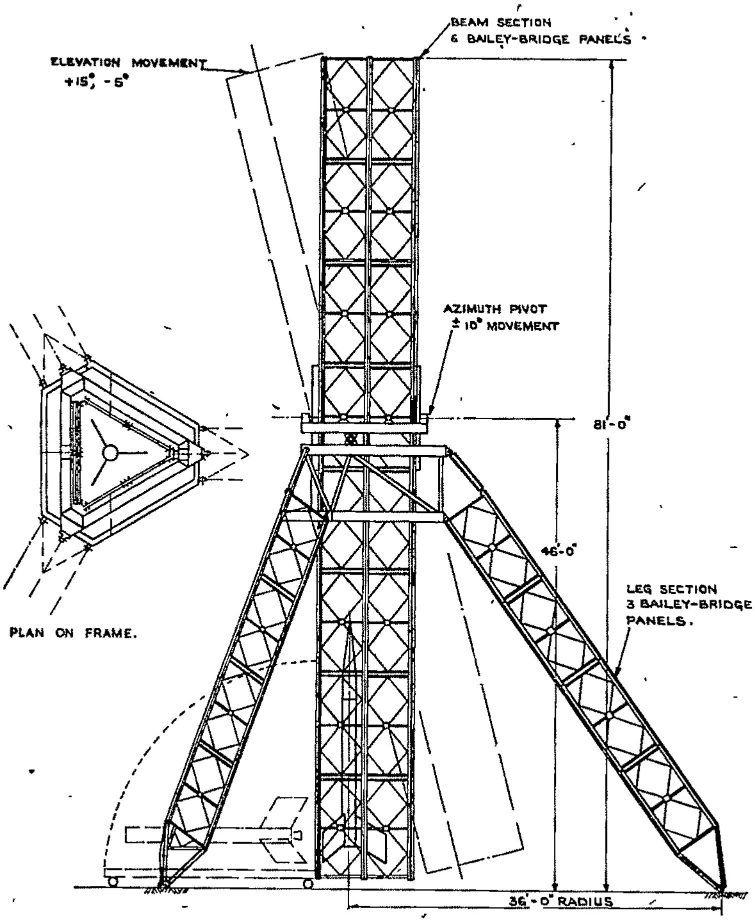


Fig. 2. Launcher. Approximate weight of structure is 35 tons; the three legs equally spaced

elevation, thus allowing for a variety of wind conditions. The launcher is 81 ft. high, stands on a 72-ft. diameter base and weighs about 35 tons. It is designed to fire either the British Gassiot vehicle described above or the American 'Aerobee' rocket without change.

Figs. 3, 4, 5 and 6 give the main performance characteristics of the rocket. Fig. 3 gives the velocity–time and height–time performance curves; Fig. 4 the height–range curves for various launch trajectories; Fig. 5 the acceleration–time curve for vertical flight and Fig. 6 the maximum height reached as a function of payload. From the curves it is seen that a height of about 550,000 ft. will be reached with a payload of 150 lb. Later versions of the rocket should reach about 700,000 ft.

The vehicle is uncontrolled, and consequently dispersion is largely an unknown factor. For this reason arrangements are being made with the Australian Government for the initial firings to take place at the Woomera Range in Australia. A launcher is due to be shipped there this spring to enable experimental firings to be done in the September–October period of 1956. It is hoped to undertake firings both at Woomera and in the United Kingdom during the International Geophysical Year (1957–58). If these tests show that the dispersion is excessive, a boost to increase the velocity at launch or a small rocket motor to produce rolling for the first 5 sec. of flight will be introduced.

The actual upper-atmosphere experiments are being designed and the flight instrumentation made by a number of university departments and by the Royal Aircraft Establishment under the general guidance of the Gassiot Committee. University College, London (Prof. H. S. W. Massey, Dr. R. L. F. Boyd), are to measure wind, temperature and pressure by the grenade method. In this experiment observations are made at a number of points on the ground of a series of grenades fired from the rocket at approximately equal intervals along the trajectory. In addition, University College, London, also plans to fly a mass spectrometer for ion sampling. The University of Birmingham (Prof. J. Sayers) is to make a study of ionospheric conductivity and relative concentration of electrons to negative ions by a sampling ionization chamber fitted with a pulse method of distinguishing between ions and electrons. The Queen's University of Belfast (Prof. D. R. Bates) is to make measurements with photoelectric photometers and filters to study the relative intensities of certain spectral lines of molecular oxygen and the altitude of the night airglow in the regions of the oxygen green line and the Meinel OH bands; it is also planned to study the emissions resulting from the

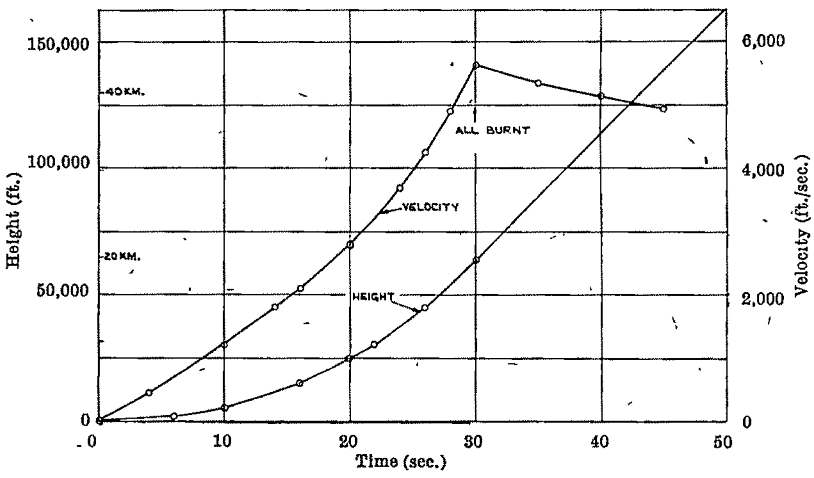


Fig. 3. Velocity–time and height–time performance curves

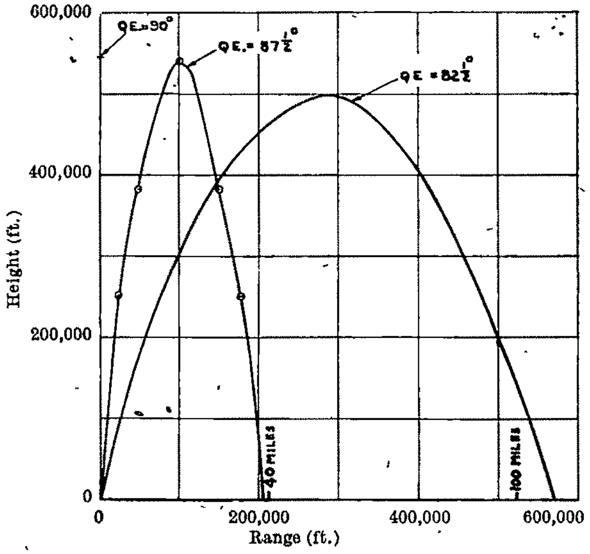


Fig. 4. Height–range curves

release of sodium and potassium vapour at high altitudes. University College, Swansea (Dr. W. J. G. Beynon), is working on two methods—continuous-wave Doppler and the pulse method—of measuring electron densities in the ionosphere and is correlating these simultaneously with measurements made from the ground. The Royal Aircraft Establishment is planning to measure skin temperature and altitude of the rocket and is also studying the design of a sun-seeker for carriage in the rocket. The sun-seeker would be used for measurements of solar radiations and for obtaining ultra-violet pictures of the sun at high altitude.

The rate of progress in the design and construction of the various instruments is such that there is every likelihood of a number of measurements being made during the International Geophysical Year.

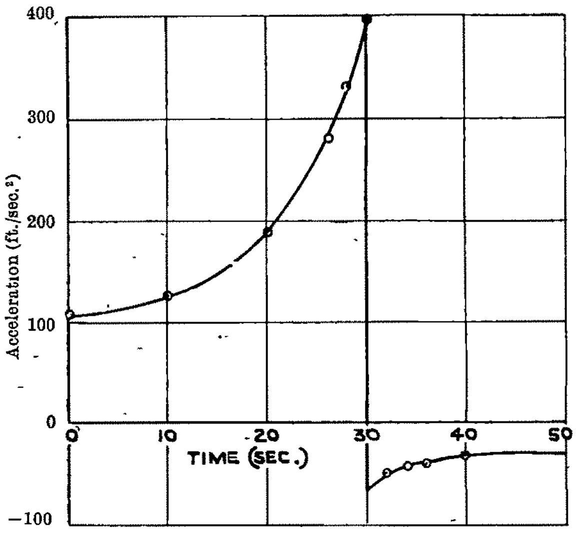


Fig. 5. Acceleration–time curve for vertical flight The final deceleration is 1*g*

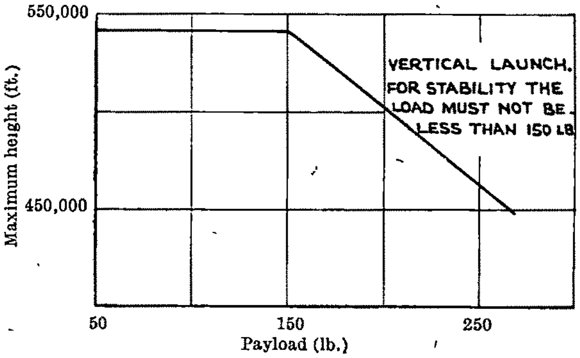


Fig. 6. Maximum height as a function of payload

Acknowledgment is made to the Controller of H.M. Stationery Office for permission to publish the illustrations.

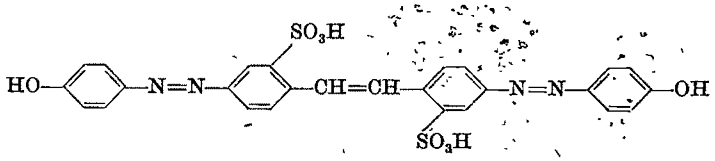
RECENT ADVANCES IN THE CHEMISTRY OF COLOURING MATTERS

ON February 2, the Chemical Society held a symposium in London on "Recent Advances in the Chemistry of Colouring Matters". This was organized by Prof. E. A. Braude (Imperial College of Science and Technology, London) and held in the Royal Institution. Prof. W. Wardlaw, president of the Society, opened the proceedings. He reminded those present that this year marks the centenary of the discovery by W. H. Perkin of the very first synthetic dyestuff, mauve. He quoted Sir Robert Robinson to the effect that the discovery itself had little scientific importance : what was important was the fact that Perkin embarked upon its manufacture, which he achieved, and he thus became founder of the coal-tar dyestuffs industry.

Dr. R. P. Linstead (vice-president of the Society) took the chair for the afternoon session. The following papers were read : "Steric Effects in Azo and Indigoid Dyes", by W. R. Brode (U.S. Bureau of Standards, Washington) ; "*Cis-trans* Isomerism in Azo-dyestuffs", by R. H. Peters and E. Atherton (Manchester College of Technology) ; and "Synthesis of Azaporphins and Related Macrocycles", by J. A. Elvidge (Imperial College).

Dr. Brode gave evidence that there is no selective adsorption of certain optically active dyes on asymmetric fibres such as wool, silk or cotton. However, with simpler compounds, for example, *m*-nitromandelic acid, there is selective adsorption of one of the optical forms. It appears that the resonance centre of the dye molecule is more important for adsorption than an asymmetric centre, particularly in the absence of conjugative coupling between the two.

Dr. Brode then described *cis-trans*-isomerization effects in dyestuffs. Changes in light absorption on irradiation can be correlated with *trans* to *cis* isomerization about azo-links. *Ortho* substituents



(I) Chrysophenine *G*

inhibit this phototropism, as also can hydroxylic solvents by a hydrogen-bonding effect. Studies have also been made on bis-azo dyes in order to determine the extent of resonance interaction between the two chromophoric centres. Where the chromophoric systems are insulated sterically or by methylene groups, the property of direct dyeing of cotton is lost. For dyes of this class which show phototropism, only *cis*- and *trans*-modifications are apparent in solution and the spectral curves show isosbestic points. When there is conjugative coupling between the chromophoric systems, an isosbestic line is found, because of the possible existence of an intermediate *cis-trans*-chromophoric system.

The bis-azo stilbene dye, chrysophenine *G* (I), shows phototropism in aqueous solution, but this is restricted to intensity, rather than colour, changes. The two azo-benzenoid chromophores are electronically connected and the dye is substantive, even though the sulphonic acid groups *ortho* to the stilbene ethylenic linkage prevent coplanarity in the molecule.

The absence of phototropism in indigo can be attributed to strong hydrogen-bonding. There is none in NN′-diacetylindigo or -dimethylindigo, and these derivatives show phototropic inversion, as also does thioindigo in neutral solution.

Lastly, Dr. Brode described association effects. Whereas mixtures of brilliant yellow and guinea green show summation spectra, brilliant yellow and genacryl pink do not because of association. Optical bleaching agents, which in effect are colourless dyes, may also associate with dyestuffs and thereby affect their colour. The prevention of association by heat, powerful solvents and dispersoids has been studied, particularly for the system chrysophenine *G*–sky blue *FF*. Here, irradiation also causes a change toward the summation spectrum, apparently because of inversion of chrysophenine *G* into its *cis*-form, which does not associate with sky blue *FF*. The association of dyes appears to be an adhesion of strongly charged resonance structures, probably closely akin to the adhesion to fibres, which are isoelectric charged materials. In each case, the distortion of the resonance system, consequent upon the adsorption, could account for the slight change in absorption spectrum.

The second paper, read by Prof. Peters, provided evidence that *trans* to *cis* isomerization in azo-dyestuffs is responsible for the fading or change in colour of dyed textiles in light: the *cis*-form would be removed in subsequent washing of the textile, as it is not firmly adsorbed in the fibre. In fading experiments, the rates of destruction of a series of benzene-azo-α-naphthylamines, substituted in the benzene nucleus, were determined. Rate constants for the *cis* to *trans* change of these compounds in the dark were also measured, and the activation energies found to be around 20 Cal. This supports the assumption that the phototropy is the result of inversion of the azodye to the *cis*-form in light.

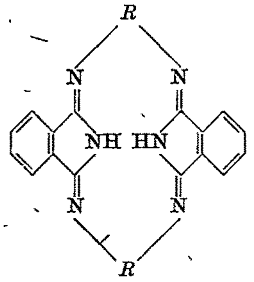
The phototropy of the direct cotton dye, chrysophenine *G*, was also studied. There are three possible centres about which *cis-trans* isomerism can occur, but since the spectra show isosbestic points, only two forms are present in the irradiated solutions. Rates of conversion and activation energies indicate that the transformation involves azo links and not the ethylenic group.

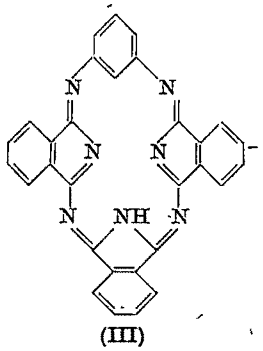
The absorption spectrum of the *cis*-form was determined from the spectrum of a mixture of the two forms by a method involving the dependence of the optical density on wave-length. Also the *trans*-form could be removed from a mixture by chromatography on cellulose powder.

The *cis*-form showed very little substantivity for cellulose fibre. This suggested that the dye needs to be linear and planar, and the latter condition does not hold in the *cis*-form. No *cis*-form was detected in the spectrum of dyed cellulose sheet.

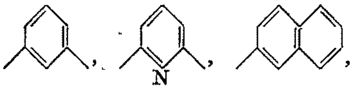
Similar considerations apply to the interaction of chrysophenine *G* with chlorazol sky blue *FF* (Col. Index, 518), which has a linear structure. The spectrum of a solution of a mixture of these dyes departs from additivity. Irradiation causes a change towards the summation spectrum, because doubtless the non-linear and non-planar *cis*-form of chrysophenine *G* is unable to adlineate itself alongside the linear and planar molecule of sky blue. In the dark, the system recovers its original absorption spectrum at a rate equal to the *cis* to *trans* conversion for chrysophenine *G*.

The third paper, on the synthesis of azaporphins and related macrocycles, was given by Dr. Elvidge. The established methods for synthesis of the phthalocyanines have, of course, been extended to the preparation of symmetrically substituted tetrazaporphins, but they are unsuitable for the preparation of unsymmetrical derivatives. In 1950, Prof. R. P. Linstead had suggested the use of imidines as intermediates. The imidines (nitrogen analogues of cyclic anhydrides) are readily obtained from vicinal dinitriles and ammonia. One of their many reactions is ready condensation with amines, and this led to unexpectedly easy syntheses, from phthalic imidine and cyclic-1 : 3-diamines, of cross-conjugated macrocycles (II) with 16-, 20- and 24-atom rings. These compounds are mainly yellow. That with *R* = 2 : 6-pyridyl has a central arrangement akin to that in the azaporphins and, like them, complexes bivalent tetra-co-ordinate metals.





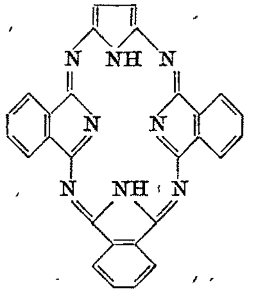
(III)

(II; *R* =  etc.)

Resulting from an attempt to separate the several stages which must be involved in the formation of the macrocycles (II), the red, cross-conjugated macrocycle (III) was obtained. This has, in a sense, three-quarters of the chromophore of phthalocyanine.

Dr. Elvidge then outlined working principles which seem to apply to the *self*-condensation of imidines. A mixture of three molecular proportions of an unsaturated imidine with one of a saturated imidine can give rise directly, by elimination of four molecules of ammonia, to a tetrazaporphin ; other proportions, and self-condensations, can yield tetrazaporphins only through supplementary oxidation-reduction processes and are in general unfavourable.

Interaction of the imidines derived from phthalonitrile and succinonitrile affords tribenzotetrazaporphin (IV), the first unsymmetrically substituted tetrazaporphin to be isolated and fully characterized. This and homologues are of interest for their light absorptions and behaviour on hydrogenation. The tribenzotetrazaporphins can yield comparatively stable dihydro derivatives, like the porphyrins, in contrast to the symmetrically substituted azaporphins, the reduction of which has so far resulted in the isolation only of tetrahydro derivatives.



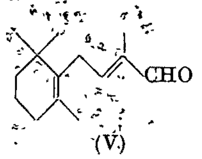
(IV)

By the condensation of a mixture of appropriately substituted imidines, an alkyl substituted tetrazaporphin had been prepared which is at the tetrahydro level : this can only pass to the normal tetrazaporphin 'aromatic' level by the migration of alkyl groups, so that it is ordinarily stable and easy to handle. It was hoped through this and related macrocycles to determine the relative positions of the hydrogen atoms in the tetrahydroazaporphins and thence in those hydroporphyrins which are at the bacteriochlorophyll level.

The afternoon session of the symposium concluded by an open discussion, which lasted some forty-five minutes. One participant, Dr. J. S. Holt (Courtauld Institute of Biochemistry), presented strong evidence for intermolecular, as opposed to intramolecular, hydrogen bonding in indigo.

At 7.30 p.m. Sir Alexander Todd took the chair for the evening session. The papers read were : "Synthetic Carotenoids", by O. Isler, H. Lindlar, M. Montavon, R. Rüegg, G. Saucy and P. Zeller (F. Hoffmann-La Roche and Co., Ltd., Basle), and "Modern Theories of Colour", by M. J. S. Dewar (Queen Mary College, London).

Dr. Isler indicated some carotenoids that his group has synthesized : β-carotene, 7 : 7′-dihydro-β-carotene, lycopene, zeaxanthin, cryptoxanthin, physalien and bixin, and the building principles employed in the manufacturing processes.



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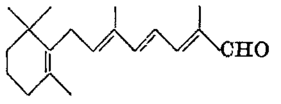

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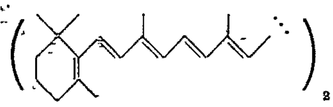


(VII)

β-Carotene is being produced—in ton quantities—starting from β-ionone. This is converted to the C_{14} aldehyde (V) by glycidic ester synthesis and treatment with alkali. The carbon chain is then lengthened by the reaction of the acetal of (V) with ethyl vinyl ether. Treatment of the product with acetic acid gives the crystalline C_{16} aldehyde, which is then converted to the C_{19} aldehyde (VI) by similar steps involving ethyl propenyl ether. Two molecules of C_{19} aldehyde are condensed with acetylene *via* its Grignard or lithium derivative, and the resulting C_{40} diol is treated with alcoholic hydrogen chloride to cause allylic rearrangement and dehydration. The 15 : 15′-dehydro-β-carotene (VII) crystallizes out well and is easily separated from all by-products. Catalytic hydrogenation with Lindlar's catalyst and isomerization at 30° (both with the crystalline carotenoids in suspension in petroleum) complete the synthesis of β-carotene.

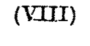
From the C_{40} diol with lithium aluminium hydride (an application of the Nayler–Whiting reaction) crystalline 7 : 7′-dihydro-β-carotene is obtained in more than 80 per cent yield.

Dr. Isler then outlined syntheses of zeaxanthin and physalien, which can be achieved on similar lines to that of β-carotene Several alternative routes to β-carotene were also described.

In a synthesis of lycopene, use was made of the Wittig reaction. Geranyl bromide, from linalool, is added to triphenylphosphine, and the phosphonium bromide converted with phenyl lithium to geranylidenetriphenylphosphine, which is condensed with crocetindialdehyde to yield crystalline lycopene. The crocetindialdehyde is obtained by starting from acetylene and α-methacraldehyde, which yield a C_{10} dialdehyde. Chains are added at each end with ethyl vinyl ether and then ethyl propenyl ether, via the aldehyde acetals, and the final step is semi-hydrogenation of the central triple bond of the C_{20} dialdehyde to yield crocetindialdehyde.

Dr. Isler concluded with a tribute to his team in Basle, and he quoted Sir Ian Heilbron to the effect that with the overcoming of the major synthetical problems of carotenoid chemistry, it should now be the turn of the biochemist to help uncover the role of the carotenoids in the living cell.

Prof. Dewar began by illustrating how ideas of quantum theory provide a qualitative understanding of the relation between colour and constitution. A molecule such as that of hydrol blue (VIII), for which two classical structures of identical energy can be written, will be a hybrid or superposition of these structures. Its wave-function, ψ, will be a combination of those (φ_1 and φ_2) of the individual structures,



(VIII)

and two values can be derived, one ($\psi_1 = \varphi_1 + \varphi_2$) representing a ground-state of lower energy than either interacting structure alone, and a second ($\psi_2 = \varphi_1 - \varphi_2$) of higher energy. The molecule will, of course, normally exist in the ground-state, but may be excited to the higher one by absorption of light of appropriate frequency. Where two possible classical structures for a molecule differ in energy, the energy difference between ground- and excited-states becomes greater, and such a dye will absorb at a shorter wave-length than otherwise.

These ideas have been successfully extended to the cyanine dyes, which can be represented as $\overset{+}{A}.\text{—}B \longleftrightarrow A\text{—}.\overset{+}{B}$. The more chemically similar the end groups *A* and *B* are, the less will the position of the absorption band deviate from the mean position of those for the two symmetrical dyes *A*—*A* and *B*—*B*. The Brooker deviation series provides a striking confirmation.

Prof. Dewar also mentioned how these ideas explain the solvent effect on the position of absorption bands. There is nevertheless a flaw in the treatment, because interaction of pairs of classical structures can only take place through a series of intermediate structures. Analysis of the resonance between the complete set of structures is mathematically very difficult; but calculations have been done and they justify the conclusions of the simpler treatment. Easier to apply is the molecular orbital method, which has met with considerable success in accounting quantitatively rather than qualitatively for the colour of cyanine and other cationic or anionic dyes. Prof. Dewar elaborated the 'free electron molecular orbital' approach, pointed out its limitations and successes, and went on to describe the 'perturbation molecular orbital' method. This is capable of accounting quantitatively for the light absorptions of aromatic hydrocarbons, as well as of cyanines, and related basic, acidic and azo dyes.

The relation between colour and constitution for the vat dyes, however, is much more difficult to interpret and possibly requires the development of more precise theoretical methods.

The papers of the symposium, with bibliographies, will be published by the Chemical Society, London, in *Special Publication* No. 4; this will include an account of the discussions, which were tape-recorded.

J. A. Elvidge

OBITUARIES

Dr. H. E. Woodman

Herbert Ernest Woodman died on February 13 at the age of sixty-six. He had been on the staff of the School of Agriculture at Cambridge for thirty-six years and was well known to generations of undergraduates. He was a leading authority on animal nutrition in Great Britain.

After graduating at the University of Leeds, he spent another year working under Prof. J. B. Cohen in the Chemistry Department there. He was then awarded an 1851 Exhibition and spent two years at Göttingen under Prof. O. Wallach, working on the terpenes, and he received the degree of Ph.D. in 1914. Later that year he joined the Animal Nutrition Research Institute, then at Leeds. He was awarded the D.Sc. degree of Leeds in 1921. Woodman at first worked with C. Crowther on the nitrogen metabolism of the dairy cow, and later with H. W. Dudley on the origin of the proteins in milk. This work established the identity of euglobulin and pseudoglobulin, whether from serum or colostrum, but showed that lactalbumin and serum albumin were two distinct proteins. When the Institute was transferred to Cambridge in 1920, Woodman went with it. He was appointed University demonstrator in October 1926, University lecturer in October 1930, and reader in animal nutrition in 1950.

In the early 'twenties, ensilage was rapidly gaining adherents in Britain, but there was a complete lack of knowledge of the magnitude and nature of the chemical changes occurring in the silo. Woodman, therefore, in conjunction with A. Amos, carried out a detailed and systematic investigation of the conditions responsible for the production of different types of silage and devised methods of analysis that are still in common use. The results were published in the form of a bulletin ("Ensilage", Bull. 37, Ministry of Agriculture), which was revised periodically by Woodman, and proved a great boon to the practical farmer as well as to the teacher.

In 1925, Woodman, with the encouragement of Prof. T. B. Wood, gathered together a team of young scientists to secure information concerning the nutritive value of pastures. This work continued over a period of twelve years and became a classic. It involved the determination of yield of dry matter, chemical composition, digestibility for sheep and pigs and the starch equivalent and protein equivalent per acre when the pasture was subjected to varying systems of management. A noteworthy finding was that young grass is a protein-rich concentrate, comparable in some respects with linseed cake. Living in Cambridge, with its lawns and playing fields, Woodman was attracted by the idea and possibility of the preservation of young grass for winter feeding by artificial drying. He carried out pioneer work in this field, and the present flourishing crop-drying industry is a tribute to this early work. Afterwards, investigations were made into the effect of management on the nutritive value of other forage crops like lucerne and kale. This information proved of inestimable value during the war years.

Woodman was the author of about 170 scientific papers covering a wide range of subjects. He made a valuable contribution to our knowledge of such diverse subjects as sheep nutrition, the nutritive value of sugar beet by-products and the mechanism of cellulose digestion in the ruminant.

In 1930 Woodman and I published our first joint paper, the forerunner of many more, during a close research partnership that lasted more than twenty-five years. In 1936, the first of a series of eighteen papers on the nutrition of the bacon pig appeared. Great stress was laid in this paper on experimental technique and the importance of designing an experiment so that the results could be analysed statistically. It was shown that an individual-feeding trial could be four times as accurate as a corresponding group-feeding trial. The question of the protein requirements of pigs received early consideration. It was demonstrated that equally good results could be obtained, from the point of view of growth, economy of food conversion and carcass quality, when all-meal rations supplying only 7 per cent of white-fish meal were fed, as with diets much richer in protein. Moreover, it was shown that if the protein-rich concentrate was omitted altogether from the diet after 90 lb. live-weight, it was without the slightest effect on the rate of live-weight gain or on the leanness of the carcass. Considerable economies were therefore possible in the use of white-fish meal, which proved of great importance when supplies were short. The replacement of animal protein by vegetable protein plus minerals was also investigated.

On the death of Prof. T. B. Wood in 1930, Woodman became responsible for the sixth edition of "Rations for Livestock", the best-seller among the *Bulletins* of the Ministry of Agriculture. It became imperative in 1948 that the *Bulletin* should be almost entirely rewritten, and from this date Woodman assumed full responsibility as author. Woodman was also the author of the other bulletins—"Home Grown Feeding Stuffs" and "The Use of Oil Cakes and Extracted Meals"—which have lately been out of print. Finally, mention should be made of his contributions to *Agriculture*, during the War, of "Notes on Feeding Stuffs", which gave the results of research work at Cambridge and elsewhere, and were greatly appreciated by farmers and others.

No account of the work of Woodman would be complete without reference to his ability as a teacher. His great joy in life was in lecturing to the degree class at Cambridge. He was a born teacher and took infinite pains in the presentation of the material and had the gift of making a difficult subject seem easy.

He leaves a widow, a son and daughter, and a grandson.

R. E. EVANS

Dr. H. Wormald

HARRY WORMALD, who died at his Maidstone home on December 10 last at the age of seventy-six, was distinguished for his pioneer work, over the past forty-five years, on the pathology of fruits and hops, and more particularly for his original researches on the two important groups of diseases, brown rot (*Sclerotinia* spp.) and bacterial canker (*Pseudomonas mors-prunorum* and *Ps. prunicola* Worm.), in both of which fields he became an authority of international repute.

Born a Yorkshireman, he first trained as a schoolteacher and for eight years taught a general curriculum in schools in Bradford and Leeds. It was therefore not until he was thirty years of age, in 1908, that with a Board of Education scholarship he went to London to read botany at the Royal College of Science (Imperial College of Science and Technology) under Prof. J. B. Farmer. Three years later he gained his A.R.C.S. and also the B.Sc. degree of the University of London with honours; and after a further year of research at the Royal College of Science, when he was awarded the diploma of the College, he went in 1911 to Wye College in Kent (University of London) as assistant in the Botany (Mycology) Department under E. S. Salmon. The dominating interest in fungal and bacterial diseases of fruits and hops which Wormald developed at Wye is reflected in the award of the D.Sc. degree in 1919 for his early publications on brown rot, and in his transfer in 1923 to the then young East Malling Research Station as the first head of its Plant Pathology Section. There he worked for twenty-two years under the inspiring directorship of R. G. Hatton, and as the beloved chief and mentor of a long succession of postgraduate students and colleagues. It was at East Malling that Wormald consolidated his early work on the brown rot and crown gall diseases, and initiated the brilliantly original etiological studies on the bacterial canker diseases of the stone fruits.

In 1936 Wormald was appointed assistant director at East Malling, and for ten years, from 1935, he edited the Station's Annual Report. In 1940 he became president of the British Mycological Society and was joint editor of the *Transactions* of that Society during 1931–45. He also served as a member of the Council of the Association of Applied Biologists (1937–39) and as a vice-president (1938–39).

In 1945, in his sixty-sixth year, Wormald finally retired from East Malling, and in the same year joined the staff of the Commonwealth Bureau of Horticulture and Plantation Crops, stationed at East Malling, where for seven years he exercised his linguistic gifts (he could translate fluently from seven languages, including Russian) as an abstractor of world horticultural literature.

In 1952, at the age of seventy-three, Wormald was obliged to retire from the Bureau because of the illness to which three years later he was to succumb, only, however, to continue at home, with the quiet and patient tenacity of purpose which characterized his whole research career, the preparation of new editions of his two principal works, the monograph "The Brown Rot Diseases of Fruit Trees" (Ministry of Agriculture and Fisheries), and the standard text-book on his subject, embracing the impressive corpus of his original research papers, "The Diseases of Fruits and Hops" (Crosby Lockwood and Son, Ltd.). With the devoted and unflagging support of his wife, these immense tasks were brought to a successful conclusion, and within six months of the publication of the new edition of his text-book he died.

R. V. HARRIS

Mr. F. W. K. Gervers

FRANK WALTER KITCHENER GERVERS was born on April 17, 1920. He went to school at Bradfield, where he became an enthusiastic member of the School Natural History Society and published a paper of unusual quality for a schoolboy on the biology of a small stream. When he left school in 1939 he followed a family tradition and joined the Regular Army. He served in the Royal Artillery in North Africa, Italy and India; but his active military career was terminated by ill-health in 1946 and he decided to resume his interest in biology.

Gervers went to the University of Glasgow and during vacations worked in the laboratories at Pitlochry, Aberdeen and Lowestoft, and went to sea on the research vessels. After graduating he worked for a year with Dr. H. D. Slack on the biology of Loch Lomond, studying particularly the white fish or powan found there. In 1953, he joined the fresh-water fisheries staff of the Ministry of Agriculture and Fisheries and carried out a most useful study of the food of coarse fish. He also took a large part in the work on the migration of sea trout and had begun an investigation into racial characteristics of salmon. His death on the last day of October 1955 deprived all who knew him of a much-valued friend and cut short a scientific career of great promise. He left a widow and two small children to whom he was devoted, and we extend our deepest sympathy to them.

F. T. K. Pentelow

[A communication of which he was part-author appears on p. 664 of this issue of *Nature*.]

NEWS and VIEWS

Refractories Technology at Sheffield :
Prof. J. White

The firm of J. and J. Dyson, Ltd., of Stannington, manufacturers of refractory materials, has given £15,000 to the University of Sheffield for the establishment of a chair in refractories technology, which the University has named the Dyson chair of refractories technology, and Dr. James White, reader in ceramics in the University, has been appointed the first holder. After graduating in physical chemistry from the University of Glasgow in 1931, Dr. White did metallurgical research at the Royal Technical College, Glasgow, and later became lecturer in metallurgy there. In 1939 he was awarded the Carnegie Gold Medal of the Iron and Steel Institute. He left the College in 1943 to become head of research of General Refractories, Ltd., and three years later went to the University of Sheffield as senior lecturer in refractory materials, being appointed reader in ceramics in 1952. Dr. White has published a large number of research papers and is a recognized authority on the chemistry of ceramics and refractory materials. The creation of the new chair, which is the first such one to be established in Great Britain, and of a separate department specializing in the subject, should do much to further the advancement of knowledge in a field of great importance to the steel industry of Britain, and especially the industries of the Sheffield district.

Botanical Survey of India :
Dr. G. S. Puri

Dr. G. S. Puri, formerly ecologist at the Forest Research Institute, Dehra Dun, has been appointed regional botanist-in-charge of the northern circle of the Botanical Survey of India. In 1938 he came under the influence of Dr. R. R. Stewart and joined him in the explorations of the Kashmir, Hazara and Murree Hills, and collected extensively. In 1940, at the invitation of Prof. B. Sahni, he joined the Botanical Department of the University of Lucknow and worked on the flora of the Karewa formations of Kashmir, for which he was awarded the Ruchi Ram Sahni Prize for the best research in the University. He has conducted extensive geological and botanical explorations in the Kashmir Himalayas and discovered fossiliferous strata. During 1942–45 he worked on the correlation of oil-bearing strata in the Assam Tertiaries by micro-fossils for the Burmah Oil Co., Ltd., a pioneer work in India. In 1945 he was selected by the Government of India for training abroad in ecology and systematic botany and worked in the University of London under Prof. W. H. Pearsall. He is secretary of the Indian Council of Ecological Research and the Society of Tropical Ecology.

Research at Fort Dunlop, Birmingham :
Mr. E. A. Murphy

Mr. E. A. Murphy, general development manager at the Research Centre, Fort Dunlop, Birmingham, has been appointed director of research in charge of the central research division of the Dunlop organization. Mr. Murphy, who, for his services to the rubber industry, has been awarded the Colwyn Medal by the Institution of the Rubber Industry, joined the Dunlop chemical laboratories during the First World War. One of the activities of the general development division set up under him during the Second World War was the investigation of synthetic rubber manufacture. A pilot plant was then started and this led to the designing of the experimental plant for synthetic rubber production now being erected at the Research Centre, which has enabled Dunlop to take the leading part in the project for the large-scale manufacture of synthetic rubber in Britain by the recently formed International Synthetic Rubber Company.

Government Pressures on the Press

The International Press Institute, Zurich, has published as Survey No. 4 a study on "Government Pressures on the Press", which displays clearly but objectively the gravity of attacks that have been made on the freedom of the Press, even outside the totalitarian States, and the dependence of effective defence against such attacks upon an informed public opinion. The reasons which may lead even a liberal-minded government to desire the Press to exercise some restraint on publication are fairly indicated; it is emphasized that the Press is not above the law and that, although ideally the freedom of the Press should be complete, in practice this has to be qualified, nor can governments be indicted for not tolerating attacks which might endanger their existence. The first part of the study analyses pressures based on the law, the second those of an economic, administrative or purely political nature, and the third part in particular shows that the scientific and technical Press is no more immune from such pressures than the newspapers. The Institute is particularly concerned about the situation in South Africa, and especially because of the public apathy to successive government enactments during the past five years which have made the position of the Press there most precarious. In Australia and in India there are restrictive laws which are potentially dangerous; though they are not likely to be so applied by present or viable governments. The value of the study lies in the assembly of a large amount of factual material in convenient form and in indicating the nature and causes of the present threats to freedom of the Press. By and large, they arise less from the spread of illiberalism than from the growth of government and the domain of official policy in a divided and uneasy world.

National Research Development Corporation of India : Report for 1954–55

The National Research Development Corporation of India was registered on December 31, 1953, its main function being to stimulate the development of patents and inventions arising out of researches conducted in research institutions financed out of public funds and, where feasible in the public interest, of patented inventions from individuals also. The Corporation has an authorized capital of Rs. 1 crore, and the late Sir Shanti Bhatnagar was an original member of its board of seven directors, of whom S. K. Lalbhai is chairman. Its first annual report (pp. 17; from the Corporation, New Delhi), to which are appended the statement of accounts and the objects of the Corporation as set forth in the articles of association, covers the period ended March 31, 1955, a period in which 177 inventions from twenty-four institutions and eight private individuals were reported for development. Trials have been arranged of a process for the manufacture of paper from wattle-wood, and negotiations were in progress for trials of processes for the manufacture of newsprint and cheap printing-paper from bamboo and for the de-ionization of cane-sugar; licences have also been negotiated for ten other processes. Processes for the manufacture of writing and printing paper from bagasse, for the recovery of nickel and fat from spent hydrogenation catalyst of vanaspati (vegetable oil) factories and for myrobalan extract in the myrobing of East Indian tannage of skins and kips have been made available to industry without any conditions regarding payment of royalties, and 62 processes are under critical examination. Normally the Corporation proposes to take 30 per cent of the gross earnings from premiums and royalties and pay 70 per cent to the research institutions.

Technical Education in Britain

In reply to questions in the House of Commons on March 20, the Secretary of State for Scotland said that in central institutions in Scotland there are about five hundred full-time and a thousand part-time teachers of technical subjects, of whom some three hundred full-time and twenty part-time teachers are doing work of approximately university level; and in other institutions of further education there are 650 full-time and 5,100 part-time teachers of technical subjects. Education authority projects in preparation include local technical colleges at Aberdeen, Dundee, Kilmarnock, Clydebank, Inverness, Motherwell and Bathgate, and three at Edinburgh; a schedule of accommodation has been approved for local technical colleges at Ayr and Falkirk, and projects which have been started include a local technical college at Paisley, Lauder Technical College, Dunfermline, Stow College of Printing, Glasgow, and Lees Castle College, Ross and Cromarty. Projects at central technical institutions expected to start in the next two years include internal adaptations and new premises for the School of Navigation at the Royal Technical College, Glasgow, and extensions to Paisley Technical College, to the Pharmacy Department of Heriot-Watt College, Edinburgh, and to Robert Gordon's Technical College, Aberdeen.

Society for Analytical Chemistry

The eighty-second annual general meeting of the Society for Analytical Chemistry was held in London on February 29, when the financial statement and the report of the Council for the past year were submitted and approved. The membership of the Society was reported as 1,842, an increase of 43 since last year. During the year the Society organized six ordinary meetings in London (three of which were organized by the Society's subject groups), and the first joint meeting with the Association of Public Analysts was held in Cardiff; in addition, the Society's Sections and Groups held thirty-seven meetings. A special meeting was held in London on November 29, when Prof. J. Heyrovský, an honorary member of the Society, gave a lecture entitled "The Development of Polarographic Analysis". The following officers and members of Council were elected for the forthcoming year: *President*, K. A. Williams; *Past Presidents serving on the Council*, Lewis Eynon, D. W. Kent-Jones, J. R. Nicholls and George Taylor; *Vice-Presidents*, D. C. Garratt, J. Haslam and H. M. N. H. Irving; *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, N. L. Allport; *Honorary Assistant Secretary*, R. E. Stuckey; *Other Members of Council*, S. G. Burgess, R. C. Chirnside, C. H. R. Gentry, W. C. Johnson, D. D. Moir, T. McLachlan, R. F. Milton, Miss Mamie Olliver, F. C. J. Poulton, S. A. Price, A. A. Smales and A. F. Williams; *Ex-officio Members*, J. R. Walmsley (chairman, North of England Section), F. J. Elliott (chairman, Scottish Section), P. J. C. Haywood (chairman, Western Section), J. R. Leech (chairman, Midlands Section), G. F. Hodsman (chairman, Microchemistry Group), J. E. Page (chairman, Physical Methods Group) and K. L. Smith (chairman, Biological Methods Group).

The Relation of Pure to Applied Research in Agriculture

The annual general meeting on February 29 of the Society for Analytical Chemistry was followed by the Bernard Dyer Memorial Lecture, which this year was given by Sir William Slater, secretary of the Agricultural Research Council, his subject being entitled "The Evolution of Agricultural Research". Sir William stressed that agriculture is an industry and that consequently a worker in agricultural research has to combine the qualifications of a scientist with an understanding of farmers and their problems. The growth of research institutes in which pure investigations are possible as well as the development of practical applications, and the academic prestige attached to pure research, have led to a growing tendency for universities to encourage graduates to look to pure rather than to applied research for a career. Since the Second World War the difficulty of recruiting workers to applied research has been augmented by the increasing complexity and cost of the apparatus required for such research. In agriculture there is also the problem of providing facilities for work on farm animals. Nevertheless, pure research has brought about great changes in agricultural practice, and Sir William cited the example of the modern use of hormone weedkillers. New techniques such as the use of radioactive tracers offer possibilities for taking the work further. Sir William pointed out that it is necessary to have an intermediary who can explain to the farmer what the pure research worker has discovered in the laboratory and help in the application of the knowledge on the farm, and for this the National Agricultural Advisory Service has its specialist advisory officers, who work together with the district and county officers. But such men are all too few, and there is a need for a body of similar workers based on the research institutes. Looking into the future, Sir William sees two groups working together in the agricultural research institutes: one going ever deeper into specialized investigations in the laboratory, and the other devoting itself to the immediate solution of the applied problems of the industry and maintaining contact with the Advisory Service and the farmers.

Giornale di Microbiologia: New Italian Journal of Microbiology

THE editorial board of a new Italian journal, the *Giornale di Microbiologia* (edited from the Istituto di Patologia, Via Sant'Andrea delle Dame 8, Napoli; 2,500 lire per vol. for home subscribers, and 3,000 lire for foreign), intends to collect, from the international field, only original papers which have general microbiological importance and which will interest not merely people concerned with curative and preventive medicine, but also biologists and biochemists. Specialization, says the preface to this first issue, increases, but there is also a technical and theoretical integration of the various branches of science, and works of synthesis and analysis are needed more by microbiology than by the older, more precisely delimited, sciences. This first issue begins with a paper by H. Schmidt, of the Behring Institute for Experimental Therapy, Marburg, on the problem of allergy. R. Haas and H. Wolff, of the same Institute, contribute a paper on the culture of three strains of the influenza virus on ferret kidney cells. P. Lépine, of the Pasteur Institute, Paris, writes on vaccination for poliomyelitis. E. Baldacci and A. Grein, of the Institute of Plant Pathology, University of Milan, discuss the form of the spore of *Actinomycetes* as studied by the electron microscope and the classification of the forms seen; this paper is illustrated by remarkable photographs.

T. Scotti and P. Zocchi contribute a paper, also illustrated by photographs, on the structure of the mycelium of *Streptomyces aureofaciens*. R. Tulasne, T. Terranova and J. Lavillaureux, of the Institute of Bacterial Biology of the Faculty of Medicine, Strasbourg, claim that B-vitamins, especially riboflavin, can be used instead of horse serum or ascitic fluid to obtain either L-forms of certain Gram-negative bacteria or stable cultures of L-colonies already formed. A paper by C. Castagnoli, P. Donini and F. Graziosi, of the Institute of Physics and the Microbiological Institute, University of Rome, discusses some biophysical aspects of inactivation of the BM phage through decay of assimilated phosphorus-32. M. Teti, of the Institute of General Pathology, University of Naples, discusses the effects of ultra-violet radiation on a non-inductable lysogenic strain of *Escherichia coli*; and G. Cavallo, of the same Institute, reports on the sensibility to non-ionizing radiation of a temperate phage obtained from a lysogenic strain of *Micrococcus pyogenes*. The issue ends with a paper, illustrated by photographs, by G. A. Maccacaro and A. Angelotti, of the Institute of General Pathology, University of Milan, on their electron microscope study of the filaments of *Escherichia coli*. All the papers have short English summaries. The journal is well printed and attractively produced, its photographic illustrations being particularly commendable.

Radio Noise of Terrestrial Origin: Report of the International Commission

THE eleventh General Assembly of the International Scientific Radio Union was held in The Hague during August 23–September 2, 1954 (see *Nature*, 176, 451; 1955), and Part 4 of the proceedings dealing with the meetings of Commission 4, on Radio Noise of Terrestrial Origin, under the chairmanship of Mr. J. A. Ratcliffe, has now been published (pp. 60; from the General Secretary of the Union, 42 Rue des Minimes, Brussels; 60 Belg. fr., 8*s*. 8*d*., or 1.20 dollars). In accordance with the practice of this Union, the reports of national committees on work related to the Commission are published in full, but reference to the other scientific papers submitted is limited to a list of titles and authors. A paper presented by Mr. Ratcliffe deals with the question: "What are the most easily measured characteristics of Terrestrial Radio Noise from which the interference to different types of communication systems can be determined?" This question, which was discussed at a joint meeting with Commission 6, on Radio Astronomy, defines the scope of an investigation of great scientific and practical importance; and a working party was set up to examine the problem in more detail. Some of the recommendations made at the Assembly contain suggestions for continuing research on atmospherics during the forthcoming International Geophysical Year and for the preparation of revised charts showing the general level of atmospheric noise all over the world and its variation with time and season. In view of the great importance of this work to radio communication, the Union maintains close co-operation with the International Radio Consultative Committee in this field.

History of Polish Science

DESPITE the difficulties of finance and printing, the output of scientific books and periodicals in post-war Poland has been remarkably large and the standard of the publications impressively high. Apart from numerous new journals and text-books devoted to advances of modern science, the Polish Academy of Science has brought out during the past few years several new monumental monographs devoted specifically to the history of scientific developments in ancient and modern Poland. The most recent addition to this series is Vol. 2 of the "Studies and Materials from the History of Polish Science" ("Studia i Materjaly z Dziejów Nauki Polskiej". Pp. 881. Warsaw: Polska Akademia Nauk, 1954). Of the eighteen papers which compose this volume, about half are devoted to Polish science of the sixteenth and seventeenth centuries. Three essays deal exclusively with Copernicus (Kopernik) and contain a most interesting and striking analysis of his ideas and their influence on the development of modern physics and mathematics.

Modern Development of Commercial Pesticides

A HANDSOME illustrated brochure, entitled "Fifteen Years of Geigy Pest Control", has been published by the Geigy Co., Ltd., Manchester (pp. 150; n.p.), which gives a clear account of Geigy's work on products for pest control and the way it developed out of mothproofing agents into insecticides, seed disinfectants, timber preservatives, etc. The brochure displays the many purposes for which dichlorodiphenyltrichloroethane and like products are now used and also describes its pharmacology and toxicology, its physics and chemistry, and mode of action. Besides describing these DDT insecticides and their importance, the brochure outlines recent work in this field by the Geigy Co., including that on repellants, the control of resistant flies and mosquitoes, systemic insecticides, selective acaricides, rodenticides, and on weedkillers such as 'Gesin' and the parathion preparation 'Etilon' which originated outside Geigy's laboratories. This part of the brochure is provided with a good bibliography and will be highly useful to the technical worker. The part describing the development of such products, including the experimental farm at Pfeffingen, and their marketing is of more general interest. The brochure as a whole gives an impressive picture of the way in which these products have been intensively developed in little more than a decade.

Physical Society's Exhibition

The Physical Society's annual Exhibition of Scientific Instruments and Apparatus will be held in the Old and New Halls of the Royal Horticultural Society, London, S.W.1, on the following dates: May 14, 10.30 a.m.–8 p.m. (members and Press only, 10.30 a.m.–2 p.m.); May 15 and 16, 10 a.m.–8 p.m.; May 17, 10 a.m.–5 p.m. The size of the Exhibition is expected to be similar to that of last year, but the use of the Old Hall will give extra space and make for easier access. A greater number of universities, colleges and research organizations will be taking part this year, thus increasing the proportion of purely research exhibits. The discourses this year will be as follows (each one at 6.15 p.m.): May 14, "Recent Developments in Light Sources", by Mr. H. G. Jenkins (Research Laboratories of the General Electric Co., Ltd.); May 15, "The Production of Images of Chemical Molecules", by Prof. H. Lipson (Faculty of Technology, University of Manchester); and May 16, "Colour Television: Considerations which have led to Recent Trends", by Mr. G. G. Gouriet (Research Laboratories of the British Broadcasting Corporation). As in previous years, the Society is publishing a "Handbook of Scientific Instruments and Apparatus" in connexion with the Exhibition (6*s*., or 7*s*. 6*d*. by post). All inquiries should be sent to the Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Announcements

Dr. Paul R. Burkholder, discoverer of the micro-organism that produces the antibiotic chloromycetin, has been appointed director of research at the Brooklyn Botanic Garden, New York. He will take up his new duties on July 1. Dr. Burkholder is at present head of the Department of Bacteriology at the University of Georgia, Athens, Georgia.

Prof. H. C. Longuet-Higgins, Plummer professor of theoretical chemistry in the University of Cambridge, has been appointed Arthur D. Little visiting professor of chemistry in the Massachusetts Institute of Technology. During his three-months stay he will give a series of lectures on the application to chemistry of modern physical theories of atomic and molecular structure. Dr. Edwin H. Land, president of the Polaroid Corporation, has been appointed the first Fellow of the newly established School for Advanced Study at the Massachusetts Institute of Technology. The offices of the Polaroid Corporation are near the Institute, and Dr. Land will give part-time services to the educational and research activities of the Institute.

The National Vegetable Research Station, Wellesbourne, Warwick, is holding its first open day on June 5. Applications for invitations should be sent to the Station.

Two Ramsay Memorial Fellowships, normally tenable for two years and worth £600 a year plus a grant for expenses of research not exceeding £100 a year, are being offered for chemical research. One of the Fellowships will be limited to candidates educated in Glasgow. Full information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom application forms must be sent not later than April 20.

An autumn course in nuclear engineering, for graduates wishing to take up the subject, will be held at Queen Mary College, London, during September 3–October 12. Lectures will be given on nuclear physics, heat transmission, reactor theory, materials for nuclear reactors, instrumentation associated with reactors, health physics, shielding of reactors, reactor design, fuel technology, reactor kinetics and the control of reactors. Application forms, to be completed by June 1, and further information can be obtained from Dr. R. F. Saxe, Queen Mary College, Mile End Road, London, E.1.

The Ninth International Congress of Applied Mechanics will be held in the University of Brussels during September 5–13, under the presidency of Prof. F. van den Dungen, professor of analytical mechanics in the University. The technical sessions of the Congress will be in two sections: fluid dynamics and aerodynamics; and mechanics of solids (rigid dynamics, vibrations, elasticity and plasticity). The official languages of the Congress will be English and French. Those wishing to participate should register before June 30. Application forms and further information can be obtained from the general secretary of the Congress, J. Vandenkerckhove, University, 50 Avenue F.-D. Roosevelt, Brussels.

The Fifteenth International Congress of Pure and Applied Chemistry (Analytical Chemistry) will be held in Lisbon during September 9–16. The following subjects will be considered: microchemical methods, biological methods, electrical methods, optical methods, radiochemical methods, organic complexes, statistical interpretation of results, adsorption and partition methods, general, and standardization of methods and miscellaneous applications. Circulars and entry forms are obtainable from Prof. P. A. Laurent, Instituto Superior Tecnico, Avenida Rovisco Pais, Lisbon, Portugal. British persons wishing to submit papers to the Congress should send summaries, not later than May 1, to the Secretary of the British National Committee for Chemistry, Royal Society, Burlington House, London, W.1.

The Sixth International Spectroscopical Colloquium will be held in Amsterdam during May 14–19 under the auspices of the Koninklijke Nederlandse Chemische Vereniging and of the Nederlandse Natuurkundige Vereniging. Like former colloquia, this one will cover mainly emission spectroscopy (flame photometry, arc spectra, spark spectra and quantometry) and absorption spectroscopy (infrared and Raman spectroscopy; ultra-violet, visible and fluorescence spectroscopy). In addition, there will be a session on instrumentation, and two evenings will be reserved for discussions on such problems as nomenclature, normalization and documentation (the use of punch-cards, etc.). An exhibition of instruments and scientific literature will also be held. Further information can be obtained from the Laboratorium voor Analytische Chemie, 125 Nieuwe Achtergracht, Amsterdam-C4.

RECENT SOVIET RESEARCH ON MICROBIOLOGY IN THE ARCTIC AND OTHER REGIONS

DURING recent years scientists in the U.S.S.R. have given much attention to various problems of research in the North Polar area, including those of microbiology, and this field alone forms the subject of three important articles by Dr. A. E. Kriss (*Vestnik Akad. Nauk SSSR*, No. 8, 22 (1954); No. 1, 30, and No. 9 (1955)). Among previous Russian work referred to is that of B. L. Isachenko 1908–14, recorded in a monograph, "Bacterial Studies in the Northern Arctic Ocean". Dr. Kriss discusses at some length the scientific significance of micro-organisms—their high and varied enzymatic activity (for example, as bio-catalysts in different reactions) in relation both to organic and inorganic constituents of seas and oceans; low forms of vegetation, and other manifestations both on the ocean floor and in the waters above. He describes some bacterial counts at different depths in the Black and Caspian Seas, with tables and illustrations showing varying density of population, at depths down to 2,000 m. or lower. Much of this work, including notes on the Pacific Ocean adjoining the Sea of Okhotsk, is based on earlier studies by M. N. Lebedeva, V. I. Biryuzova, E. A. Rukina, etc. The research is being continued in the Sebastopol and other biological stations.

Seasonal changes and density fluctuations have been studied, with the causes thereof, so far as these can be discovered. Similar work in the United States is criticized as yielding little satisfactory result because the test samples of water were taken directly on the shore (at the end of a pier) and studied by the culture method. Samples, say the Soviet workers, should be obtained at a sufficient distance from dry land and subjected to direct microscopical examination. A table gives comparative figures of bacterial counts per millilitre of water at three stations in the Black Sea at depths down to 2,000 m. as shown by colony counts and by direct microscopy. Vertical distribution and density are also shown diagrammatically for the 'bio-masses' of micro-organisms in the deep-water parts of the Black Sea down to 2,000 m. at five stations (Lebedeva); and in addition in the oxygen zone of the same Sea 30 miles from the shore, winter and summer, down to 200 m. The first of these diagrams shows considerable uniformity down to 2,000 m.; while the second indicates that during the summer there is a relatively large maximum at 25 m., decreasing rapidly to 75 m., after which it is fairly constant; and, for the winter, a similar but smaller decline—from the surface maximum, down to about 50 m., with gradual expansion to the initial maximum down to 150 m., followed by relative constancy to 250 m.

Among the results of these Black Sea and other studies is the evident indication that bacteria constitute the primary organic material and are here associated with phytoplankton. Quantitative determination of the whole mass of micro-organisms gives some idea of the extent of their work in mineralizing dead organic matter. Starting with the fact that one microbial cell requires for its development energy approximately equal to that of the decomposition of organic matter three times exceeding its own weight, it is possible from the magnitude of the bio-mass of micro-organisms to realize in some measure the amount of organic matter in sea-water subjected to mineralization.

But the methods hitherto used for determining bacterial life in marine waters have been unsatisfactory. A new method is described by Dr. Kriss, which, though still imperfect, is claimed to surpass others so far known. The method is related to direct microscopic examination and in essence consists in lowering to various depths microscopic slides that remain in position for a specified period and are then drawn up. After suitable treatment and staining, the number of micro-colonies forming on the slides and the number of cells in each are calculated. In this way, it is possible to estimate the rate of propagation of bacteria in a given stratum of sea-water. (Though Dr. Kriss claims this as a new method, it seems to be akin to the usual technique used by microbiologists; as he admits, it is imperfect, in that it gives preference to organisms that will settle on a glass surface, and neglects those that do not.) Some results obtained by this so-called 'glass overgrowth' method are described, and the significance of the ratio of micro-organism products to their bio-mass is discussed. The need is emphasized for taking into account the widely varying conditions of season and place; for example, as between coastal and open-sea localities and between winter and summer, including also the ocean-bed where accessible. Work in the waters of the Caspian Sea is again cited by way of example of what has been done in the Soviet Union. Among other things, it has been found that about half the microbial cells (Russian *kletka*) found in the sea-bed ooze are absorbed or digested by *Nereis siccinea* during passage of lumps or particles of ooze through the alimentary tract of this worm.

Much yet remains to be done in elucidating the complex relations or links between micro-organisms and phytoplankton or phytobentos (or the corresponding zoo-types); in the study of many biogenic substances in sea-water; in increasing our knowledge of bacterial bio-catalysis; and much else. It is interesting to note that, on the floor of the Black Sea at about maximum depth, considerably more organic material easily assimilable by micro-organisms is found than on the floor of the Okhotsk Sea, the difference between them being of the order of a thousandfold.

The need for better methods of study is again emphasized by Dr. Kriss, and some of the wider aspects of this research are indicated, for example, chemical nature and constitution of sea-water; the physical aspects such as the effect of high pressure or low temperatures, combined with study of the barophyllic organisms; and other departments of science. Recent research in the Pacific at depth, or even on its floor, shows that the barophyllic type may exist in vast quantities. Special forms include those of the hydrogen sulphide depths of the Black Sea that have lately been widely investigated by Soviet workers. Other matters briefly discussed are the effect of sea-water organisms on the corrosion of structural iron and steel and concrete, and the nature and significance of marine microbial biocenoses (biocenogenesis ?).

In his second article, Dr. Kriss deals more specifically with Arctic conditions, and in addition to the earlier work of Isachenko he refers also to that of V. S. Butkevich during 1935 in the high latitudes from 82° 42′ almost to the north pole. No study at depth was undertaken, but only surface layers—presumably of ice or pack-ice. Kriss himself undertook two flights to the polar regions during July and September 1954, to establish the 'drift stations' of which the principal was called North Pole-3. Positions were lat. 88° 04·3′ N., long. 151° 16′ W., and lat. 89° 29·5′ N., long. 65° 43′ W.; the ocean depths were respectively 3,450 and 4,116 m. The July station was on the Pacific side of the Lomonosov submerged ridge, and that of September on the Atlantic side, and were thus of special interest. As already known, this ridge extends from the New Siberia islands through the north polar region to Greenland and Zembla Elsmir. In some parts of the Central Arctic, the height of these submarine mountains is more than 3,000 m.

The microbiological laboratory was set up in the hydrological building (hut or tent). Samples of water and soil were collected through holes in the ice, about 2 m. in diameter, using a special windlass made by the Arctic Institute and water-sampling bottles; also used was a core-sampler or tube designed by Alekseev (of the Arctic Institute) for ooze or mud cores. In July, samples of water were taken from the surface and at eighteen different depths down to 3,400 m. The surface water was obtained by separation near the ice floes. In September, the maximum depth was 3,700 m. In fact, the ocean floor was reached to get the cores.

The treatment of samples, filtering, preparation of cultures are described, and the results tabulated show for July and September 1954, respectively, at various depths down to 3,700 m., the number of colonies (per litre of water) and morphological state. For July, at the surface, there was continuous growth of bacilli (or rod-shaped bacteria), following which at the various depths there was considerable fluctuation in number of colonies: 1,120 at 10 m., 35 at 25 m., 490 at 75 m., 2,660 at 100 m. . . . 210 at 3,000 m., and nil at 3,400 m., in some cases with sporogenetic rods and in others with non-sporing rods (the latter being more frequent). For September, the count at the surface was of 525 colonies, with both sporing and non-sporing rods, cocci and yeasts; at 10 m. 1,995 non-sporing colonies; at 25 m. 2,485 sporing; at 50 m. 350 both sporing and non-sporing; at 150 m. 2,660, 200 m. 3,045, 300 m. 980, all non-sporing; . . . at 3,500 m. 350 sporing; and at 3,700 m. 140 non-sporing. Thus heterotrophic bacteria are found at practically all depths. It is interesting to note that at 750 m. in July the count was 70 and in September nil (the only depth in either month when the result was nil except, of course, at 3,400 m. and lower in July).

The samples of water were poured into sterilized flasks of 250 ml. into which had been previously placed narrow glass slides, and the flasks closed with ground stoppers; they were maintained for about a week at 5–7° C., and afterwards at 18–20° C. Bacterial growths—up to millions—are described; for example, from 350 colonies taken at 3,500 m. depth 5 million colonies resulted in relatively short time.

A second table gives cell counts per ml. at various depths of the north pole region during July and September and, for comparison, figures obtained from eleven out of the twenty-six stations of the north-western Pacific during May–July 1953 at depths down to 9,000 m. (for Station 26). In both cases the maxima this time are at or near the surface (50 m.) and then show a somewhat fluctuating but general decline (down to 3[illegible] counts/ml. at 8,500–9,000 m., Station 26). As might be expected, the Pacific figures are much larger, as a rule, than the north pole ones and are of the order of 100,000 to 400,000 counts/ml. from surface to 50 m. The Pacific stations were about 180–200 miles from the Kurile Islands and Kamchatka.

Methods of calculating the bio-mass content are described in a footnote, and the results given in a third table show average bio-mass of micro-organisms of usual form and cocci form—with thickened coatings—at the different depths down to 3,500 m. in the north polar region during July and September 1954, reckoned in mgm./cu. m. water. The cocci forms are 0·04 mgm. at the maximum depth up to about 0·12 at higher levels. The ordinary forms range from 0·005 mgm. at depth to 2–4 mgm. at or near the surface (0–50 m.). Some differences in form and type of organism are discussed for the north polar region as compared with the Pacific.

In regard to study of the ocean bottom near the north pole, Dr. Kriss observes that the top layer of ooze (0–2 cm.) was separated with all necessary precautions and placed in sterilized test-tubes, from which cultures were prepared, with different nutrients for the various types—inorganic salts with asparagine, calcium citrate, calcium lactate, honey, etc. The organisms included denitrifying and desulphurizing types. Reference is also made to a thionovic or thionic acid type (Russian: *tionovo-kisli*). From weighed portions of ooze suspensions were also prepared in the proportions 1/10, 1/100 and 1/200 in 0·0004 *N* sodium hydroxide spread—for direct microscope study by the Vinogradsk method—on slides to the extent of 6 sq. cm. and suitably treated for separation of the microbial forms. Rates of growth with different nutrients are noted, including also nitrite and nitrate formation, the behaviour of which was specially studied in various media. Reckoned on 1 gm. of natural ooze, microbial counts were 4–304 million for usual cells, and 170–400 million for the thick-walled cocci. Observation of these cultures from the ooze extended over three to five months.

It is thus shown that, close up to the north pole, micro-organisms exist under the perennial pack-ice practically at all levels in the water and on the bottom, with consequent continuous mineralization of organic matter and conversion of biogenic compounds; thus justifying the possibility of other forms of life, both vegetable and animal, in the highest latitudes of the Arctic region. The significance of this in connexion with general hydrological research is indicated.

The third paper by Dr. Kriss deals with a Russian expedition to the Arctic in the spring of 1955, in which leading biologists of the Soviet Union took part. It seems to have practically reached the north pole. Dr. Kriss, who accompanied the party, says that stations were established throughout the Central Arctic between latitudes 82° and 90°, including Drift Stations designated as North Pole 3 and North Pole 5. Among other things, from a hydrological point of view, the greater concentration of bacterial content in boundary or junction waters of different seas and oceans, or currents, was specially studied.

It was shown, for example, that at or near the upper and lower boundaries of Atlantic currents reaching the north polar area, the micro-organism population was several times larger than in the average of higher or lower levels.

Dr. Kriss presents some graphs showing the relation between depth (in metres) and micro-population at different seasons (June and September) as indicated by the two methods: filters, and glass overgrowth or submerged slides. There are substantial 'peak' differences with the two methods; for example, at about 100–150 m. and between 750 and 1,200 m. A map of the north polar region is also shown, giving the distribution of about 15 points where samples were taken from surface layers down to 4,000 m.

Nearly all the 1955 stations were on pack ice, and only two on the continental dip at depths of 900 and 1,850 m. Holes of 1–1·5 m. were drilled in the ice, and sampling bottles of the Nansen type were lowered to the different depths. It was evident that organisms on the ocean floor can exist under pressures up to several hundred atmospheres. It was possible in many cases to determine approximate rates of propagation at various depths. W. G. CASS

BIBLIOGRAPHY OF THE BAUXITE DEPOSITS OF THE WORLD

ALUMINIUM now competes with copper for second place after iron as the most widely used metal in commerce, and virtually all the pure alumina used for the manufacture of the metal, upwards of five million tons a year, is obtained by processing bauxite. This material is therefore an ore of the first importance, both commercially and strategically. Deposits are widespread throughout the world, though their distribution is somewhat capricious, at least from a strategic point of view. All the bauxite used by the aluminium industry in Britain is imported, and the deposits within the United States and Canada are insufficient to provide for the enormous consumption by the aluminium industry in North America.

Since Dr. C. S. Fox published, more than twenty years ago[1], a monograph on the subject containing an extensive bibliography, the literature on the subject has grown steadily. It is, however, scattered through the scientific and technical journals of many countries, so that the United States Geological Survey has fulfilled a real need by publishing a new "Annotated Bibliography of the Bauxite Deposits of the World", by Elizabeth C. Fischer (Geol. Survey Bull. 99. Pp. 221+1 folding map. Washington, D.C.: Government Printing Office, 1955; n.p.). This bibliography, which contains more than a thousand entries, was commenced originally for the use of the staff of the Survey and enlarged to meet the demand for information arising out of the greatly increased use of aluminium during the Second World War. It covers various aspects of the subject, including the origin, geology, mineralogy, chemistry, reserves and production of bauxite. A selection of papers on 'laterite' and 'lateritization' has been included, because these terms have often been used as synonyms for bauxite (that is, aluminous laterite) and the processes leading to its formation. On the other hand, accounts of the technical aspects of the mining and processing of bauxite have largely been excluded.

The entries are arranged alphabetically under authors' names, and the index is sub-divided into subject and locality headings so that references to any particular subject or area can be found quickly. There is also a useful world map showing the distribution of the principal bauxite deposits. The bibliography includes publications issued up to the end of 1950, only. Even so, it will prove extremely welcome to all interested in the subject, and it may be hoped it will be followed by a supplement.

V. A. EYLES

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[1] "Bauxite and Aluminous Laterite", 2nd ed. (Crosby Lockwood and Son, London, 1932).

STRUCTURE OF FRONTS IN METEOROLOGY

THE conception of a 'front', a roughly plane, sloping zone dividing air masses of different origin with the warmer air below the colder air, is a fundamental one in meteorology. The major areas of deep cloud and precipitation over the British Isles are associated with fronts, and the word has thus become a familiar one to all listeners to the weather forecasts broadcast on the radio. A front is a warm front if warmer air replaces cold air as the front passes over any point, and the converse for a cold front. Until recently, knowledge of the structure of fronts was obtained from surface observations of temperature, humidity and cloud forms, from rather isolated 'vertical' aircraft ascents, and from observations obtained by balloon-borne instruments.

During 1950–52 the Meteorological Research Flight of the Meteorological Office made twenty-three flights from its base at South Farnborough to observe the cloud structure and the temperature and humidity variations along fixed levels approximately perpendicular to the front. The flights were made following plans decided on the basis of the synoptic charts drawn at the Central Forecast Office.

The observations, in conjunction with those of the nearly simultaneous radio-sonde ascents, are analysed by J. S. Sawyer in Geophysical Memoir 96 of the Air Ministry—Meteorological Office, entitled "The Free Atmosphere in the Vicinity of Fronts: Analysis of the Observations by the Meteorological Research Flight, 1950–52" (M.O. 584*d*. Pp. 24. London: H.M.S.O., 1955; 5*s*. net). The observations show a great complexity of structure, indicating that no simple idealized structure can adequately represent an individual front, but clearly confirm the existence of sloping regions of change between two roughly homogeneous air masses. Mr. Sawyer finds that, in the region between about 6,000 and 20,000 ft. explored in the flights, there were (*a*) a frontal region, varying from 200 to 1,000 miles in width, with an average of 600 miles, across which there was a temperature difference of 5–29 deg. F., average 15 deg. F., at a fixed height, and (*b*) within the frontal region a relatively narrow frontal zone of up to 250 miles in width, average 130 miles, with a temperature contrast up to 21 deg. F., average 9 deg. F. Frontal zones of less than 50 miles wide were uncommon. The slopes of the frontal zones varied between 1 and 250 and 1 in 30, with an average of 1 in 55. This slope is much steeper than the value of 1 in 100 stated in some text-books.

A hitherto unknown feature of frontal structure revealed by the flights was the existence of a tongue of relatively dry air extending downwards along the frontal zone to an average height of about 6,000 ft. Mr. Sawyer shows that this tongue is produced, not by vertical motion down the front, but by horizontal advection of air the relative humidity of which had been reduced by descending motion some eighteen hours before in the ridge of high pressure ahead of the front. The change of humidity across a front is from moist warm air to cold dry air across a warm front, the rate of change of frost-point or dew-point being greater than that of temperature, and of a dry transition zone at cold fronts between two relatively moist air masses. The clouds observed were mainly stratiform in nature, with convectional cumulus clouds in places in all the cold fronts and in six of the seventeen warm or quasi-stationary fronts. The main cloud mass associated with the front was in the warm air, with little extension into the transition zone at nine of the twenty-three fronts examined, partly in the warm air and transition zone in seven of them; in only one was there a solid mass of cloud in the cold air.

PRESERVATION OF ANIMALS AND PLANTS BY DRYING FROM THE FROZEN STATE

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METHODS which are being used for the preservation (*a*) of the natural colours of animals and plants possessing labile pigments, and (*b*) of the natural shape of those which are soft-bodied, leave much to be desired. Bottled specimens preserved in alcohol or formalin take up a great deal of space, and neither these nor specimens preserved in resins or synthetic polymers are readily available for close examination. Dried skins are fragile, often they retain little of the natural colour and rarely reproduce accurately the shape or attitude of the original specimens. Insect larvæ, spiders, annelids, molluscs and fungi are among the most difficult forms of life to preserve satisfactorily for examination and exhibition.

Hard-bodied insects which have stable pigments, for example, most butterflies and moths, present no difficulty; but dragonflies, except those the colours of which are due to light interference by their surface structure, lose their colours rapidly after death. These colours can be preserved by drying *in vacuo* using a water pump[1] or very rapidly, preferably at low temperature, with a high-vacuum pump[2].

Soft-bodied insects cannot be preserved in this way; even if the pressure is lowered very gradually to prevent bursting, they finally dry in a shrunken shapeless form. This difficulty can be overcome by freeze-drying, which not only maintains the natural shape and size of specimens, but also is least damaging to their colouring materials.

Freeze-drying, introduced by Florsdorf and Mudd, has become the normal method for recovering biologically active large molecules from aqueous solutions[3]. Cooling due to the rapid vaporization of ice in a high vacuum is sufficient to maintain the frozen state when solutions are dried in an ordinary glass desiccator at room temperature if the depth of the solution does not exceed a few centimetres, and there is no restriction of the absorption or condensation of water vapour. More elaborate freeze-drying equipment incorporates a heater to prevent the temperature from falling too low and slowing the rate of evaporation unduly.

When the evaporation from the surface of a frozen object is restricted, there is insufficient cooling to maintain the frozen state; caterpillars fall into this category, since their integument protects them against the drying conditions of the environment. On the other hand, it has been found that animals which normally live in water or in very moist conditions, for example, fish and marine worms or slugs and earthworms, are unable to resist the egress of water vapour.

Caterpillars can be freeze-dried in the following way: specimens are killed with cyanide, weighed and placed in the bottom of a test-tube which is partly immersed in a mixture of acetone and solid carbon dioxide at − 65° C., where they become completely frozen in a few minutes. They are then placed in an ice-box at − 15° and their temperature allowed to rise to this point, where they are in no danger of thawing nor is their vapour pressure too low for reasonably rapid drying at the pressure obtainable with a good oil pump (10–25μ mercury). A glass desiccator containing phosphorus pentoxide is precooled to −15°, the specimens transferred to it and a high vacuum applied. Specimens up to 2 in. in length (300–500 mgm.) dry under these conditions overnight, and those weighing up to 5 gm. can be dried in a few days. During this process, 65–75 per cent of weight is lost; on re-exposure to the air 1–2 per cent of moisture is reabsorbed. By the nature of the process, the products retain their shape and form, they are hard but slightly flexible, and cannot be broken by pressing between the fingers, nor is the main structure damaged by dropping on a hard floor. Whereas the colour of most specimens was quite unimpaired, the transparency of the integument is lost; and in cases where the colouring is contributed to from within, as in some green caterpillars, the final appearance is not satisfactory. In some instances green specimens retained their colour, but in others where green survived the drying process, this colour faded in a few weeks even in a sealed tube of nitrogen in the dark. Apart from this difficulty, specimens have been stored after freeze-drying without deterioration for more than a year in a laboratory atmosphere, and there is no reason for supposing that their condition is not permanent under normal storage conditions. Their final state does not differ from that of some vacuum-dried dragonflies, which have retained their natural colours for ten years.

Until the rate of drying of a particular type of specimen has been determined, it is necessary to find when constant weight has been reached. Care must be exercised when handling incompletely dried specimens, which must not be touched except with forceps cooled well below 0°, to prevent local thawing, otherwise a brown mark appears on the dried product. Rapid freezing at −65° is desirable, because slow freezing gives relatively large ice crystals which disrupt cells and body structures to give a more fragile product.

Spiders can be preserved very satisfactorily as dried specimens; they are generally less transparent objects than many insects, so that their natural colour and appearance remain quite unchanged. Difficulty was experienced initially in freezing spiders, due apparently to the presence of rather large amounts of fat in the body. When specimens were soaked overnight in trichloroethylene and then exposed to the air for the solvent to dry away, they could, however, be set on pieces of cork, frozen and dried *in vacuo* as already described.

Earthworms and slugs dried rapidly after freezing, but the dried products were opaque and white. This was due to the presence of mucous substances on their surfaces which could not be completely washed off. This difficulty has not been overcome; the specimens are perfect from the morphological point of view, but for exhibition purposes can only be recommended as better objects for colouring artificially than models. In the case of marine worms, the parapodia could be maintained in the extended condition by dropping specimens into a beaker containing ethanol at − 65° held in the acetone–carbon dioxide bath.

Although theoretically there is no limit to the size of animals which could be preserved by freeze-drying, the increasing ratio of volume to surface area in larger subjects imposes a practical limit. Among vertebrates, small fishes have been dried by freezing a dish full of water in which they were swimming and evaporating the whole contents of the dish to dryness. In this way the fins remain in an extended and natural position; however, like invertebrates which live in moist environments, the dried fishes were white and opaque. A pipistrelle bat presented no difficulty, and a mouse weighing 18 gm. dried successfully, losing 68 per cent of its weight. The mouse showed itself to have considerable protection against loss of water and took three weeks to dry; this does not make the process uneconomical, however, as a large number of specimens can be placed in one desiccator.

Of interest to botanists will be the observation that fungi are beautifully preserved in the dry state by this technique. A large toadstool weighing 30 gm. dried to constant weight in 24 hr. and became re-equilibrated to laboratory atmosphere on regaining only 2 per cent of its original weight. The greatest loss of water on drying was found among the fungi, some of which lost more than 90 per cent of their weight. It might be of interest to record in this connexion that the least loss to constant weight (50–54 per cent) was found with migratory locusts, which, on account of their relatively rigid structure, could be vacuum-dried at room temperature without freezing in 2–3 hr.

Although no deterioration has been detected after storing any specimens preserved by freeze-drying, it might be wise to inject a non-volatile disinfectant, before freezing, into those which are required for permanent collections.

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A STIMULATORY ACTION OF INDOLE-3-ACETIC ACID ON THE UPTAKE OF AMINO-ACIDS BY PLANT CELLS

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It is a striking fact that, although plant growth-regulating substances produce many profound and far-reaching effects on plant cells, yet when they have been applied to animal cells little or no effect has been demonstrated. A recent report by Christensen, Riggs and Coyne[1] that indole-3-acetic acid (in relatively high concentration) stimulated the accumulation of amino-acids by mouse tumour cells was therefore of especial interest, and led us to investigate whether the auxin acts similarly on the uptake of amino-acids by plant cells.

Etiolated sunflower seedlings, six days old, were used in this investigation. Segments 1 cm. long were cut from the hypocotyls at a distance of a centimetre below the crook, and, after being washed in distilled water, were suspended in briskly aerated, buffered solutions of radioactive amino-acids, which were uniformly labelled with carbon-14. After periods varying from 0·5 to 3·5 hr. the segments were removed, well rinsed with distilled water, and freeze-dried. Their radioactivity was then determined by a technique involving wet combustion.

A very marked increase in the amount of carbon-14 incorporated from solutions of glutamic acid and glycine has been observed when indole-3-acetic acid is present in the medium. Typical experiments are summarized in Table 1. This response to auxin is a rapid one, being clearly apparent in experiments lasting less than 30 min. As Table 1 indicates, it is produced by physiological concentrations of indole-3-acetic acid. Further experiments have shown that the curve relating magnitude of effect to auxin concentration closely follows that for extension growth. The stimulation is dependent on the presence of oxygen: under nitrogen, although the figure for carbon-14 incorporation reaches approximately two-thirds of that for aerated solutions, the auxin effect is abolished.

In these experiments the uptake of glutamic acid was accompanied by the uptake of water from the surrounding medium. Water uptake was, of course, considerably greater in the presence of auxin, leading to a gain in fresh weight of approximately 13 per cent during a 2-hr. experiment as compared with

Table 1. THE EFFECT OF INDOLE-3-ACETIC ACID ON THE ACCUMULATION OF CARBON-14 FROM SOLUTIONS OF UNIFORMLY-LABELLED AMINO-ACIDS BY SEGMENTS OF SUNFLOWER HYPOCOTYL

Experiment	Experimental conditions	Indole-3-acetic acid concentration	Specific activity of segments (mμc. per m.mole carbon)†	Per cent increase in specific activity produced by indole-3-acetic acid
I. Glutamic acid 10^{-2} *M*	16 segments* in 3 ml. for 2 hr.	0	10·3 11·1	
		$8{\cdot}6 \times 10^{-6}$ *M*	17·5 19·3	72
II. Glutamic acid $2{\cdot}1 \times 10^{-3}$ *M*	12 segments* in 2 ml. for 2·25 hr.	0	53·4 53·8	
		$2{\cdot}9 \times 10^{-5}$ *M*	81·7 92·3	62
III. Glycine 2×10^{-3} *M*	12 segments* in 3 ml. for 2 hr.	0	47·4 43·2	
		$2{\cdot}9 \times 10^{-5}$ *M*	59·7 69·5	43

* The fresh weight of 10 segments is approximately 280 mgm.

† The carbon content of the segments was not perceptibly affected by the treatments.

3–4 per cent in the absence of auxin. To discover whether the uptake of water and the uptake of glutamic acid were in any way linked, experiments were carried out in which net water uptake was reduced or eliminated by the addition of mannitol to the external medium. It was found that the presence of mannitol did not depress, but on the contrary slightly enhanced, carbon-14 accumulation by segments not treated with auxin. The percentage increase in carbon-14 accumulation produced by auxin was, however, markedly diminished. It thus appears that, at least in the absence of auxin, there is no direct connexion between the uptake of water and the uptake of glutamic acid. The reduction in the auxin-induced stimulation of amino-acid uptake is possibly connected with the arrest of cell extension, which may prevent auxin from exerting its full effect.

In further experiments extracts of the segments were made at the conclusion of the experiment and their radioactive compounds examined by chromatographic techniques, using both filter paper and 'Dowex-50' columns as described by Moore and Stein[2]. It was found that only about 30 per cent of the radioactivity of an alcoholic extract is in the form of glutamic acid. No marked difference in the level of glutamic acid has been observed between auxin-treated and control segments. Colorimetric determinations revealed that the native level of glutamic acid is very low in this tissue, of the order of 25 μgm. per gm. fresh weight or less. It may be that the balance of the reactions involving glutamic acid in these cells is such that the concentration of free glutamic acid is always very low. Thus any glutamic acid entering the cells, whether in the presence or absence of auxin, is immediately metabolized. The free glutamic acid which is detected in the samples at the end of the experiments may, in fact, be recovered from the intercellular spaces and cell walls, not from the cytoplasm itself.

Table 2. EFFECT OF INDOLE-3-ACETIC ACID ON THE QUANTITY AND SPECIFIC ACTIVITY OF CO_2 EVOLVED BY SEGMENTS OF SUNFLOWER HYPOCOTYL BATHED IN SOLUTIONS OF UNIFORMLY-LABELLED GLUTAMIC ACID

(11·2 gm. tissue samples in 125 ml. 2×10^{-3} *M* glutamic acid for 2 hr.)

Treatment	μMoles CO_2 evolved	Specific activity of CO_2 (mμc. per m.mole carbon)
No indole-3-acetic acid	185 185	783 750
$2{\cdot}9 \times 10^{-5}$ *M* indole-3-acetic acid	230 247	936 878

Under the conditions of this investigation the rate of respiration of auxin-treated segments was enhanced by 20–30 per cent. When the carbon dioxide evolved was collected, precipitated as barium carbonate, and tested for radioactivity it was found that the specific activity, too, was decidedly higher in the case of the auxin-treated tissue. A typical experiment showing this interesting result is summarized in Table 2. It will be seen that, not only was the amount of carbon dioxide evolved 29 per cent higher in the presence of auxin, but this carbon dioxide was 18 per cent richer in carbon-14. It follows, therefore, that treatment with auxin had brought about a 52 per cent increase in the amount of glutamic acid respired, while only raising the all-over rate of respiration by 29 per cent.

The results reported here indicate that auxin influences the amount of amino-acids entering the cell from the surrounding medium. In the animal cells referred to earlier[1] it is thought that indole-3-acetic acid achieves its effect through its action on a transfer process. No such transfer mechanism is definitely known to exist in the plant tissue investigated here. Arisz[3] has reported active transport of amino-acids in certain highly specialized organs, the tentacles of *Drosera capensis*. Webster[4] has shown that respiratory inhibitors depress carbon-14 accumulation by bean hypocotyls bathed in solutions of labelled amino-acids; but this action may be indirect. While it seems probable, therefore, that in these cells, as in the animal cells, indole-3-acetic acid stimulates the active transfer of amino-acids (either into the cell or into some specific region of it) other possibilities have to be considered. Amino-acids may, for example, penetrate by diffusion against a considerable resistance, and auxin may bring about a lessening of this resistance. Again, it is possible that auxin does not act directly on the entry of the amino-acids: it may stimulate one or more of the processes which remove free amino-acids within the cell and which are thus responsible for maintaining an inward diffusion gradient for the acid. Should this be the correct explanation, the respiration experiment (Table 2) is significant. In the presence of auxin, glutamic acid formed a larger proportion of the substrate respired. One possible explanation is that under these conditions more glutamic acid reached the respiratory centres—that is, that auxin directly facilitated the uptake of the acid. But an alternative explanation is that glutamic acid was preferentially respired in the auxin-treated segments. This would suggest a special connexion between the action of auxin and the respiration of amino-acids (or of some derivative of amino-acids within the cell).

A fuller account of this investigation will be published elsewhere.

We wish to express our appreciation of the encouragement given us by Prof. G. E. Blackman, director of this Unit.

[Feb. 24

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron Microscopic Observations on the Secondary Wall of the Protoxylem of *Cucurbita*

During an examination of the sieve plates of *Cucurbita* already briefly reported[1], some observations on the structure of the secondary wall in the protoxylem have been made which seem worth recording.

Since the early work of Crüger[2] a number of later workers have recorded the close relationship between the structure of the cytoplasm and the pattern of thickening in annular and spiral vessel segments.

Barkley[3] has described the development of the secondary wall in the protoxylem of *Trichosanthes anguina*, a member of the Cucurbitaceæ. According to her account the cytoplasm of differentiating vessel segments shows a banded structure, due to the development of rows of vacuoles lying between bands of cytoplasm which remains denser. The vacuoles separating the cytoplasmic bands in annular vessels are larger than those in spiral ones. During ontogeny of the vessels, the bands of cytoplasm lay down the secondary cellulose wall which then undergoes lignification. Sinnott and Bloch[4] observed a similar behaviour in *Coleus* during regeneration from parenchyma after wounding. Majumdar[5], working with *Heracleum sphondylium*, recorded additional observations on the development of the secondary wall; according to him, development of the secondary wall is preceded by the deposition of pectinaceous bases on which the secondary wall is then laid down. These bases are said to prevent the secondary wall from making intimate contact with the primary wall.

The sections presented here (Figs. 1 and 2) show the detailed structure of the secondary wall as seen in longitudinal section. Examination of these does not show the pronounced bases by which the secondary wall is said to be attached to the primary one. Although there is some indication of the lenticular-shaped base, this is very small and does not seem to prevent the secondary wall layers from making contact with the primary wall. The primary wall, due to stretching, is very thin and shows no detailed structure. The cellulose lamellæ of the secondary wall, however, are very clear (Fig. 2) and seem to be laid down in concentric rings of increasing radius. The several lamellæ appear to be firmly held together by a ground substance which may be lignin.

The lamellæ indicate, of course, the position of the cytoplasm at the

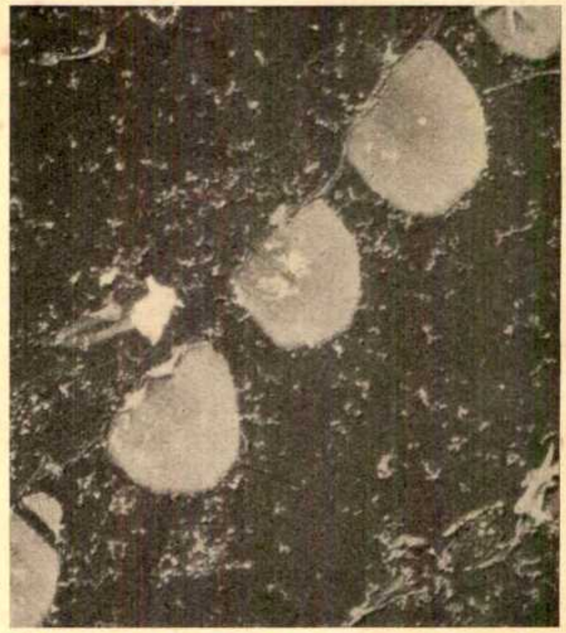

Fig. 1. Electron micrograph of longitudinal section of one wall of a protoxylem vessel element (× 3,400). Methacrylate removed. Shadowed palladium–gold. Note the thin primary wall with the superposed (presumably spiral) secondary thickenings

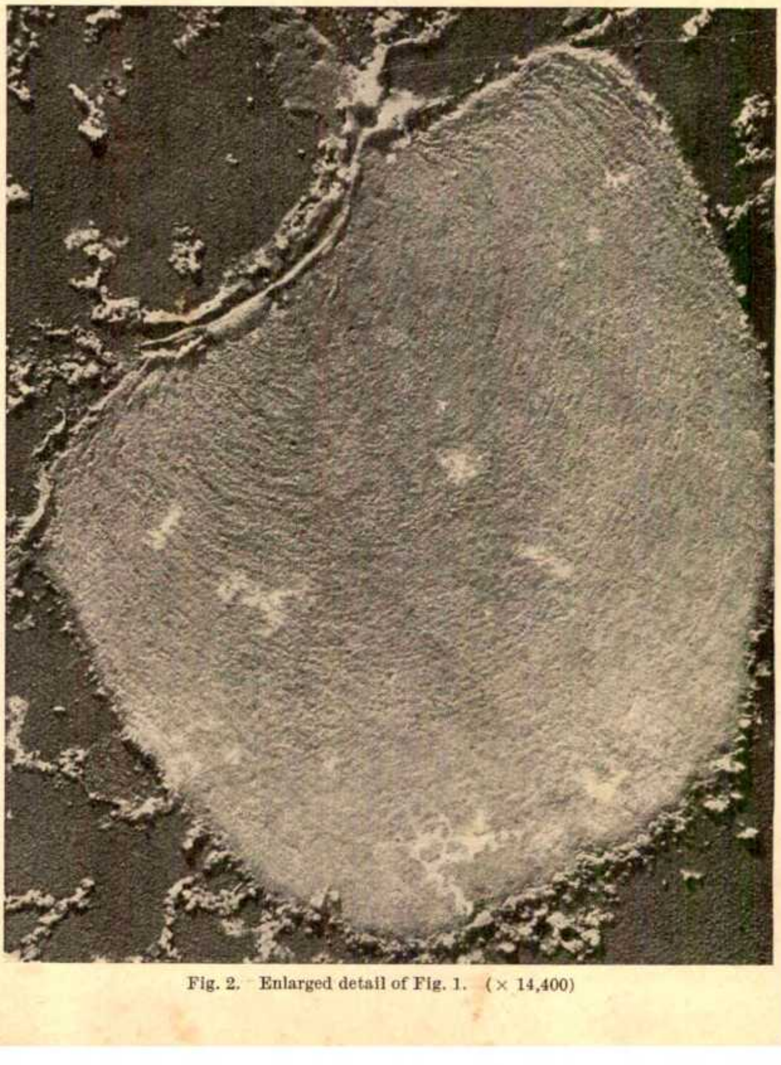

Fig. 2. Enlarged detail of Fig. 1. (× 14,400)

moment of deposition. The photograph therefore shows most clearly the enormous local expansion of the cytoplasm during the deposition of these thickening bars.

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Uptake of Radioactive Phosphorus by Larvæ and Adults of Mosquitoes

Eight batches of twenty-five second instar larvæ of *Aedes aegypti* were immersed in separate beakers filled with a radioactive bath composed of 30 ml. tap water and progressively increasing amounts of a solution of radioactive disodium hydrogen phosphate ($Na_2H^{32}PO_4$). The concentrations of the radio-isotope ranged from 17 to 4,480 mμc./ml. Rolled oats (0·25 gm.) was added to each beaker to serve as larval food. Larvæ in baths with a concentration of 17–68 mμc. of phosphorus-32 showed the earliest (seven days from the day of immersion) and highest frequency of emergence as adults (approximately 60 per cent). Larvæ in baths with progressively higher concentrations of the radioisotope showed a delayed pupation, though at the end of two weeks most of the larvæ in all baths pupated except for the bath with the concentration of phosphorus-32 amounting to 4,480 mμc./ml. In concentration up to 140 mμc./ml., the emergence from pupæ took place on the average within 48 hr. after pupation, and there was a considerable mortality of emerged or half-emerged adults. This mortality was roughly proportional to the concentration of the radioactive isotope in the larval bath.

Larvæ in the bath with a concentration of phosphorus-32 amounting to 2,240 mμc./ml. remained apparently normal for more than three weeks but produced dead pupæ.

After two weeks, it was found that a very considerable proportion of radioactivity was adsorbed by the remaining larval food and debris.

The viable adults were collected each day with a suction tube, killed with chloroform vapour, dried for 24 hr. in the desiccator, weighed and their radioactivity assessed with regard to a standard reference day (day 10) of the life-cycle. The results of this investigation are shown in Table 1.

The resulting radioactivity of the adult was related to the concentration of the larval bath. It appeared that concentrations exceeding about 100 mμc./ml. of the larval bath were injurious to *A. aegypti* in so far as they greatly decreased the number of the emerged adults. The amount of radioactivity shown by the adult female was proportionately greater than in the male. While the female was on the average 1·6 times heavier than the male, the amount of radioactivity exhibited by her was about 2·5 times higher.

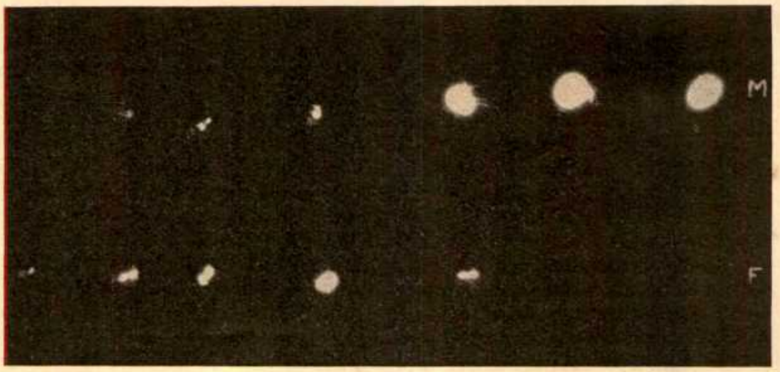

Fig. 1. Autoradiographs of a series of adult *A. aegypti* labelled with phosphorus-32 and exhibiting varying radioactivities. Males: 0·9, 1·8, 2·8, 4·2, 20·0, 32·0, 71·0 mμc. Females: 2·0, 4·3, 6·2, 16·2, 12 mμc.

Emerged adults were, after drying, mounted with 'Durofix' on a lead-rubber sheet, covered with a thin 'Cellophane' sheet and autoradiographed in a standard exposure holder on 'Kodak Crystalex' X-ray film. The time of the exposure varied between 4 and 18 hr. Autoradiographs, indicating clearly the radioactive mosquitoes and roughly the amount of their radioactivity, were obtained. A mosquito with radioactivity corresponding to 1 mμc. is clearly shown on

Table 1. Amount of Radioactivity of Adult Mosquitoes produced from Larvæ kept in Various Concentrations of Phosphorus-32

Beaker	Concentration of phosphorus-32 in larval bath (mμc./ml.)	Mean day of emergence	Mean day of counting	Sex	Numbers	Mean dry weight of mosquito (mgm.)	Mean counts per minute	Mean radioactivity of mosquito (mμc.)
Control	0	10 10	11 11	M F	12 10	5 5	1 1	0 0
2	17	10 10	11 11	M F	10 9	5 7	532 1,400	0·8 2·0
3	34	10 10	11 11	M F	5 6	6 10	1,206 2,871	1·7 4·1
4	68	10 10	11 11	M F	6 7	5 9	2,043 3,533	2·9 5·1
5	140	10 10	12 12	M F	4 3	3 7	2,767 8,642	4·0 12·4
7	560	10 10	11 11	M F	6 4	5 9	14,426 12,882	20·6 18·5
8	1,120	10	11	M	5	6	40,975	58·5
9	2,240	12	13	M	1	5	50,167	71·7

the film after 12–16 hr. exposure (see Fig. 1). About five hundred mosquitoes can be mounted on the 8 in. × 10 in. standard film, and it is suggested that this simple method of detection of labelled insects might be of value for qualitative ecological studies, such as investigation of the range of flight. This is of particular interest in tropical areas where electronic equipment is not available in field conditions.

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Nutritional Aspects of *Mortierella hygrophila* Linn.

PHYSIOLOGICAL studies on micro-organisms regularly isolated from soil profiles may lead eventually to a clearer interpretation of the ecological relationships of these organisms. To this end studies were initiated on the nutrition of a species of *Mortierella*. Although members of this genus are consistently isolated from soils, little is known of their nutrition.

A strain of *Mortierella hygrophila* Linn. was kindly supplied by Mrs. Turner of the Botany Department, University of Nottingham (Uni. Nott. No. 11—isolated by Claussen), and a single-spore isolation was made. The subsequent culture was employed in experiments and a subculture has been deposited at the Commonwealth Mycological Institute, Kew (Herb. I.M.I. No. 50115). Cultures were maintained on potato carrot agar, and washed-spore suspensions were employed as inoculum at a concentration of 50,000 spores/flask.

The composition of the basal culture medium was: carbohydrate source, 5,000 mgm. C; nitrogen source, 500 mgm. N; K_2HPO_4, 1·0 gm.; $MgSO_4.7H_2O$, 0·5 gm.; $FeCl_3$, 0·02 gm.; 1 ml. micro-element solution, supplying the following concentration of trace metals per litre: iron, 0·2 mgm.; zinc, 0·18 mgm.; copper, 0·04 mgm.; manganese, 0·02 mgm.; molybdenum, 0·02 mgm., twice glass-distilled water to 1 l. All chemicals were 'Analar' grade and sugars were supplied by Kerfoot and B.D.H.; *p*H initially adjusted to 6·0–6·5.

Cultures were grown in 25-ml. medium in 100-ml. Erlenmeyer flasks, and mycelial felts were washed and dried overnight at 75° C. The results were expressed as the mean weight in milligrams of five replicates.

With glucose as the source of carbohydrate the utilization of various sources of nitrogen is shown in Table 1. No growth was obtained with sodium nitrate as the source of nitrogen. However, the incorporation of 0·2 per cent yeast extract ('Difco') into the medium appeared to result in a partial utilization of the nitrate-nitrogen. Further investigation showed that the addition of small quantities of yeast extract or of peptone in a glucose medium resulted in an increase in mycelial weight above the weight due to the nitrogen content of the additions alone (Table 2).

This effect did not appear to result from a growth-factor requirement because no stimulation of growth was recorded when the following vitamins were employed singly and in combination: thiamin, riboflavine, pyridoxine, calcium pantothenate, nicotinic acid, ascorbic acid, *p*-amino-benzoic acid, biotin and inositol. No growth response was noted when yeast extract was ashed and added to a sucrose–nitrate medium. Various amino-acids were added to a glucose–nitrate medium at a concentration of 0·016 gm. acid per cent. Some growth resulted with almost all, the relative growth-rates being: L-arginine, DL-alanine, > DL-ornithine, L-glutamic, aspartic acid, asparagine, glycine, L-cystine, L-tyrosine, > DL-threonine, L-histidine, > DL-phenyl alanine, DL-valine, DL-methionine, DL-*nor*leucine, and none on DL-tryptophan. At best, growth was not as good as with peptone. Apparently there was no indispensable amino-acid.

Table 1

Nitrogen source	Mycelial weight on: Basal medium + glucose	Basal medium + glucose + 0·2 per cent yeast extract	Basal medium + sucrose + 0·2 per cent yeast extract
$NaNO_3$	0·0	102·1	77·2
$NH_4H_2PO_4$	14·6	75·8	20·3
$(NH_4)_2SO_4$	9·6	65·3	14·9
NH_4NO_3	9·2	81·1	13·7
Glycine	36·5	115·8	18·0
Peptone	147·3	141·6	140·2
Yeast extract 0·2 per cent	81·9	—	—

Table 2

Source of nitrogen	Mycelial weight on basal medium + glucose
$NaNO_3$	0·0
Yeast extract, 0·2 per cent	88·2
$NaNO_3$ + yeast extract, 0·2 per cent	161·7
Peptone, 0·1 gm.	62·7
$NaNO_3$ + peptone, 0·1 gm.	94·9
Peptone, 0·01 gm.	6·4
$NaNO_3$ + peptone, 0·01 gm.	23·0

The replacement of glucose with sucrose in the basal medium plus yeast extract provided a similar pattern of nitrogen utilization (Table 1).

In order to utilize nitrate-nitrogen, *M. hygrophila* may require a source of preformed nitrogen compounds to provide sufficient energy for the production of an adaptive nitrate reductase enzyme. This explanation appears to be only partially true because with decreasing peptone additions mycelial weights also decrease.

The availability of various sources of carbohydrate to *M. hygrophila* was determined on a medium containing sodium nitrate and 0·2 per cent yeast extract. The results are shown in Table 3.

Table 3

Carbohydrate source	Mycelial weight on basal medium + $NaNO_3$ + 0·2 per cent yeast extract
Glucose	106·9
Maltose	87·2
Raffinose	25·3
Lactose	24·5
Sucrose	20·9
Arabinose	17·5
Starch	32·6
Glycogen	20·2

Macerated, washed Whatman No. 50 filter paper was added to the basal medium containing sodium nitrate and yeast extract to test for possible cellulolytic activity. *M. hygrophila* was not able to grow on this medium, even when 0·05 per cent 'starter' glucose was added.

This work was carried out during the tenure of a research fellowship in the University of Nottingham.

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Eggs of *Lestinogomphus africanus* (Fraser)

In June 1955 I had the good fortune to obtain batches of eggs from two females of the archaic dragonfly *Lestinogomphus africanus* (Fraser) taken near Kuru, Northern Nigeria. These eggs presented a feature which has apparently not hitherto been described in the Odonata, although similar structures are known in certain genera of the Ephemeroptera. The posterior pole of the egg was produced into a coiled filament about 30 mm. in length, at first tightly wound and forming a small cap over the end of the egg, but opening out into a loose spiral on contact with the water.

A fuller description of the egg and of the early nymphal stages will shortly be published elsewhere by myself and Mr. A. E. Gardner, who has reared some of these eggs up to the third instar, so no further details are necessary here.

Morgan[1] described and figured very similar structures in the egg of the mayfly *Stenonema*, and these have been discussed by Needham, Traver and Hsu[2]. They are generally considered to be an adaptation to life in rapidly flowing water and to serve for anchorage, although eggs both with and without special anchoring structures can be laid in both rapid streams and quiet ponds.

Dr. P. S. Corbet, of Jinja, Uganda, informs me that he has very recently obtained some eggs from *Ictinogomphus ferox* (Rambur) and finds that they have filaments similar to those shown in some sketches of *Lestinogomphus* eggs that I had sent him; it therefore appears possible that these filaments may be found in a number of different genera of the Gomphidae. Dr. Corbet has found fully grown nymphs of both *Lestinogomphus* and *Ictinogomphus* in sheltered muddy portions of lakes in Uganda, and considers that the presence of these filaments may be evidence of rheophilic ancestry in species at present able to live in a stagnant and muddy environment. In Nigeria, *Ictinogomphus* breeds in muddy ponds; but the *Lestinogomphus* in question were taken beside a flowing stream, so it would appear that the latter species is able to breed in both running and stagnant water.

I am grateful to Dr. Corbet for permission to quote his observations.

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Dec. 3.

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Ink Ejection by Cephalopoda

It has long been said that the ink discharged by the great majority of cephalopods is ejected as a black cloud, under cover of which the animal may escape from a threatened attack. That this is false is apparent to anyone who has watched the phenomenon. The ink (of such cephalopods that I have seen) initially does not form a cloud, but remains a discrete, dark, viscous mass; water turbulence breaks up the mass, dispersing it in the form of streaks indicating the direction of the current flow, and even in a small volume of water such as an aquarium tank, cloud formation takes place only after some considerable time. The importance of this may not be readily apparent in a brightly illuminated aquarium; but the following observation, made under conditions of reduced light intensity one evening aboard the Singapore Regional Fisheries Research Vessel *Manihine* (October 1955), appears to present the true interpretation of this escape reaction.

I attempted to catch a small (unidentified) squid, some three inches long, which was being kept alive in a large, light-coloured wooden tub. The squid displayed evidence of agitation as it was manœuvred into a suitable position for capture, changing colour rapidly in the manner which is well known. When my hand was within about nine inches of the animal the squid assumed a dark coloration and appeared to become stationary. I seized the dark object, but it proved to be nothing more than a volume of ink; the squid was found to be at the opposite side of the tub. On repeating the attempted capture, I was able to see that, after assuming the dark coloration, the squid discharged a quantity of ink sufficient to produce a discoloured volume of water of similar size to the squid itself, simultaneously becoming pale in colour and moving away rapidly around the perimeter of the tub. Although I had been anticipating a discharge of ink during the first attempted capture, so efficiently had the operation been performed, and so intent had I been on the capture of a dark-coloured creature, that I had failed completely to see the escape of the squid in its light-coloured guise. I had the advantage of viewing the events laterally: a 'natural' enemy would have suffered the additional complication of having the ink discharged between it and the squid.

I have not yet had the opportunity of comparing with this the behaviour of other cephalopods, but in the case of the specimen examined the important features of the escape reaction are: (1) the assumption of a dark coloration immediately before (2) the discharge of a quantity of ink sufficient only to discolour a volume of water of similar size to the animal itself, this ink functioning primarily as a decoy, but also masking to some extent (3) the rapid change of the animal to a lighter colour and (4) the rapid departure of the animal from the scene of the impending attack.

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Variation in Mortality with Differences in Humidity among Mosquitoes exposed to BHC, Dieldrin and DDT

Since 1949 a long series of trials of residual insecticides has been carried out by this Unit at Taveta, Kenya, using the trap-hut method originated by Thompson[1]. In a number of the trials carried out since 1952, using BHC and dieldrin, a pronounced seasonal effect has been observed. During the dry season, the percentage mortality among female anophelines entering the houses has frequently declined, increasing comparatively rapidly at the onset of the next rainy season. This has been noted in huts lined with an impervious surface (banana leaf) treated with dieldrin and in others with reed roofs

Table 1. PERCENTAGE MORTALITY AMONG FEMALE *A. gambiae* AND *A. funestus* SUSPENDED IN CAGES IN THREE HUTS TREATED WITH INSECTICIDE

Date 1954–55			Oct. 13–14	Nov. 23–24	Dec. 16–17	Feb. 7–8	Feb. 28–Mar. 1	Mar. 28–29
Rain in previous week (in.)			0·33	0	0	3·15	0	1·40
Hut No.	Insecticide	Position						
1	BHC	Wall	64	50	0	100	18	100
		Middle	0	32	16	100	12	100
2	BHC	Wall	0	10	0	100	0	100
		Middle	0	24	0	53	0	73
3	Dieldrin	Wall	0	0	0	100	0	100
		Middle	0	0	0	44	0	—
4	Control	Wall	0	0	0	0	0	0
		Middle	0	0	0	23	0	0

Table 2. PERCENTAGE MORTALITY OF FEMALE *Anophelines* SUSPENDED IN CAGES IN HUT 3 (TREATED WITH DIELDRIN) DURING EARLY RAINY SEASON 1955

Date	Mar. 11–19	20	21	22	23	24	25	26	27	28	29	30	31	Apr. 1	2	3	4	5	6	7	8–11
Rain (in.)	0	1·20			0·6	0·35	0·25	0·20													
Mortality (per cent)	0	0	46	75	80	100	100	100	95	100	60	100	83	19	14	90	94	0	16	0	No tests

Date	Apr. 12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	May 1	2	3	4
Rain (in.)	0·6	0·3										0·5											1·15
Mortality (per cent)		100	100	60	0	0	47	56	40	100	84	100	32	76	42	100	95	90	100	80	31	0	57

Date	May 5	6	7	8	9	10	11	12	13	14
Rain (in.)			0·5	0·45		0·14	0·45			
Mortality (per cent)	67	70	—	100	–	100	45	100	42	20

and walls plastered with mud, and treated with either dieldrin or BHC. The phenomenon has not been noted with DDT in this series of trials; but it possibly occurred in the earlier set conducted in the same locality by Davidson (ref. 2, Table 3) using DDT oil-bound suspension on a mud-and-gravel wall. Hocking[3] observed an increase in kills in a tent treated with DDT dissolved in kerosene when heavy rain fell, but his observation seems to have been overlooked.

It is suspected that rising atmospheric humidity is the reason for increasing mortalities in our trials. Throughout these experiments, regular tests have been made with blooded female *Anopheles gambiae* and *A. funestus* suspended in the huts in gauze cages. One cage has been fixed so that one side is about ¼ in. from a wall but not touching it; the other has been hung from the roof, about 5 ft. from walls or thatch. The results of a series of tests in three huts, all with mud walls, during the period October 1954–March 1955 are given in Table 1. This period comprises the short rains, short dry season and beginning of the long rains; but the season in question was remarkable for heavy unseasonal rains between February 2–8. Table 1 gives the percentage mortality of female vectors for each date, together with the total rain recorded during the previous week one mile distant at the offices of Taveta Sisal Estate, Ltd., to which I am indebted for these figures.

The kill in the huts treated with BHC during November 23–24 is probably due to increased humidity preceding 2·52 in. of rain during November 25–27. Apart from these two entries, the relation between rain and high mortalities is consistent.

These observations were followed by daily exposure of mosquitoes in the hut treated with dieldrin. These results are given in Table 2. Direct readings of relative humidity were commenced; but the hygrograph used was afterwards found to be unserviceable. As the rainy season becomes established, the relation between precipitation and mortality becomes less intimate, consonant with the generally high level of humidity at this season.

These experiments measure only the vapour or, in the case of dieldrin, particulate action of the insecticide[4], and similar results have been obtained with dieldrin in Mexico by Bordas and Navarro[5]. However, the seasonal variation among mosquitoes entering the huts naturally, which is mentioned above, has been detected in huts no longer showing any vapour or particulate action, and evidently the effect is also apparent in mosquitoes contaminated by direct contact. A detailed account of the experiments will be submitted for publication elsewhere; but the purpose of this communication is to direct attention to a factor which may have important practical effects in two ways. First, an insecticide-spraying routine which is quite adequate in a coastal or forest area with constant high humidity may fail when applied in a dry inland zone where breeding of anophelines takes place in river pools, irrigation water or artificial containers. Secondly, when conducting tests to determine the persistence of a treatment, or to detect possible acquired resistance to insecticides, misleading results are possible unless test conditions are standardized with regard to humidity.

This work was undertaken as part of a scheme authorized by the Colonial Pesticides Committee and financed from the Colonial Development and Welfare Fund.

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Occurrence of *Achtheres percarum* Nordmann in English Waters

Achtheres percarum Nordmann[1] is a copepod crustacean well known as an ectoparasite in the buccal cavity and on the gills of perch, pike and pike-perch from Germany, Italy, Czechoslovakia, Finland and the U.S.S.R. as far east as Lake Baikal. Until recently, however, there has been no authentic record of it in the British Isles. Gurney[2] pointed out that T. and A. Scott's record[3] of it in the Ray Society monograph on British Parasitic Copepoda was an error due to a misidentification of specimens of *Salmincola thymalli* (a parasite of trout).

It was therefore of considerable interest to find that parasites taken from the mouth of a perch from the Kennet and Avon Canal at Burfield by Mr. S. Prudhoe on June 17, 1954, belonged to this species, and in November, quite independently, one of us (F. W. K. G.) found them, also on perch, in the River Colne, near Rickmansworth, two fish trapped during an investigation of the food of coarse fish being infected. Further samples from three stations, covering six miles of the River Colne and Grand Union Canal system, confirmed that perch were the only hosts of this parasite. Pike, roach and gudgeon were also present but not attacked. Among the small number of perch examined (240 specimens) the overall percentage of infected fish from the three stations investigated was 7½ per cent.

Seven per cent of the perch were infected at the highest station (*A*) in the River Colne, just before its entry into the Grand Union Canal two-thirds of a mile above Rickmansworth. Below Rickmansworth the old course of the River Colne forms a series of intermittent channels linked with the Grand Union Canal. In one such channel at the second station (*B*) two and a half miles below station (*A*) and immediately before its reunion with the canal at the sewage works near Maple Cross, no fewer than 27 per cent of the perch population were infected. Three and a half miles farther down at station (*C*), in the Colne near Denham Studios, one hundred and twenty-four perch were examined and found entirely free from this parasite.

All sizes of perch (10·0–32·0 cm. in length) were attacked by the parasite; but the percentage was much greater among the larger fish (longer than 14·0 cm.).

Individual hosts frequently bore one or two parasites, but the larger parasitized fish (more than 20·0 cm.) had two or more and in one case ten parasites per host. According to Schäperclaus[4], the number of parasites per host is much greater on the Continent of Europe.

In perch from the River Colne the parasite was only found in the buccal cavity and never on the exterior of the body. In some cases the parasite attached itself to the gill bars, rakers or palate, but was most frequently found on the edge or tip of the tongue, where the parasite would seem most vulnerable to damage when the host is feeding.

There is the possibility that *Achtheres percarum* Nordmann has been accidentally introduced into Britain with perch, pike or pike-perch, all of which, according to records available since 1937, have been imported intermittently into south England in small numbers from Holland, Germany and Italy for stocking inland fisheries and aquaria.

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Sporulation of Fungi inside the Plant Host Cell

The sporulation of fungi usually occurs when suitable conditions of nutrition and aeration are provided. It appears that whereas the conditions inside plant cells commonly admit of the formation of resting spores, they are, in general, less suitable for the formation of non-resting ones. Thus in Plasmodiophorales, the plasmodia develop into resting spores within the host cells, whereas the active swarm spores are typically formed outside the host. Again, in Pythiaceae, Albuginaceae and Peronosporaceae, the resting spores (zygotes) may be formed inside the host tissue; but the zoosporangia and conidia are usually formed outside it. The powdery mildews, smut and rust fungi, in different ways, exemplify this same phenomenon. So far as I know, conidia as defined by Mason[1] are rarely reported to be formed inside plant cells and, more particularly, at some depth in a tissue matrix. In these few cases where they have been reported, they typically occur inside the vessels, for example, microconidia of *Fusarium oxysporum cubense* inside the spiral vessels of banana plants[2], and the presence of microconidia of *Fusarium oxysporum conglutinans* has been described in the xylem of the cabbage plant[3]. It may be that it is not uncommon in the experience of pathologists to encounter conidia in plant cells; but the phenomenon does not appear to have been given much attention and it has not been dealt with in standard texts.

In the course of my present experimental work on fungal rots of potato tubers during storage, conidia of a pathogen were found inside host tissue. It was observed that a synergistic effect between *Rhizoctonia solani* Kühn and *Fusarium solani* sensu Snyder and Hansen resulted, under certain conditions, in the formation of pimple-like outgrowths. These 'pimples' were caused by the division and enlargement of the parenchymatous cells beneath the cork layers. The periderm also divided and enlarged to cover this tissue extension (Fig. 1). At a later stage, *F. solani*, proceeding from the inside of the tuber, invaded the pimples and sporulated abundantly inside the elongated parenchyma cells, but conidia were not

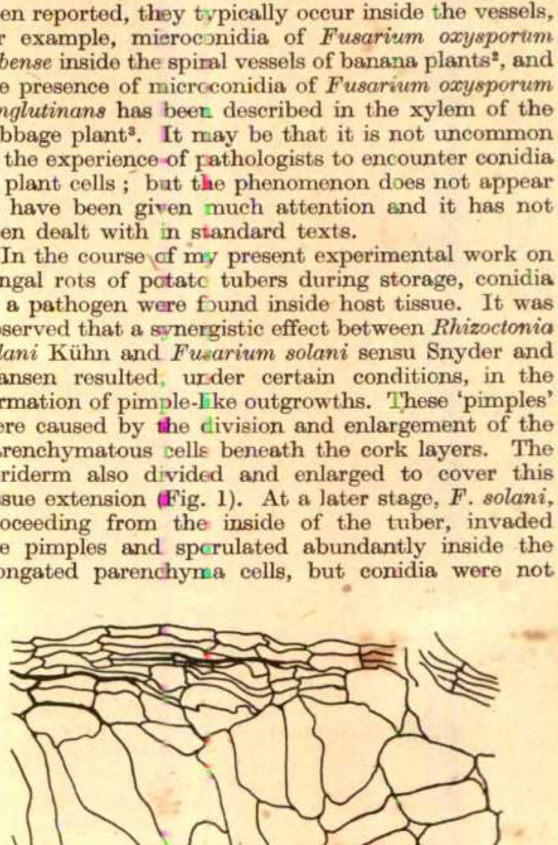

Fig. 1. A part of a 'pimple' showing the elongation of the parenchyma and cork cells, before fungus invasion. (× 100)

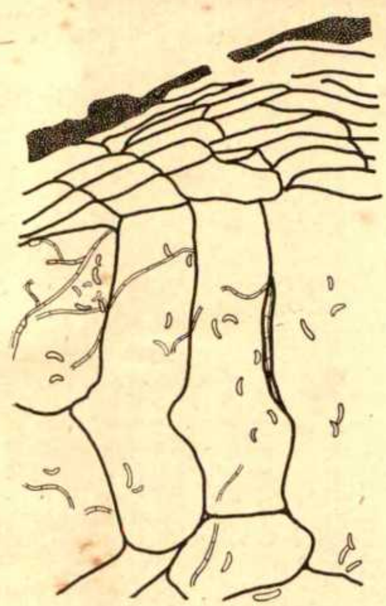

Fig. 2. A part of a 'pimple' after *Fusarium solani* invasion, showing hyphæ and microconidia inside the elongated cells. (× 250)

observed in other adjacent sub-superficial parenchymatous tissues. The conidia observed were mostly microconidia with a few macroconidia (Fig. 2). Measurements of conidia showed that those formed inside the host were significantly smaller than those formed on ten-day old cultures on potato dextrose agar.

The reason for the formation of conidia in the pimples and not in other parts of the plant is not known; but it may be correlated with the factor which stimulates the division of the cells. The low number of macroconidia and the smaller size of spores inside the cells may be due to different factors, among which light may be important[4].

I wish to express my thanks to Prof. C. W. Wardlaw, under whose supervision this work was done.

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Nuclear Vacuolation in the Liver Cells of Depancreatized Baboons

SEVERE nuclear vacuolation has been observed in the liver cells of human diabetics[1-3], of infants suffering from malnutrition[2] and of patients suffering from various diseases[2-5], but has not been reported in experimental diabetes, whether produced by pancreatectomy or by alloxan in laboratory animals. The factors promoting nuclear vacuolation still await investigation.

In our laboratory, depancreatized baboons rapidly develop all the manifestations of diabetes. The blood sugar rises to more than 500 mgm. per 100 ml., accompanied by 2–3 gm. per cent of glucose in the urine and severe ketonuria. Diabetes in the baboon can be controlled by insulin.

Serial liver puncture biopsies performed by the technique previously described[2] have revealed that nuclear vacuolation does not occur in baboons in a variety of experimental situations. Within four days after withholding insulin from depancreatized baboons, however, some degree of nuclear vacuolation is to be found in the liver cells adjacent to the portal tracts and, by the end of the seventh day, almost all cells throughout the lobule contain abnormally vacuolated nuclei (Fig. 1).

When fully developed, the vacuolated nucleus is characterized by a thick nuclear membrane to which is adherent the still prominent nucleolus and a thin rim of chromatin. The vacuole is filled with glycogen and occasionally contains a small globule of sudan-positive material. The concentration of nuclear glycogen contrasts with the paucity of cytoplasmic glycogen. Indeed, the nuclear reactions observed in the liver cells of depancreatized baboons are unmistakably similar to those present in the livers of human diabetics.

Although the number of vacuolated nuclei can be reduced by the administration of insulin, once these nuclei have appeared in the livers of depancreatized baboons, some are always to be found whether or not the diabetes is eventually controlled. Indeed, even in man when diabetes is well controlled dietetically and with the aid of insulin, a few vacuolated nuclei have always been found in the liver.

The presence of vacuolated nuclei cannot be correlated either with the severity of the glycosuria or of the ketonuria. Apparently, in depancreatized baboons, deprivation of insulin for a minimum period of four days initiates a process which profoundly alters the structure of the liver nuclei. Once developed, insulin can reduce the number but cannot abolish completely the vacuolated nuclei. Apparently, such nuclei remain as a permanent stigma of a temporary but complete deprivation of insulin.

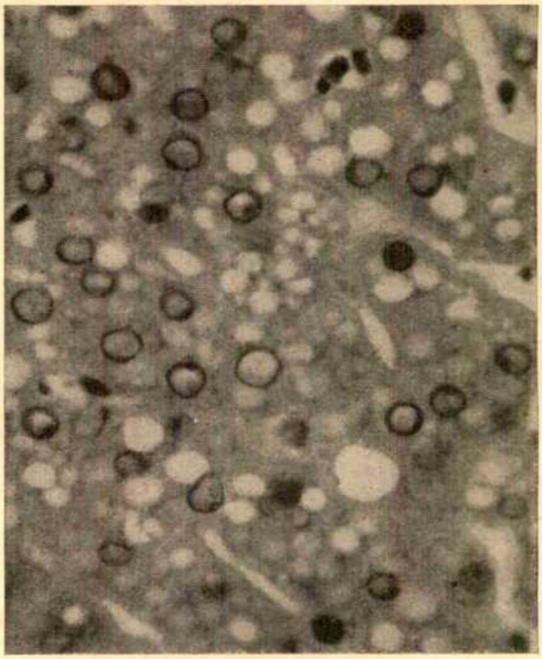

Fig. 1. Liver cells of depancreatized baboon showing numerous vacuolated nuclei each containing a large globule of glycogen

We wish to express our appreciation to Drs. J. C. Allan and A. J. Leonsins, of the Department of Surgery of this University, for depancreatizing the baboons.

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Pseudo-Cholinesterase in the Central Nervous System of the Frog

A RECENT reference in the literature[1] suggests that there may be no pseudo-cholinesterase in the central nervous system of the frog. The conclusion is based on two kinds of evidence: (1) with Warburg manometric technique the tissue did not split significant quantities of benzoylcholine; and (2) there was evidently no splitting of butyrylthiocholine when the tissue was examined histochemically by Koelle's[2] modified technique. Our own evidence suggests that this conclusion is incorrect.

Many studies[3] have shown that benzoylcholine is for many species, notably the ruminants, not a suitable substrate for the demonstration of pseudo-cholinesterase. Butyrylcholine is for this reason the substrate to be preferred in comparative studies. Using butyrylcholine, one of us (D. C. H.) has found that frog tissue (homogenate of brain, spinal cord and sciatic nerve) can split butyrylcholine, and the results clearly suggest the presence of both true and pseudo-cholinesterase (see Table 1).

Table 1

Tissue	Substrate (10 m*M*)	µl./hr./mgm. tissue No inhibitor	DFP 10^{-6} *M*
Brain	Acetylcholine	14·2	12·9
	Butyrylcholine	3·5	0
Spinal cord	Acetylcholine	18·4	14·6
	Butyrylcholine	7·3	0
Sciatic nerve	Acetylcholine	1·2	1·3
	Butyrylcholine	about 0·7	0
Mixed nervous tissue*	Acetylcholine	12·0	10·9
	Butyrylcholine	2·7	0

* Mixed tissue = combined brain, spinal cord and sciatic nerve.

Moreover, as mentioned earlier[4], it can be shown that sections of frog retina split butyrylthiocholine when the incubation system is that first described by Koelle[5]. Here, and in the spinal cord of the frog, the quantity of enzyme splitting butyrylcholine seems to be small; but it is demonstrable. An interesting finding is that both true and pseudo-cholinesterase may be present in the supporting cells of the optic nerve trunk.

These results underline the care required in attempting to characterize an enzyme by its activity towards one substrate only; this is particularly true of the use of benzoylcholine as a test for pseudo-cholinesterases, the specificity pattern of which varies markedly from species to species.

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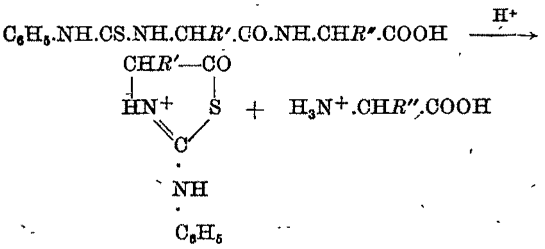
Mechanism of the Phenyl *Iso*thiocyanate Degradation of Peptides

A STUDY of the mechanism of the phenyl *iso*thiocyanate degradation of peptides[1] has made necessary a revision of our earlier formulation of this reaction. It has been found that the compound initially formed in the acid-catalysed cleavage of a phenyl thiocarbamyl peptide is not the expected 3-phenyl-2-thiohydantoin derivative of the N-terminal amino-acid, but instead the isomeric 2-anilino-5-thiazolinone.



$$C_6H_5.NH.CS.NH.CHR'.CO.NH.CHR''.COOH \xrightarrow{H^+} \begin{array}{c} CHR'\text{—}CO \\ | \qquad\quad | \\ HN^+ \quad\;\; S \\ \diagdown \;\; \diagup \\ C \\ \vdots \\ NH \\ | \\ C_6H_5 \end{array} + H_3N^+.CHR''.COOH$$

This intermediate is clearly distinguishable from the thiohydantoin by its ultra-violet absorption curve (Fig. 1) and by its behaviour on paper chromato-

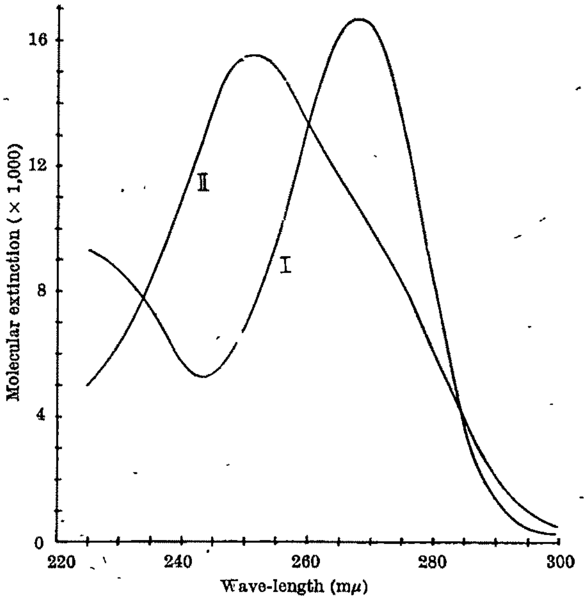
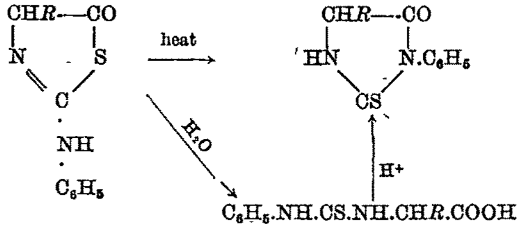


Fig. 1. Ultra-violet absorption curves of 5-*iso*butyl-3-phenyl-2-thiohydantoin (I) and 2-anilino-4-*iso*butyl-5-thiazolinone (II) in ethanol

graphy. Its marked instability explains why it has eluded discovery earlier. Thus, for example, recrystallization converts it to the isomeric 3-phenyl-2-thiohydantoin. Furthermore, it has been found that the thiazolinone can be converted to the thiohydantoin along two different routes. Under anhydrous conditions the conversion takes place as an intramolecular rearrangement, whereas in aqueous solution the thiazolinone is first rapidly hydrolysed to the phenyl thiocarbamyl amino-acid, which later slowly undergoes ring closure to the thiohydantoin.



This reaction mechanism offers an explanation for some discrepancies noted by several workers. Thus the remarkably large difference in the rate of cleavage of phenyl thiocarbamyl peptides in non-aqueous[1] and in aqueous acid solution[2] is only apparent, since in the latter instance the reaction observed was not the cleavage of the peptide, but actually the conversion of the phenyl thiocarbamyl amino-acid to the phenyl thiohydantoin. Furthermore, the appearance of multiple spots on paper chromatograms as the result of a single step in the degradation can probably in many instances be explained by the presence of the intermediates. For the same reason the extent of cleavage of the peptide may appear low when calculated from the yield of thiohydantoin.

A full account of this work will be published in *Acta Chemica Scandinavica*. It has been aided by a research grant from Eli Lilly and Company.

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Serum Magnesium Changes in Hibernation

HYPOTHERMIA and hibernation have been subjects of increasing interest in recent years, yet there is a critical lack of observations on the biochemistry of these states. High levels of magnesium in serum have been related by several investigators to hibernation and cold exposure[1]. In the present studies levels of serum magnesium and other electrolytes, and serum specific gravities, were compared in bats in several series including both hibernating and non-hibernating conditions.

The first species (*Eptesicus fuscus*) was collected in hibernation in a cave. One group was bled while still dormant and the other group after they were maintained and fed in a flight cage for four days. The second species (*Myotis lucifugus*) was obtained from a summer colony and from a cave in winter hibernation. The specimens were bled after periods of hibernation varying from 1 hr. to 9 weeks. The serum potassium determinations by flame photometry showed no significant changes due to hibernation. For other electrolytes recently described micromethods were used; for the calcium, the method of Natelson and Penniall[2] and for magnesium the method of Orange and Rhein[3]. The serum calcium-level during hibernation decreased, whereas the cell/plasma ratio and the specific gravity of the serum increased slightly but not consistently. The serum magnesium in all hibernating groups was 50 per cent higher than in the active animals, which normally showed a level of 4·1 mgm. per 100 ml. *P* values ranged from 2 to less than 1 per cent. The specific-gravity results indicated this was not a passive process.

The increase of serum magnesium in bats occurred after only one to two hours of hibernation and was found by the time the œsophageal temperature had dropped to 13° C. There was no significant increase in serum magnesium when the œsophageal temperature had dropped to only 17–20° C. Awakening from hibernation does not require a lowering of the serum magnesium, since there was no reduction of serum magnesium when body temperature was raised to 18° C., a procedure which required 5–8 min. However, one hour after arousal from hibernation, the serum magnesium had dropped. The increase in serum magnesium in hibernation is uninfluenced by season.

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The 'Seebeck Effect' in a Purely Ionic System

IN a recent discussion of the transducing mechanism responsible for thermal sensibility, it was argued that, if the free nerve-ending and the extracellular fluid surrounding it could be regarded as a thermocouple, a single sensory mechanism could account for the sensations of 'warm' and 'cold'[1]. A calculation of the potential difference associated with temperature gradients in homogeneous electrolytic solutions indicated that a thermoelectric effect large enough to account for the depolarization of a nerve fibre would almost certainly have to arise at the interface between the two phases of such an ionic thermocouple. Such an effect, analogous to the Seebeck effect for metallic thermocouples, has not previously been demon-

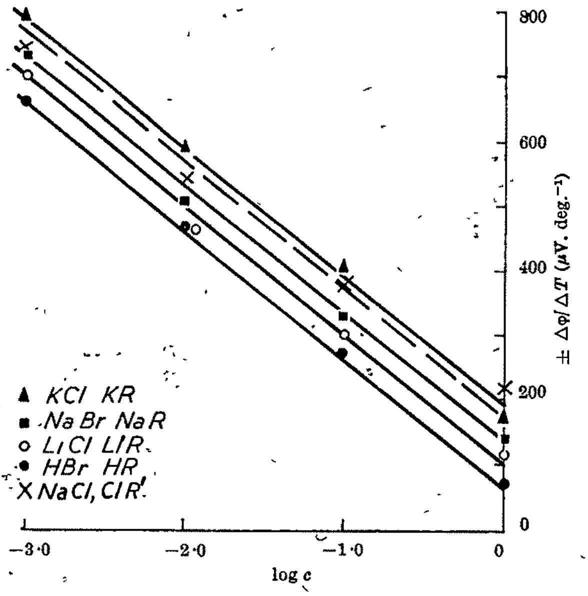

Fig. 1. Variation of $\pm\,\Delta\varphi/\Delta T$ with log c for cation-(R) and anion-(R') exchange resins. KR represent the cation resin in the potassium form, etc. The observed values of $\Delta\varphi/\Delta T$ were negative for the anion resin. The full and broken lines have the slope $2{\cdot}303\,R/zF$; the broken line refers to the anion resin

strated, so far as we are aware, for purely ionic systems. The following results show that the effect exists, and is of appreciable size.

As it was essential for the solid phase of the suggested ionic thermocouple to consist of an immobile framework of ions in which mobile ions of opposite sign are held, sheets of anion- and cation-exchange resins ('Permaplex A 10' and 'C 10' respectively) prepared by the Permutit Co., Ltd., were selected. Strips of the resin 1 cm. wide, 0·5 mm. thick and 10–16 cm. long were bent into a U shape and covered with 56° C. paraffin wax to prevent loss of moisture by evaporation. The cell used for the cation exchange resin was:

$$\begin{array}{c|c|c|c|c} \text{Ag, Ag}X & \text{Aqueous } MX \text{ conc. } C & \text{Resin in } M^+ \text{ form} & \text{Aqueous } MX \text{ conc. } C & \text{Ag, Ag}X \\ & T^\circ & T^\circ & T^\circ + \Delta T^\circ & T^\circ \end{array}$$

where X represents a halogen anion. The electrodes were introduced solely in order to make measurements of potential changes in the resin-electrolyte system possible, and made no net contribution to the e.m.f. developed by the cell. A similar cell was used for the experiments with the anion-exchange resins. The results were not intended to be precise; the main purpose of the work was the demonstration of the reality of the effect.

In general, the measured e.m.f., $\Delta\varphi$, was a linear function of the temperature difference ΔT across the strip, and the thermoelectric power $\Delta\varphi/\Delta T$ was reproducible for a given strip. Individual strips of the same nominal composition did not always show identical values for the thermoelectric power, probably because of slight differences in the concentration of the mobile ion in the solid phase. When the resins behaved reproducibly, the thermoelectric power of the cell was a logarithmic function of the concentration of the common ion (M^+ in the above cation-resin cell) in the electrolyte. This is seen in Fig. 1, where the experimental results are summarized. The values of $\Delta\varphi/\Delta T$ shown represent average values for this quantity over the range 20–55° C. and are accurate to about 0·02 mV. deg.$^{-1}$.

The variation of the thermoelectric power with the concentration of the common ion is of the form expected if the resin-solution interface is regarded as analogous to an electrode reversible to X^- or M^+ ions. On this model, the interfacial potential developed for unit change in T should change by approximately $2{\cdot}303\,R/zF$ for a ten-fold change in the concentration of the common ion in the electrolyte, where z represents the algebraic charge on this ion. If the cell illustrated is taken as an example, the electrode on the right would be positive if M^+ ions were released from the resin on heating, since the resin side of the interface would then become negatively charged. The converse should be true for a cell containing an anion-exchange resin. The straight lines in Fig. 1 show the theoretical value of the slope drawn as closely as possible to the experimentally determined points. There was, therefore, in these systems a contribution to the total thermoelectric power, dependent upon concentration, which arose at the resin-solution interface, that is, a contribution analogous to the Peltier e.m.f. in a metallic thermocouple. The remainder of the measured e.m.f. was made up of two thermal diffusion potentials (analogous to Thomson potentials) in the homogeneous phases in which temperature gradients existed, namely, in the resin strip and in the salt bridges. These were probably small in comparison with the effect at the interface; that in the electrolyte was probably of the order of tens of microvolts per degree.

If the mechanism of thermal sensation in free nerve-endings has any relation to this model system, a reasonable value for the thermoelectric power developed would be about 0·25 mV. deg.$^{-1}$. Changes in the nature of the solid phase could not change this value much. Since a voltage change of 10–15 mV. is required to initiate a propagated impulse in a wide variety of excitable tissues, it is improbable, therefore, that a single free nerve terminal could respond with the required sensitivity on the basis of this model. This does not necessarily rule out the hypothesis, since depolarization of an axon or cell body of nerve cells may be accomplished by the spatial or temporal summation of local depolarizations, individually or of a smaller magnitude than the minimum e.m.f. required for the 'triggering' of the parent axon or cell body. For the detection of a 1 deg. C. difference in temperature some forty to sixty locally propagated impulses of 0·25 mV. would be required to be summed at one stem nerve fibre to evoke a discharge. This is not an unreasonable number; in fact, many stem nerve fibres give rise to more than sixty nerve terminals.

We are indebted to Dr. T. R. E. Kressman, of the Permutit Co., for advice and for samples of the 'Permaplex' resins. The equipment used at Oxford was obtained with a grant to Dr. G. Weddell from the Rockefeller Foundation, which is gratefully acknowledged.

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[1] Tyrrell, H. J. V., Taylor, D. A., and Williams, C. M., *Nature*, 174, 918 (1954).

Flame Spectrum of Barium: Red and Infra-Red Bands

The diffuse bands appearing very strongly in the flame spectra of the alkaline-earth metals have been identified as due to the hydroxide radicals, CaOH, SrOH and BaOH. This identification is based on the work of James and Sugden[1] on hydrogen–air flames, employing photometric methods, and on work on isotope shifts with deuterium, which have been obtained for CaOH by Gaydon[2] and for SrOH by Huldt and Lagerqvist[3]. The flame method has now been extended to the strong red and infra-red barium bands.

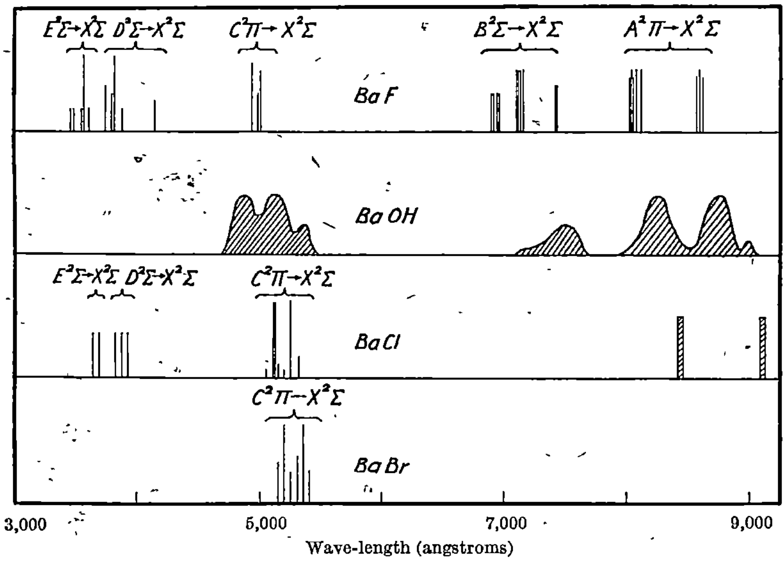


Fig. 1. Diagrammatic spectra of barium halide radicals, compared with the diffuse bands of barium flame spectrum

It has been pointed out by James and Sugden that there is a very marked similarity between the spectra of the alkaline-earth halide radicals and hydroxide radicals, the hydroxide falling between the fluoride and chloride. With calcium and strontium the green and orange and orange and red flame bands correspond to $B^2\Sigma \rightarrow X^2\Sigma$ and $A^2\Pi \rightarrow X^2\Sigma$ systems of the halide radicals. In the case of barium the blue-green bands correspond to the $C^2\Pi \rightarrow X^2\Sigma$ halide system. Bands analogous to the first two systems can be predicted to lie in the red and infra-red, in the region 7000–9000 A. It has been suggested by Huldt and Lagerqvist that barium flame bands lying at 8000–10,000 A. might be due to BaOH.

These bands were photographed, and the spectrum is represented diagrammatically in Fig. 1, together with the spectra of barium halide radicals as listed by Pearse and Gaydon[4]. It extends from about 7200 A. to 9000 A. (and probably beyond). The bands are all broad and diffuse and cannot possibly be confused with the red BaO bands, which show heads and are degraded to the red. The general appearance of these bands is exactly the same as of those in the blue and green, which are known to be due to BaOH. The resemblance between the distribution of the diffuse bands and BaF bands is very marked. It thus seems very probable that all the diffuse bands in the flame spectrum of barium arise from the same molecule, BaOH.

Further evidence was obtained from measurements of the integrated intensities, using a glass spectrometer of low resolution combined with a photoelectric device. The measurements were made in various flames, obtained by burning different mixtures of hydrogen and oxygen, with nitrogen diluent, in a Méker burner. The flames were of the shielded type, described by James and Sugden[5], and barium was introduced into them in the form of a fine spray of a dilute salt solution. The flame temperatures were measured by the sodium D-line reversal method.

In Fig. 2, $\log_{10} I_{\text{band}}$ is plotted against $1/T°$ K. for the red and infra-red bands, the green BaOH band (λ approx. = 5150 A.) being included for comparison. The experimental points do not lie on smooth curves but are grouped into 'families' of four, characterized by different nitrogen-to-oxygen ratios in the pre-burned gases. This effect illustrates the dependence of the concentration of the emitter on the composition of the flame, and it is practically the same for the three bands considered. (The accuracy of the measurements decreases towards lower temperatures.) Very similar results are obtained for the corresponding bands in the spectra of calcium and strontium. In all cases the dependence of band intensity on flame composition is characteristic, and so the red and infra-red BaOH bands fit very well into the general scheme of hydroxide radical bands. It will be recalled that it was on the basis of measurements made on the band intensities in isothermal flames that James and Sugden originally identified the strongest features of the alkaline-earth flame spectra as due to hydroxide radicals.

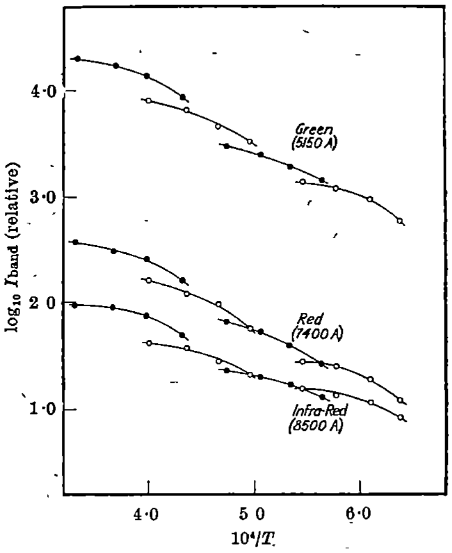


Fig. 2. Intensities of BaOH bands in various flames

I am grateful to Dr. T. M. Sugden for his advice and encouragement, and to Girton College and the Ministry of Education for a studentship.

E. M. Bulewicz

Department of Physical Chemistry,
University of Cambridge.
Dec. 6.

[1] James, C. G., and Sugden, T. M., *Nature*, 175, 333 (1955).

[2] Gaydon, A. G., *Proc. Roy. Soc.*, A, 231, 437 (1955).

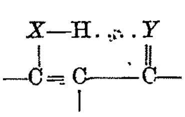
[3] Huldt, L., and Lagerqvist, A., *Naturwiss.*, 42, 365 (1955).

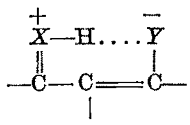
[4] Pearse, R. W. B., and Gaydon, A. G., "The Identification of Molecular Spectra" (2nd edit., Chapman and Hall, London, 1950).

[5] James, C. G., and Sugden, T. M., *Nature*, 171, 428 (1953).

Infra-red Spectra of Chelating Agents: 2-Phenacylpyridine Derivatives

It has been suggested that in a conjugated system of the type (I), where XH and Y can form a hydrogen bond donor–acceptor system, there is a significant contribution of the ionic form (II) to the ground state of the chelate system.


(I)


(II)

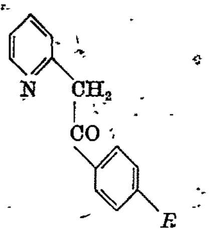
This phenomenon has been termed 'conjugate chelation', and has been observed to occur in acetylacetone, enolizable cyclic β-keto esters, in partially fluorinated β-diketones, in 2-acetyl-1-hydroxy naphthalene and related compounds, in 1-hydroxy anthraquinones, in flavanones and in ortho hydroxy aromatic aldehydes and ketones. All these compounds belong to the type (I) where X and Y represent oxygen atoms, but they fall into two classes. On one hand, there are the aliphatic and alicyclic materials, in which the double bond plays no part in any resonant system other than the chelate ring; and on the other hand are the aromatic compounds where the enol double bond is involved in an additional resonant system.

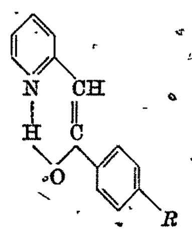
The systems mentioned above are characterized by carbonyl absorptions which are of increased intensity and widely shifted from the normal position. Furthermore, the hydroxyl absorptions are weak and diffuse, and so greatly shifted from the normal position as to indicate extremely strong hydrogen bonding.

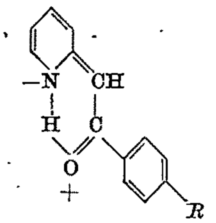
As part of a general investigation into the infra-red spectra of chelating agents and metal chelates, some derivatives of 2-phenacylpyridines[1] have been examined. These compounds, which are of interest because of their possible bacteriostatic activity[2], are now shown to represent another class exhibiting conjugate chelation.

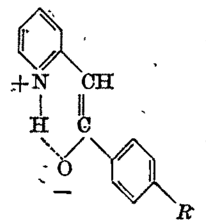
All the compounds were examined as solid mulls in 'Nujol' and as solutions in chloroform, carbon tetrachloride or bromoform. The spectra were obtained with a Perkin–Elmer double-beam automatic recording spectrophotometer with a rock-salt prism.

The infra-red spectrum of 2-phenacylpyridine (III, R = H) in the solid state does not show an absorption in the position normal for a carbonyl which is conjugated with an aromatic ring (1,700–1,680 cm.$^{-1}$)[3], and neither can any hydroxyl absorption be observed. In chloroform or carbon tetrachloride solution, however, where an equilibrium between the keto and enol forms exists, a very weak, diffuse hydroxyl absorption can be observed in the anomalous position of 2,600 cm.$^{-1}$. It can be concluded, therefore, that not only does 2-phenacylpyridine exist, in the solid state, in the enol form (IV, R = H), but also that the intramolecular hydrogen bond is greatly strengthened by resonance stabilization with the ionic forms (V, R = H and VI, R = H) (cf. resonance stabilization of carboxylic acid dimers, C. A. Coulson, "Valence", p. 303).


(III)


(IV)


(V)


(VI)

Similar results were obtained from a series of 2-phenacylpyridine derivatives (see Table 1), with the exception of the hydroxy- and amino-compounds, which show a normal carbonyl absorption, and exist in the keto form in the solid state. It is significant that the hydroxy- and amino-groups have the largest negative Hammett σ values of the various substituents in Table 1, but it should also be noted that these two groups offer alternative hydrogen donors for hydrogen-bond formation.

The compounds listed in Table 1 show only two bands in the out-of-plane C—H deformation vibration region, and these can be assigned to the pyridine ring substituted in the α-position and the para di-substituted benzene ring. In each of the compounds which exists in the enol form (and where conjugate chelation occurs), the benzene and pyridine ring absorptions are constant, but situated at the extremes of the normal ranges. In the hydroxy- and amino-compounds, however, the frequencies are not constant, but appear in expected positions. Furthermore, both the benzene- and pyridine-ring absorption bands appear as doublets, or undergo considerable shifts,[4] when these compounds are examined in

Table 1. OUT-OF-PLANE C—H DEFORMATION FREQUENCIES OF 2-PHENACYLPYRIDINE DERIVATIVES

Compound	Hammett σ value of substituent*	Pyridine ring vibration frequency (cm.$^{-1}$)	Benzene ring vibration frequency (cm.$^{-1}$)
2-*p*-Bromophenacylpyridine	+ 0·232	741	800
2-*p*-Chlorophenacylpyridine	+ 0·227	741	800
2-*p*-Fluorophenacylpyridine	+ 0·062	738	803
2-*p*-Methylphenacylpyridine	− 0·17	741	800
2-*p*-Methoxyphenacylpyridine	− 0·268	738	803
2-*p*-Hydroxyphenacylpyridine	− 0·357	756	822
2-*p*-Aminophenacylpyridine	− 0·660	763	833

* Jaffe, *Chem. Rev.*, 53, 191 (1953).

bromoform solution in which both the keto- and enol-forms exist. (Bromoform is transparent in this region.) There is normally very little difference between the spectra of the solid and the solution for these particular frequencies.

This observation is of interest in view of the attention currently being given to the relation between polarity and infra-red frequencies[4]. These results also indicate that it may be possible to study keto–enol tautomerism in these cases in the low-frequency region which possesses the advantages of being fairly clear and containing strong bands.

Further work on these compounds will be published later. Thanks are due to Drs. A. H. Beckett and K. A. Kerridge, of the School of Pharmacy, Chelsea Polytechnic, for providing the samples.

R. F. Branch

Ministry of Supply,
Chemical Inspectorate,
Block "A",
Station Approach Buildings,
Kidbrooke,
London, S.E.3.
Nov. 18.

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[1] Beckett and Kerridge, *J. Chem. Soc.*, 2948 (1954).

[2] Beckett, Kerridge, Patricia Clark, and Smith, *J. Pharm. Pharmacol.*, **7**, 717 (1955).

[3] Bellamy, "Infra-red Spectra of Complex Molecules" (Methuen, London, 1954).

[4] Bellamy, *J. Chem. Soc.*, 2818 (1955).

Photoelectric Phenomena with Copper Phthalocyanine

On the evidence of the dependence of electric conductivity upon temperature, Eley[1] and Vartanyan[2] reached the same conclusion, namely, that both phthalocyanine and its metallic derivatives should be regarded as kinds of semiconductors. In this connexion we wish to report that copper phthalocyanine exhibits the following photoelectric phenomena: (1) photoconductivity, (2) generation of electromotive force, and (3) change of the surface potential, both (2) and (3) being induced by illumination.

Experiments were conducted *in vacuo* at room temperature, employing crystal films prepared by vacuum sublimation. The light sources were a tungsten filament lamp, and mercury and sodium vapour lamps. Suitable filters being employed, whenever necessary, it was ascertained that the photoelectric phenomena occurred upon the illumination with ultra-violet or near infra-red as well as with visible light.

Conductance was measured by means of a surface cell. The organic crystal was deposited by sublimation on the surface of a quartz plate between the two gold electrodes of the cell. Photocurrents obey Ohm's law within the range studied (up to 100 V./cm.), and are proportional to the square roots of the light intensities.

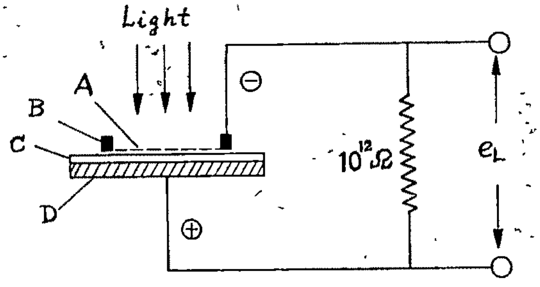

Fig. 1. Photocell for the measurement of electromotive force. *A*, translucent gold film; *B*, metallic ring; *C*, specimen film; *D*, platinum disk

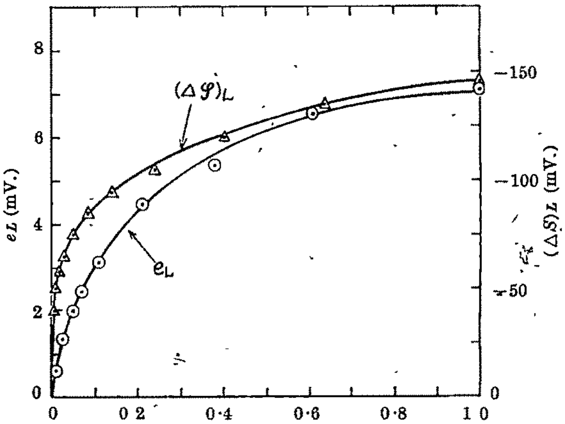

Fig. 2. The terminal voltage e_L and the change of surface potential $(\Delta S)_L$ plotted against light intensity (tungsten filament lamp

The cell used in measuring the electromotive force was of the sandwich type; that is, the crystal to be tested was first deposited on the surface of a platinum disk and then a thin translucent film of gold was prepared by evaporation upon the organic crystal (Fig. 1). When the photocell was illuminated without imposing any external voltage, an electromotive force was generated, and the film of gold became negative. In Fig. 2 the terminal voltage e_L induced by the illumination is plotted against the light intensity.

The surface potential was measured with a vibrating capacity electrometer. The fixed electrode was a platinum disk covered with the organic film. There occurred a distinct change upon illumination in the surface potential of the crystal film. The photoelectric effect of this experiment was of the same nature as found in the usual inorganic semiconductors such as germanium[3] and in organic dyes such as crystal violet[4]. The relation between the change of surface potential (ΔS_L) and the light intensity is also shown in Fig. 2.

These photoelectric phenomena are possibly due to the creation of mobile charges (electrons or positive holes) by the illumination, so that they should all be related to one another. They are certainly evidence of the semiconducting character of copper phthalocyanine. Similar phenomena have also been observed in our laboratory in crystals of metal-free phthalocyanine.

Details of the work described above will be published elsewhere. We thank Prof. K. Higasi for his interest and encouragement.

Hiroaki Baba
Kazuo Chitoku
Keijiro Nitta

Research Institute of Applied Electricity,
Hokkaido University,
Sapporo, Japan. Nov. 26.

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[1] Eley, D. D., *Nature*, **162**, 819 (1948). Eley, D. D., Parfitt, G. D., Perry, M. J., and Taysum, D. H., *Trans. Farad. Soc.*, **49**, 79 (1953).

[2] Vartanyan, A. T., *J. Phys. Chem. U.S.S.R.*, **22**, 769 (1948); *Chem. Abstr.*, **43**, 1272 (1949)

[3] Brattain, W. H., and Bardeen, J., *Bell Syst. Tech. J.*, **32**, 1 (1953).

[4] Baba, H., and Nitta, K., *Bull. Res. Inst. App. Elec., Hokkaido Univ.*, **7**, 10 (1955).

FORTHCOMING EVENTS

Monday, April 9—Tuesday, April 10

Society of Chemical Industry, London Section (in the William Beveridge Hall, Senate House, University of London, London, W.C.1), at 9.30 a.m. daily—Symposium on "Applications of Infrared Spectroscopy".

Monday, April 9—Saturday, April 14

Institution of Electrical Engineers (at Savoy Place, London, W.C.2)—Convention on "Digital-Computer Techniques".

Tuesday, April 10

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. I. Downes: "Patents in Chemical Engineering".

Society for Analytical Chemistry, Physical Methods Group (in the Large Chemistry Lecture Theatre of the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 6.30 p.m.—Meeting on "Plant Instrumentation". Dr. B. W. Bradford: "Progress in Plant Analytical Control Methods"; Dr. A. E. Martin: "The Sonic Gas Analyser"; Mr. D. A. Patient: "Automation in the Laboratory".

Tuesday, April 10—Thursday, April 12

Faraday Society (in the Great Hall, The University, Nottingham)—General Discussion on "Membrane Phenomena".

Tuesday, April 10—Friday, April 13

Institute of Metals (in London)—Spring Meeting.

Tuesday, April 10

(At the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Dr. Willis Jackson, F.R.S.: "Ferroelectrics—the Dielectric Analogue of Ferromagnetics" (May Lecture).

Wednesday, April 11

(At Church House, Great Smith Street, S.W.1), at 10 a.m.—Annual General Meeting. Major C. J. P. Ball: "The History of Magnesium" (Presidential address).

Wednesday, April 11

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Raymond Pickering: "The Pleistocene Geology of the South Birmingham Area". (Paper to be read by Prof. F. W. Shotton.)

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. J. Paton: "The Polar Aurora" (Symons Memorial Lecture).

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. W. Platt: "The Oil Industry—Its Place in the World and Its Future".

Society of Chemical Industry, Food Group—Nutrition Panel (at the Royal Society of Medicine, 1 Wimpole Street, London W.1), at 5.45 p.m.—Annual General Meeting; at 6 p.m.—Fourth and Final meeting of the series "Nutritional Requirements and Food Fortification".

Society for Analytical Chemistry, Microchemistry Group (in the Restaurant Room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion meeting on "Complexones in Microchemistry". Opening Speakers: Mr. H. J. Cluley and Mr. C. Whalley.

Wednesday, April 11—Thursday, April 12

Laboratory Animals Bureau (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 9.30 a.m. daily—Ninth Congress.

Wednesday, April 11—Friday, April 13

Society of Chemical Industry, Plastics and Polymer Group (in the William Beveridge Hall, Senate House, University of London, London, W.C.1), at 10 a.m. daily—Symposium on "Epoxide Resins—Their Chemistry and Structure in Relation to Their Properties and Applications".

Thursday, April 12

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. H. Nutcombe Hume: "The Work of the Colonial Development Corporation" (Thomas Holland Memorial Lecture).

Institution of Chemical Engineers (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. L. Wilson, Mr. P. A. White and Mr. J. G. Milton: "The Control, Conveyance, Treatment and Disposal of Radioactive Effluents".

Physical Society, Acoustics Group (at the Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. A. Poliakoff: "Development of Transistor Hearing-Aids".

Society of Chemical Industry, Microbiology Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6 p.m.—Annual General Meeting. Mr. H. J. Bunker: "Microbiology in Industry".

British Psychological Society (joint meeting of the Industrial and Social Psychology Sections, in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 7.30 p.m.—Prof. Ross Stagner (University of Illinois): "Recent Psychological Research in Industrial Relations".

Thursday, April 12—Friday, April 13

Institute of Physics, X-Ray Analysis Group (joint meeting with the Low Temperature Group of the Physical Society, at the Clarendon Laboratory, Oxford)—Conference on "Low Temperature Crystallography".

Society of Leather Trades' Chemists (in the Chemistry School, Pembroke Street, Cambridge), at 9.30 a.m. daily.—Symposium on "Vegetable Tannins".

Friday, April 13

Laboratory Animals Bureau (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 9.45 a.m.—Symposium on "Infections of Laboratory Animals". Chairman: Prof. J. W. Howie.

Biochemical Society (in the Department of Biochemistry, The University, Glasgow), at 11.30 a.m.—Scientific Papers.

Institute of Metals (in the Weir Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1), at 2.30 p.m.—Prof. Erich Schmid (University of Vienna): "Electron Emission from Metals".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Meeting.

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Prof. J. L. M. Morrison, Mr. B. Crossland and Mr. J. S. C. Parry: "Fatigue Under Triaxial Stress—Development of a Testing Machine and Preliminary Results"; Mr. N. E. Frost and Mr. C. E. Phillips: "The Fatigue Strength of Specimens Containing Cracks".

Institute of Physics, Industrial Spectroscopy Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. F. W. J. Garton: "Determination of Isotopic Abundance by Emission Spectroscopy".

Aslib (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. C. N. Kington: "Industrial Research for Small Firms, with special reference to the Role of Information Services".

Friday, April 13—Sunday, April 15

Botanical Society of the British Isles (in Tuke Hall, Bedford College, Regent's Park, London, N.W.1), at 10.15 a.m. daily—Conference on "Progress in the Study of the British Flora".

Sunday, April 15

Field Meeting in the neighbourhood of Hitchin, Hertfordshire.

Saturday, April 14

Association of Clinical Biochemists (joint meeting with the Biochemical Society, in the Biochemistry Department, The University, Glasgow)—Papers and Demonstrations, including a Symposium on "Clinical Control of Electrolyte Deficiencies".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (Grade A) in the Electrical Engineering and Physics Department, primarily for physics, calculations and engineering science—The Secretary, Poplar Technical College, Poplar High Street, London, E.14 (April 14).

Assistant Lecturer or Lecturer (with special qualifications in applied mathematics or theoretical physics) in the Department of Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (April 14).

Assistant Lecturer or Lecturer (with special qualifications in either inorganic or physical chemistry) in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (April 14).

Chemist (honours graduate, preferably with experience of spectrochemical equipment) for advisory work concerned mainly with trace elements in plant nutrition—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (April 14).

Director (scientist or technologist of established reputation, with administrative experience) of the Science Museum—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4575/56/1 (April 14).

Assistant Lecturer (preferably female) in Physics—The Principal, Royal Holloway College, Englefield Green, Surrey (April 16).

Lecturer or Assistant in the Joint Department of Chemical Technology and Chemical Engineering (University of Edinburgh and Heriot-Watt College)—The Assistant Secretary, The University, Edinburgh (April 16).

Scientific Officer, Grade 3 (with a degree of high standard, with physics as a major subject, together with several years relevant research experience) in the Defence Standards Laboratories, Department of Supply, Maribyrnong, Victoria, Australia, for research in X-ray and gamma-ray physics—The Senior Representative (AP.58), Department of Supply, Australia House, Strand, London, W.C.2 (April 16).

Forestry Officer (with a degree in forestry from a British university) for work on schemes for the planting of derelict pit heaps, tree preservation orders, felling licences, park layout, etc.—The County Planning Officer, 10 Church Street, Durham (April 18).

Lecturer (with a good honours degree) in Chemical Engineering—The Registrar, King's College, Strand, London, W.C.2 (April 18)

Assistant Lecturer in Biology—The Registrar, University College of North Staffordshire, Keele, Staffs (April 20).

Chemist (with an honours degree in chemistry or equivalent qualifications, and at least two years industrial experience) in the Technical Policy Branch of the Industrial Group of the United Kingdom Atomic Energy Authority, to assist in the preparation of long-term programmes covering all activities of the Industrial Group—The Recruitment Officer, U.K.A.E, Industrial Group. Headquarters, Risley, near Warrington (April 20).

Engineers and Physicists (Experimental Officer grade) in the Rocket Propulsion Department, Ministry of Supply, Westcott, Bucks, for research and development on rocket motors and propellants; instrumentation and recordings; investigations on high speed flow and heat transfer problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.105/6A/BN (April 21).

Assistant Lecturer in Applied Mathematics—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (April 25).

Senior Lecturers, Lecturers or Assistant Lecturers in Botany, Organic Chemistry, Mathematics and Zoology, at the University College of Khartoum, Sudan—The Secretary, Inter-university Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 25).

Assistant Lecturers (Grade III) or Demonstrators (2) in Physiology—The Registrar and Secretary, The University, Bristol (April 27).

Aerodynamicist or Mathematician (with a first- or second-class honours degree or equivalent in engineering or mathematics, and preferably with experience in experimental aerodynamics), at the Ministry of Supply Royal Aircraft Establishment, Bedford, to work in a section responsible for full-scale aerodynamics research on helicopters—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.110/6A (April 28).

Assistant (with an honours degree in physics) in the Department of Natural Philosophy—The Assistant Secretary, The University, Edinburgh (April 28).

Lecturer (with special qualifications in mineralogy, including a working knowledge of X-ray techniques) in the Department of Geology—The Registrar, The University, Bristol (April 28)

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics, and subjects allied to chemistry and physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Lecturer, Grade III or Grade II (preferably with research interests in the field of high energy physics and theories of elementary particles), in the Department of Physics—The Registrar, The University, Bristol (April 30).

Lecturer or Assistant Lecturer in Philosophy at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

Lecturers or Assistant Lecturers in Botany and Zoology, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

Senior Lecturer (with a good honours degree, and preferably with experience in teaching overseas students) in Geography, at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (April 30)

Chair of Botany at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 7).

Lawrence Hargrave Chair of Aeronautical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 7).

Reader in Mechanical Engineering at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 7).

Lecturer or Assistant Lecturer in Organic Chemistry—The Registrar, The University, Leeds 2 (May 12)

Assistant Lecturer in Inorganic or Physical Chemistry—The Secretary, Queen's University, Belfast (May 15).

Research Assistant (with a degree of doctor of philosophy or equivalent research experience) to work in the Department of Applied Mathematics on quantum collision problems.—Prof D. R. Bates, Queen's University, Belfast (May 15).

Lecturer (with a university degree in forestry and additional training and experience in forest zoology, or an honours degree in entomology (or zoology including entomology)) in Forest Zoology—The Assistant Secretary, The University, Edinburgh (May 31)

Scientific Assistant (with an honours degree in biological sciences, some knowledge of foreign languages and the ability to write correct English)—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (June 1).

Leverhulme Student for research in Chemical Engineering—The Registrar, Imperial College, London, S.W.7 (July 1).

Instructors (with a Ph.D. degree or equivalent) in the Department of Chemistry, for duties which will involve undergraduate lecturing in Inorganic, Analytical and Physical Chemistry, and laboratory demonstrating—Prof. C. A. McDowell, Department of Chemistry, University of British Columbia, Vancouver 8, B.C., Canada.

Laboratory Technician (with some chemical experience)—Prof. F. C. Happold, Department of Biochemistry (University of Leeds 9 Hyde Terrace, Leeds 2.

Master to take Physics up to University Entrance standard—The Headmaster, Keswick School, School House, Keswick, Cumberland.

Research Assistant (Ph.D. standard) for work on the physical absorption of vapours on ionic crystals—Dr. F. C. Tompkins, F.R.S., Imperial College, London, S.W.7.

Technician (preferably with photographic and radiation experience) in the Physics Department, to assist in a radiation protection service—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report of the Chief Inspector of Factories for the year 1954. (Cmd. 9505) Pp. 265. (London: H.M. Stationery Office, 1955.) 8*s*. net. [301

Air Ministry: Meteorological Office. Handbook of Weather Messages. Part 1: Transmission Schedules and Station Index Numbers. Second edition. (M.O. 510a.) Pp. xi+114. (London: H.M. Stationery Office, 1955.) 6*s*. net. [311

Catalogue of Nuclear Reactors, 1955. Prepared by Atomic Energy of Canada, Limited, Chalk River Project, with the co-operation of the Atomic Energy Research Establishment, Harwell, England. (AECL No. 220. CRR-590) Pp. 60. (London: H.M. Stationery Office; Chalk River: Atomic Energy of Canada, Ltd., 1955.) 4*s*. 6*d*. net. [311

Aluminium Development Association. Information Bulletin No. 19: The Arc Welding of Aluminium. Pp. 92. (London: Aluminium Development Association, 1955.) 2*s*. 6*d*. [311

Memoirs of the Royal Astronomical Society. Vol. 67, Part 3: The Cambridge Radio Telescope. By M. Ryle and A. Hewish. A Survey of Radio Sources between Declinations −38° and +83°. By J. R. Shakeshaft, M. Ryle, J. E. Baldwin, B. Elsmore and J. H. Thomson. Pp. 13–154+plate 1. (London. Royal Astronomical Society, 1955.) 28*s*. [311

Aero Research Technical Notes. Bulletin No. 156: The Uses of Stickiness. Pp. 3. (Duxford: Aero Research Limited, 1955.) [311

Other Countries

Proceedings of the American Philosophical Society. Vol. 99, No. 6 (December 15, 1955): Studies on Benjamin Franklin (The Two Hundred and Fiftieth Anniversary of his Birth, January 17, 1956). Pp. iv+359–476. (Philadelphia: American Philosophical Society, 1955.) 1 dollar. [201

Académie Royale de Belgique. Classe des Sciences. Mémoires, Tome 29, Fascicule 3: Sur certaines classes d'espaces homogènes de groupes de Lie. Par J. Tits. Pp. 268. (Bruxelles: Académie Royale de Belgique, 1955.) 200 francs. [201

Henry N Ridley, 1855–1955. (The Ridley Centenary, 10th December, 1955, Botanic Gardens, Singapore.) Pp. 16+1 plate. (Singapore. Botanic Gardens, 1955.) [201

Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin. Klasse fur Mathematik und Allgemeine Naturwissenschaften Beiträge zur Tektonik des Thüringer Beckens. (Abhandlungen zur Geotektonik Nr. 5. Herausgegeben vom Geotektonischen Institut der Akademie.) Pp. 173+12 karten und profile. (Berlin: Akademie-Verlag, 1955.) 54 D. marks. [201

Institut Royal des Sciences Naturelles de Belgique. Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949). Résultas Scientifiques. Vol. 3, Fascicule 4: Larve de Cérianthaire. Par Eugène Leloup. Siphonophores. Par Eugène Leloup. Crustacés Décapodes, Pagurides. Par Jacques Forest. Some Opisthobranchs from West Africa. By Kathleen M. White. Alcyonaires Atlantiques Intertropicaux. Par Andrée Tixier-Durivault. Pp. 246 (6 plates). Exploration Hydrobiologique du Lac Tanganyika (1946–1947). Résultas Scientifiques. Vol. 4, Fascicule 2: Characeae. By Richard D. Wood. Hepaticae. Par Constant Vanden. Pteridophyta. Par Fernand Demaret. Compositae, Leeaceae. Lemnaceae et Vitaceae. Par André Lawalrée. Pp. 82 (6 plates). (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1955.) [201

Possibilities of Action in the Field of Nuclear Research. (Working Party on Nuclear Energy.) Pp. 70. (Paris: O.E.E.C.; London: H.M. Stationery Office, 1956.) 300 French francs; 6*s*.; 1 dollar. [301

Smithsonian Miscellaneous Collections. Vol. 131, No. 4: New Cretaceous Brachiopoda from Arizona. By G. Arthur Cooper. Pp. 18+4 plates. (Publication 4227.) (Washington, D.C.. Smithsonian Institution, 1955.) [311

Companhia de Diamantes de Angola. Servicos Culturais. Dundo–Lunda–Angola. Museu do Dundo. Subsidios para o Estudo da Biologia na Lunda. Publicacoes Culturais No 28: Preliminary Revision of the genus Catantops Schaum and Review of the Group Catantopini (Orthoptera, Acrididae). By Dr. V. M. Dirsh. Pp. 151. (Lisboa: Companhia de Diamantes de Angola, 1956.) [311

Memorie dell'Istituto Italiano di Idrobiologia "Dott. March de Marchi." Suppl. Vol. 8. Symposium on Biological, Physical and Chemical Characteristics of the Profundal Zone of Lakes, Pallanza, 21–24 Luglio 1954. (Colloque N: 19, I U.B.S.) Pp. 530. (Milano: Editore Ulrico Hoepli, 1955.) [311

Bulletin d'Information de l'Institut National pour l'Étude Agronomique du Congo Belge. Vol. 4, No. 6 (Décembre 1955): La culture du tabac au Lomami. Par R. Van Leer. Pp. 357–416. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) [311

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Forms of application are obtainable from: The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S W.1.

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UNIVERSITY OF LONDON, KING'S COLLEGE, will require on October 1, 1956, a Lecturer in Chemical Engineering Applicants should have a good honours degree Salary on the scale £700 by £50 to £1,000: £1,050 by £50 to £1,400, with family allowances and superannuation benefits, with starting point according to qualifications and experience.—Applicants should write for conditions of appointment and application forms to the Registrar, King's College, Strand, W.C 2, whom completed applications must reach by April 18

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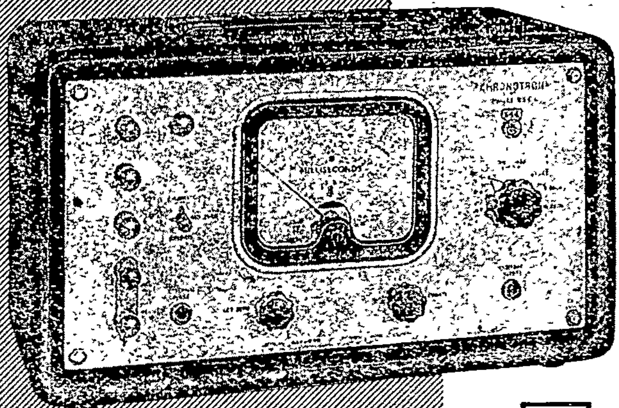

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THE BALANCE OF TECHNOLOGICAL AND TECHNICAL MAN-POWER

THE need for balancing the claims of defence research against the competing claims on Britain's limited resources of man-power, as well as the way in which the size of the Armed Services themselves inevitably affects the man-power available for industry in general, is well brought out in the White Paper on Defence (see *Nature*, April 7, p. 635). The decision to reduce the man-power in the Forces to about seven hundred thousand by March 1958, as announced last October, is intended to provide some relief to the man-power situation as well as to the national economy. While, however, the numerical demand for man-power by the Services may be thus slightly reduced, the premium on skilled man-power, particularly the highly skilled long-service regular service-man, is increased. The improvements in pay in the Armed Services which have recently been announced are intended to increase the numbers of men signing on for, or converting to, long-service engagements and to reduce the wastage of man-power that is unavoidable with a rapid turnover of short-time regulars.

In this respect the Government has thus made a direct attempt to secure the more effective utilization of the man-power of Britain, and particularly skilled man-power; but the elimination of waste in this field has by no means received the attention which it demands. Indeed, the emphasis now being placed on the expansion of technical and technological education sometimes obscures the truth that such measures—even if there were no shortages of science or technical teachers, of buildings or equipment to cause delay in implementing plans—take a term of years to fructify. There are no short cuts or quick returns in educational development; and apart from relieving a particular shortage by measures which merely drain the supply from other demands and create or intensify other shortages, the real hope for the short-term alleviation of the man-power situation lies in the more effective use of the resources already at our disposal.

Some of those possibilities were well indicated in the proceedings of a Conference on the Utilization of Scientific Professional Manpower held at Columbia University, New York, in October 1953, and which have since been published[*]. The report appears to have received little notice in Britain, although it indicates questions to which answers are urgently required in Britain if man-power resources are to be wisely handled, and indeed if the resources now to be devoted to technical and technological education are to be expended to the best advantage, from the point of view of the nation and from that of the students themselves. For example, the recent White Paper on Technical Education assumes that five or six technicians may be required for each technologist. This, however, is a ratio which will vary from one occupation or profession to another. If we are to take account of it in planning the expansion of technical and technological education, we need to have more accurate information as to this ratio and as to the relative numbers engaged in the different occupations and professions.

Nor is this all. We need to assure ourselves that the ratio of technician to technologist or professional worker is a reasonable one in the circumstances of to-day, and not one determined purely by professional tradition or conditions which are no longer relevant. For its elucidation of this point alone and for its indication of the possibilities in saving the time of the highly skilled professional worker as a result of careful re-examination of practice in medicine, in engineering and in teaching alone, the proceedings of the Columbia University Conference merit consideration by all concerned with the more efficient utilization of scientific and technical man-power in Britain. We cannot afford to allow questions of either professional status or practice to hinder the fuller use of supporting technicians when this can be done without detriment to professional standards and the quality of the service.

This question of the ratio of technicians to technologists thus opens up larger issues. We need to ask the reasons for these ratios, why they should vary from industry to industry, from profession to profession, or even from plant to plant within an industry. The answers to such questions will often throw light on the ways in which the less highly trained workers could be used to support and increase the efficiency of those fully trained, and may indeed suggest new ways in which the existing shortages of scientists and technologists could be ameliorated by making use of those with much less training.

This is only the first of six major approaches to the more effective utilization of scientific and professional man-power suggested at the Conference. Another is that adopted by the British Government in the new schemes of pay for the Armed Services, in so far as these provide incentives to prevent the wasteful turnover of professional trained personnel. This is a field in which industry, by giving more attention to the selection and placing of its recruits, could probably do even more to reduce wastage; but more still will be done if, in the new plans for the expansion of technical and technological education in Britain, due attention is given to encouraging adaptability and adequate breadth of education, as indeed the White Paper recognizes.

Another major approach specified at the Conference was the re-assessment of the appropriateness of the education and training of professional persons; and this point is one that is of especial importance in considering the expansion of technical education in Britain. Even when full account is taken of the importance of encouraging adaptability, the effective utilization of scientific and technical man-power always depends on the way in which professional education and training are related to the functions which those so trained are expected to perform. This is one reason why the syllabuses for professional examinations as well as the curricula of technical colleges and universities require continual re-appraisal in the changing world of to-day. Moreover, if wise decisions are to be made, the conception of the purpose of technological and of technical education, as well as of university education, must be clear and sound.

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[*] National Manpower Council. Proceedings of a Conference on the Utilization of Scientific and Professional Manpower Held October 7–11, 1953, at Arden House, Harriman Campus of Columbia University. Pp. xii+197. (New York: Columbia University Press, 1954.) 3 dollars 50 cents.

The development of new patterns of work to improve the total output of professional workers and technicians in concert is another major approach which demands fresh minds and constructive thinking, as well as a good deal of investigation. It could well prove a most fruitful field of investigation by the joint committees of the Department of Scientific and Industrial Research and the Medical Research Council, and some of the possibilities in this direction were indicated by the Secretary of State for Air in presenting the Air Estimates on March 5. Another major approach suggested is the increased use of capital to permit the full employment of professional skill. This is an approach which, apart from capital considerations, is clearly more difficult to explore in Britain than in the United States. Under certain conditions, additional expenditure on buildings or equipment may well increase the output of goods or services from the same number of technologists or scientists. It will not, however, be sufficient to secure their co-operation alone: the fear of redundancy must be dispelled from the minds of those who work with them, and unless this is done the capital expenditure may merely increase the cost of the goods or services without any advantage.

The sixth direction in which the Conference at Columbia University looked for the more efficient utilization of scientific and technical man-power was through improved leadership and administration. This aspect, however, in respect of research was discussed even more fully at the ninth annual conference on the administration of research held last September at the Northwestern University Technological Institute, Illinois*. The pattern of organization in the United States differs considerably from that in Britain, and some of the criticism of that pattern which was expressed at the Conference has not the same validity elsewhere. There may, for example, be less risk in Britain that research activities at the universities will be expanded in ways inimical to teaching or the real purposes of a university: sponsored research and ear-marked grants are scrutinized too carefully, and it should not be too difficult, with the existing organization rightly used, to ensure that fundamental research is pursued on a reasonably even front.

The comments on security and freedom of communication are another matter and touch as closely on the effective utilization of trained man-power in Britain as in the United States. In both countries intimate and rapid communication as well as secrecy and caution are needed in pushing back the frontiers of knowledge in other fields besides that of nuclear energy. The practical problem is to provide the necessary minimum of security around the research and development programmes in the military field without hindering the degree of communication vital to the maximum stimulation of inventive thinking and the effective application of results. To over-emphasize security is inconsistent with the effective prosecution of research, and is a continual cause of wasted man-power.

Again, waste of man-power in research easily arises out of administration which lacks full understanding of the outlook and methods of the research worker. The task of the administrator, even in applied research, consists not merely in selecting the problems but also in providing the conditions which are most stimulating for creative work. Criticisms on this point made in the United States by Mr. P. P. Barnard apply more particularly to defence research; but they have their implications for Britain also, and suggest ways in which the efficiency of such research might possibly be increased by securing greater co-operation on the part of industry.

The criticism by business executives of the administration of research in the United States is of particular interest. Expenditure there on research is estimated at some 4,500 million dollars for the year ending June 30, 1956, of which about 2,000 million dollars will be spent by industry and another 1,000 million dollars on government contracts with industry for defence purposes. The magnitude and variety of such contracts have been severely criticized, as well as the widespread invitations to tender and the tendency on the part of some government agencies in the United States to treat research as a commodity. These were all criticized as wasteful of effort, and waste also arises in the administration of contracts, primarily from the lack of understanding already noted, while secrecy can lead to serious duplication of effort by different departments and organizations. Generally it was considered that industrial research is cheaper than that administered by the Government, and this is a factor which suggests that the effort of the central government should be kept to the minimum that security and like considerations suggest.

From the point of view of the efficient utilization of scientific and technical man-power in Britain, if not of other resources, the distribution of research effort should be determined largely by the appropriateness of the projects for the type of institution. Universities, government departments and research institutions, private research institutions and those of the public corporations and of private industry all have their particular or even special competence, advantage of which must be taken if the nation's resources are to be deployed to the best advantage; nor will this need disappear even when educational developments begin to overtake the shortage of scientific and technical man-power. Merely increasing the number of those who receive technical education will not solve this problem of making full use of creative man-power. It will still be essential to apportion those resources of scientific and technological man-power where they are most needed and can be most effective.

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* Proceedings of the Ninth Annual Conference on the Administration of Research, September 7–9, 1955, Northwestern University Technological Institute, Evanston, Illinois, U.S.A. Pp. 107. (University Series.) (New York: New York University Press, 1956.) 4 dollars.

Much of this question of securing more efficient utilization of scientific and technical man-power consists essentially in the prosaic work of making small adjustments here and there, so as to improve the relations between government departments or between such departments and industry, or those between the administrator and the research worker. The principles laid down by the Atomic Energy Commission of the United States in relation to its research programme deserve, however, to be noted and applied widely at a time when fundamental research is of growing importance to military and economic security alike. The university is still an unmatched source of fundamental knowledge, and progress in research comes most rapidly when the individual scientist is free to follow the dictates of his own scientific curiosity and reasoning, without pressure from those who seek possible practical application of his findings. Moreover, the most significant progress in fundamental research is achieved by a relatively few outstanding individuals. The emphasis on a research programme should accordingly be on the effective support of selected men rather than of institutions, and the universities which produce these men should be supported in programmes that can be integrated properly with their educational function. It should be remembered, too, that the individual scientist is the best judge of what research effort will lead to the most significant progress in fundamental science ; and it should also be recognized that a programme for the expansion of technical and technological education which fails to take due account of all such considerations is very unlikely to yield the maximum return for its expenditure.

THE CHEMISTRY OF CELLULOSE

Cellulose and Cellulose Derivatives

Prepared under the Editorship of Emil Ott, Harold M. Spurlin and Mildred W. Grafflin. Second completely revised and augmented edition. (High Polymers Series: a Series of Monographs on the Chemistry, Physics and Technology of High Polymeric Substances—Vol. 5.) Part 1, pp. xvi+509 ; Part 2, pp. viii+511–1056 ; Part 3, pp. viii+1057–1601.

(New York : Interscience Publishers, Inc. ; London : Interscience Publishers, Ltd., 1954–55.) 12 dollars each part.

KNOWLEDGE of the chemistry of high polymers has grown so rapidly that it is difficult for the student of to-day to realize that only thirty years ago cellulose was generally regarded as a colloid of the micellar aggregate type based on a comparatively simple unit containing at most a few glucose residues. Even the X-ray crystallographic results were interpreted as providing supporting evidence for this view. New ideas on the possibility of a covalent bond structure for large molecules were provided by the pioneering work of Staudinger, and in 1926 Sponsler and Dore suggested a formula for cellulose in which the molecule was represented as a long chain of consecutively linked glucose residues. This particular structure could not be reconciled with the detailed chemistry of cellulose, and the one now generally accepted, which postulates a long unbranched chain of β-1,4′-linked D-glucopyranose residues, was then put forward by Haworth. Detailed interpretations of the X-ray data on the new basis were given by Meyer and Mark, and to some chemists it appeared that the problems of the structural chemistry of cellulose had been solved. Nevertheless, those whose business it was to deal with industrial applications of cellulose remained dissatisfied, feeling that many of the details which gave the substance its special properties were beyond the range of the available chemical and physical methods of investigation.

To some extent subsequent work on the organization of cotton cellulose, wood cellulose and regenerated cellulose into crystalline regions alternating with less highly ordered portions helped to explain the reactivity of the various celluloses. Much also was discovered which helped to explain the distinctive properties of the oxycelluloses and hydrocellulose. But little was known of the organization of the macromolecules in the region between the single chains revealed by chemical investigation and the relatively gross structural features visible under the ordinary microscope. Only recently has a beginning been made in this field by means of electron microscope studies carried out notably by workers of the Swedish school. Evidence of a complex fibrillar structure comprising bundles of individual cellulose molecules is now coming to light, and although it is perhaps too early to say that anything like a complete picture can yet be presented, it is significant that this recent work tends to bring us back again to the idea of a colloid which depends largely on hydrogen bonds for the preservation of its fine structure. Further work on these lines and on the infra-red spectroscopy of cellulose fibres will be awaited with much interest. Many other fundamental and industrially important problems still await solution, including the nature of the association of cellulose, hemicelluloses and lignin as they occur in lignified plant tissues.

In the meantime, however, the reader will find in the three books under review authoritative accounts of the present state of knowledge in these fields of fundamental scientific study. He will find also detailed discussions of all aspects of the technology of cellulose and its derivatives. The formidable task of revising the 1943 edition in the light of the many subsequent discoveries has been most successfully undertaken by the editors and their two dozen collaborators. Despite the number of authors, the various sections of the book are well balanced and the presentation is remarkably even.

The first part is concerned mainly with the fundamental scientific background, with chapters on the occurrence of cellulose, its chemical nature, and the structure of cellulose fibres. It concludes with a section on the nature of the various substances associated with cellulose in Nature, including brief accounts of lignin, the hemicelluloses and the structure of wood. In Part 2 the subjects considered are more industrial in character. They include the large-scale preparation of cellulose, its bleaching and purification and the special treatments employed in the utilization of wood-pulp for paper-making. There is also a chapter composed of several independent sections which deal with the esters, ethers, xanthates and other derivatives of cellulose, with valuable discussions on the chemical reactivity of cellulose and on the degradation of its derivatives.

In the first section of the third part there is a return to fundamental considerations, with authoritative and clear accounts of important physical features such as the solubility of cellulose and its derivatives, the thermodynamic properties of these solutions, the problems arising in the determination of molecular weights of macromolecular substances, theories of viscosity for dilute solutions of long-chain compounds, and a discussion of flow properties, including rheological phenomena. Next there is a section on the mechanical properties of cellulose followed by one on tests for cellulose and a series of appendixes in which are gathered together a whole host of data which will be invaluable to all whose work is in the cellulose field. Only those who have experienced it can appreciate fully the difficulty of finding such facts in the immensely scattered literature.

It will be clear from this account that this work is a book of reference rather than a text-book. Much of its usefulness will depend, therefore, on the quality of the indexing. Two indexes are provided at the end of the third book—an author index of forty-one closely printed pages and a subject index of seventy-four similar pages. Like the rest of the book, these are excellently done, and in so far as I have tested them they have been found to be readily usable, comprehensive and accurate. There is no doubt that this will long be regarded as a standard work on the subject, and the editors, authors and publishers are to be congratulated on the completion of this revised and augmented second edition.

E. L. HIRST

MATHEMATICS FOR CHEMISTRY STUDENTS

Mathematics for the Chemist

Mathematical Analysis for Chemists, Physicists and Chemical Engineers. By Prof. G. J. Kynch. Pp. vii + 356. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 30*s*. net.

PROF. G. J. KYNCH'S book is intended to meet the needs of students taking honours courses in chemistry, to provide a text with emphasis on the applications of mathematics, and to serve as a reference book for practising chemists and biochemists. Although written by a professional mathematician, it aims at being intelligible and useful in its field, and a characteristic is the brief yet reasonably strict nature of the methods used. Many results of integrations are merely stated, but the reader should easily find them by using methods which are explained.

The differential and integral calculus, series, exponential, logarithmic and hyperbolic functions, complex numbers, differential equations, determinants, vectors, Fourier series and spherical harmonics are included. An account of curvilinear co-ordinates and their applications would have been useful and could have taken the place of some of the text on approximate solution of equations and numerical methods. The treatment throughout is clear and interesting, the chapter on series being particularly good, and the book can be strongly recommended. The exercises call for thought rather than use of formulæ, and contain some useful additions to the text. References to books are given at the ends of the chapters. The book may not supply all the needs of users the author has in mind, who will want to know something about contour integrals, matrices and elementary group theory, but it provides a sound basis for future extension of knowledge.

The book is evidently based on teaching experience and a knowledge of the special difficulties of students of chemistry; many matters passed over in purely mathematical books are clearly explained, and cases where errors easily arise are pointed out. It may be suggested, with due deference, that pure mathematicians could with advantage look through the book with reference to their own courses. When the lectures to chemistry students are taken by a junior on the mathematics staff, the book will be of great assistance to him in pointing out the needs of the students and the kind of treatment which is desirable.

NATURE CONSERVATION FOR TEACHERS

Handbook for Teaching of Conservation and Resource-Use

Prepared by the National Conservation Committee of the National Association of Biology Teachers in conjunction with the American Nature Association. (Richard L. Weaver—Project Leader.) Pp. 500. (Danville, Ill.: Interstate Printers and Publishers, Inc., 1955. Obtainable from Project Leader, National Association of Biology Teachers, P.O. Box 2073, Ann Arbor, Mich., U.S.A.) 4 dollars.

A PUBLIC awareness of the importance of wise use and management of natural resources is highly desirable, particularly in view of the ever-growing demands which increasing world population makes upon them. In the United States the National Association of Biology Teachers has aimed at increasing this awareness by its conservation project, seeking to introduce conservation studies into schools wherever possible. The word conservation is here used in its widest sense—virtually an attitude of mind towards natural resources, akin to that of the ecologist regarding mankind as a biotic factor in the general scheme of Nature.

This book, which has been prepared for teachers, describes all possible methods of teaching conservation, in the class-room, school grounds and the field, sources of help for the teacher from the State and community, and schemes for extending interest in conservation teaching beyond the biology department. The matter is presented as reports, from individual schools, on actual projects which they have carried out. Examples are grouped under such headings as: films, slides and film-strips; radio programmes (the script of a radio skit broadcast by one school is given in full); aquaria and terraria; collection, preparation and exhibition of specimens; nature trails and sanctuaries.

One can find good ideas in these accounts which could be adapted to the rather different organization of teaching in Great Britain, but unfortunately they are buried in such a welter of blatantly obvious detail that one wearies of the search. For example, under

"Field Trip Technique" the reader is told: "If transportation is to be provided . . . every precaution must be taken to guarantee comfort and safety". "Leaders' Responsibility. It is helpful to plan how to keep attention centred on the main objective of the trip. . . . Leaders should speak distinctly enough for all to hear". In describing a particular field excursion, negotiations for hiring the bus are given six lines; and three-quarters of a page is spent on reproducing, in entirety, the letter to parents asking approval for their children to go on the trip, and ensuring that they will be there to meet them on their return. In the same way, many of the photographs are no more than pleasant school groups taken in the field, telling the reader absolutely nothing.

Thus, while fully agreed that the teaching of conservation is a worthy cause, one finds it hard to recommend this book (with its inevitable high price) to teachers outside the United States.

Maurice Ashby

PROBABILITY AND STATISTICAL INFERENCE

The Foundations of Statistics

By Prof. Leonard J. Savage. (Wiley Publications in Statistics.) Pp. xv+294. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 48*s.* net.

My main objection to this book concerns its title. The first half deals with theories of probability in their subjective and objective aspects; the second half defines "statistics proper" as "the art of dealing with vagueness and with interpersonal difference in decision situations". Some of the words in this definition, perhaps, provide avenues of escape; but as Prof. Savage goes straight into minimax theory, to which seven out of the closing ten chapters are devoted, it is fair to construe his attitude as one which takes statistics to be a theory of decision. This view is not shared by many British statisticians, who rightly insist, first, on the fact that statistical inference is only part of statistics and, second, on the fact that decisions are only part of statistical inference.

As a contributor to the foundations of the theory of decisions, Prof. Savage's book is, however, welcome and stimulating. He cannot subscribe to the frequency theory of probability, but adopts a new approach to the subjective theory by referring it back, like the economists, to a theory of utility. Even here the decision aspect of the subject affects his thinking, but the treatment is interesting and well written.

In founding statistical inference on minimax theory, Prof. Savage starts on the defensive; for the minimax principle, in its crude form, says that we must act as if the worst will happen, which is reasonable enough in games against a clever adversary but is not reasonable against Nature. Prof. Savage, however, extricates himself from this difficulty, not without a struggle, and proceeds to ground which is more familiar to the ordinary statistician by discussing estimation and tests of significance. He has some rather startling things to say about accepted theories on this subject, but what he says is well thought out and deserves attention. It is to be hoped that his criticisms are not lost to sight under the controversy which they may well raise.

M. G. Kendall

A HANDBOOK FOR MUSEUM CURATORS

The Preservation of Natural History Specimens

Edited and Compiled by Reginald Wagstaffe and Dr. J. Havelock Fidler. Vol. 1: Invertebrates. Pp. xiii+205. (London: H. F. and G. Witherby, Ltd., 1955.) 42*s.* net.

The intention of this book is to bring together in one place a collection of all those techniques concerned with the preservation of natural history specimens that have proved to be efficacious. In addition to the old and well-tried methods, a considerable amount of original work is included.

The first part of the book consists of a systematic survey of the chief invertebrate groups from the Protozoa to the Tunicata. In each group there is given the method of killing (preceded by narcotization where necessary), of fixing and of preserving. In cases where special manipulation is necessary, this is described and sometimes illustrated with a diagram. For the detailed formulæ in each case the reader is referred to the appropriate section of the appendix. This saves an intolerable amount of repetition.

Clearly, there are groups which lend themselves to fuller treatment than others, and the Insecta are dealt with in considerable detail, particularly as to setting and mounting. One suspects that the beauty of Miss Begg's drawings has beguiled the editors into extending this section a little beyond the limits of necessity. In the section on Echinodermata no mention is made of the corrosive sublimate method of preserving the test, particularly of *Echinus*, recommended by the late R. T. Jackson, of Harvard (see *Mus. J.*, 29; May 1930). This method preserves both the spines and the lantern and is exceedingly simple to apply. It is also useful in the case of many Crustacea.

It may be noted that throughout the book the emphasis is upon the preservation of the external features. Anatomical dissection and display are not considered.

The second part of the book consists of five appendixes dealing with apparatus and instruments; reagents; labels and labelling; storage; and microscopy. Here there is a large and useful collection of formulæ and recipes, and the description of many pieces of apparatus, both simple and ingenious. Many of them are well known; some of them are new. It is perhaps the most useful section of the book. Among the formulæ for cements for sealing museum jars, the asphalt–guttapercha mixture is recommended, particularly for jars containing formalin, but it is equally effective for 70 per cent alcohol. I have found it quite the best general-purpose cement for museum work. Stitching on to cards is recommended in a number of cases. For wet mounts, stitching on to glass is perhaps the best method, and a later edition might include a simple technique for drilling holes in glass (see *Mus. J.*, 35; Nov. 1935); or maybe it will appear in Vol. 2.

In a work of reference, the importance of the index is obvious. In this case it performs its job efficiently and with the minimum of irritation. The general format of the book is excellent. The binding is strong, the paper good, the type clear, and Miss Begg's illustrations a real embellishment. The editors are to be congratulated on a very sound job, and one looks forward to the appearance of the second volume.

W. Eric Stoneman

Principles and Practice of Field Experimentation

By Dr. John Wishart and Dr. H. G. Sanders. Second edition. (Technical Communication 18 of the Commonwealth Bureau of Plant Breeding and Genetics, Cambridge.) Pp. vii+133. (Farnham Royal: Commonwealth Agricultural Bureaux, 1955.) 21*s*.

THE first edition of this book, published twenty years ago and for a long time out of print, was a landmark in so presenting the statistical outlook on field experimentation that it could be understood and used without advanced training in statistics. A new edition is therefore of considerable interest.

Dr. J. Wishart's section, on statistical principles and techniques, has been extensively revised; the result is an improved and up-to-date version, though the emphasis on expressing yields as percentages and the deletion of any graphical explanation of covariance analysis seem unfortunate. New chapters briefly discuss factorial design, confounding, and incomplete block designs. The author has met the difficulty that his subject has grown to a much greater extent than his few additional pages can contain, so that inevitably his account appears relatively less comprehensive than in the first edition. He is therefore the more to be congratulated on so well combining clear instructions for analysis of simple experiments with laying a sound foundation for further study. The contribution by Dr. H. G. Sanders is a general discussion of the practical aspects of field experiments, ranging from advice on when—and when not—to do experiments to rules for good recording. Changes from the first edition are slight; but the section remains perhaps one of the best published guides to experimental policy and details of field technique.

This book should be in the hands of all who conduct field experiments: they will learn from it much that will help their understanding of how statistical science can assist their work.

D. J. FINNEY

Le Microscope à Contraste de Phase et le Microscope Interférentiel

Par Maurice Françon. Pp. 150+1 plate. (Paris: Éditions du Centre National de la Recherche Scientifique, 1954.) 1,000 francs.

AFTER reading this book one is left wondering how it is possible to cover the subject so completely in only 125 pages. The answer is that the exposition is so clear and the selection of topics so excellent that scarcely a word is wasted. The only exception is the section on the applications of phase-contrast, which is too short and might be either omitted or expanded in future editions.

The first part of the book deals with general optical theory. After discussing the modification of the Airy disk pattern by aberrations and errors of focus, the formation of images of extended objects by coherent and incoherent light is examined. This is an excellent simple introduction to modern physical optics. The chapter on phase-contrast describes the main optical systems that have been used, including those for variable and coloured phase-contrast. Such questions as the effect of absorption in the phase plate and the resolving power are dealt with, but one could have wished for an account of the defects of the method, particularly the halo effect.

The final chapter is devoted to interference microscopy and is one of the best compilations so far available on this subject. Progress in this field is so rapid that it is sometimes difficult to decide priority. British readers may feel that the work of F. H. Smith does not receive proper acknowledgment, and that some of his designs have been unwittingly re-invented by others. The diagrams are for the most part excellent and a useful bibliography is added. A few minor printing errors were noticed. This is a book which can be read with profit by many and with real pleasure by all interested in optics.

An Introduction to the Calculus of Finite Differences

By Prof. C. H. Richardson. Pp. vi+142. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 28*s*. net.

THIRTY years ago, the student of numerical analysis had no English text readily available save the brilliant pioneer work by Whittaker and Robinson, "Calculus of Observations" (1924). Since then the rapid growth of the subject, and the widening field of its applications, have produced many good books in English, some covering the whole field, some with a view to special applications. Prof. Richardson has based his book on a short course for actuaries and statisticians, but the course has also proved of value to electrical engineers and other technicians. The elements of finite differences, on a somewhat formal basis, are expounded in 120 pages: the operators E and Δ; the finite sum, with special reference to the Stirling numbers; the Euler and Bernoulli polynomials; interpolation and numerical integration; the gamma function; and simple difference equations. Only the simplest elements of the infinitesimal calculus are assumed to be known, and arguments are often plausible rather than strictly logical. The book should therefore serve as an outline of methods and problems, preparing the novice for the further study of more substantial treatises on the numerical or theoretical aspects of the difference calculus.

Some Beautiful Indian Trees

By Ethelbert Blatter and Walter Samuel Millard. Second edition, revised by William T. Stearn. Pp. xv+165+78 plates. (Bombay: Bombay Natural History Society; London: Wheldon and Wesley, Ltd., 1954.) Rs. 20; 30*s*. net.

THIS well-known book has been out of print for some considerable time, so now the second edition, edited by Mr. W. T. Stearn, is assured of a hearty welcome. Both the authors of the original book have died; but I feel sure that they would have approved of the way Mr. Stearn has carried out his part of the work, for this is not a mere reprint but an amended, corrected and enlarged account of the beautiful trees to be found in any large city in India. I am particularly glad to see that he has adopted the correct botanical name for the species where a change has become necessary.

The original plates were printed in England by a well-known firm of colour printers and were very well executed. It is not stated where the plates for the second edition were produced; but they are most unworthy of the book—cold, lifeless and falsely coloured.

The statement that there is a live specimen of *Amherstia nebilis* in one of the hot-houses at Kew is, alas, not true. The specimen referred to was lost during the War.

This book can be recommended to anyone who is visiting India.

N. L. BOR

ARTIFICIAL ICE-FORMING NUCLEI

By B. J. MASON and J. HALLETT
Imperial College of Science and Technology, London

THE fact that supercooled clouds commonly occur in the atmosphere at temperatures above −20° C., with the implication that efficient ice-forming nuclei are often deficient, and the possibility of inducing rain by supplying artificial nuclei, stimulated the search for substances which, when dispersed as an aerosol, might produce vast numbers of efficient, durable nuclei. The most important discovery was made by Vonnegut[1] in 1946, who found that when silver iodide smoke was introduced into a supercooled cloud in the laboratory, some ice crystals appeared when the temperature fell below −4° C. and that the numbers increased with decreasing temperature until, at about −15° C., most of the silver iodide particles appeared to serve as ice nuclei. Since one gram of silver iodide in solution could be vaporized to produce about 10^{16} nuclei, large-scale cloud seeding became a practical possibility. The success of silver iodide, which was chosen originally because the lattice constants of the hexagonal form are very similar to those of ice (see Table 1), initiated an intensive search for substances which might be either more efficient or less expensive than silver iodide. Papers have appeared from several different laboratories[1-6] reporting on the ice-nucleating ability of a wide variety of chemical compounds introduced either as smokes, sprays or as fine dusts into a supercooled cloud formed in an expansion- or mixing-cloud chamber. Except in the case of silver iodide, which is generally agreed to be the most effective of all the substances so far tested, the results obtained by the different workers are very conflicting; for example, substances reported as highly effective by one laboratory are found to be completely inactive by another.

We believe that in many of these experiments, spurious results may have resulted from the presence of trace contaminants (particularly silver and iodine) in the air, and of trace impurities in the various chemicals. We therefore decided to carry out very careful tests on those substances which have been reported as producing highly efficient ice nuclei by at least two independent workers. These include: silver iodide, lead iodide, mercuric chloride, silver nitrate, silver sulphate, silver sulphide, lead chloride, sodium chloride, iodine, ammonium iodide, sodium iodide, cadmium iodide, cobalt iodide, mercuric iodide and thallium iodide.

We have found that, if spectroscopically pure materials are used and great care is taken to exclude all traces of iodine and silver from the air in the experimental chamber, the great majority of substances reported as active by other workers fail to produce ice crystals in a supercooled cloud at temperatures above −40° C., when spontaneous nucleation of the supercooled droplets occurs.

That minute particles of silver may react very rapidly with iodine vapour in low concentration to produce particles of silver iodide was noticed by one of us several years ago. On opening a bottle of iodine near an open-top mixing-cloud chamber in which traces of silver aerosol may have remained from a previous experiment, the supercooled cloud became transformed into ice crystals within a few seconds; but iodine failed to produce crystals when introduced into a sealed cloud chamber filled with filtered air. A similar effect may be demonstrated by causing a small electric spark between two thin silver wires in a large flask containing a small iodine crystal; on passing air through the flask into a cloud chamber, the supercooled water cloud may be transformed completely into ice within a few seconds of forming the spark. These experiments suggest that should any silver salt which may either decompose on heating or dissolve inside a droplet be dispersed into a supercooled cloud containing small traces of iodine, particles of silver iodide might be formed and cause the appearance of some ice crystals at high temperatures; a similar result might be expected if an iodide were dispersed in an atmosphere containing traces of silver.

Experimental Procedure

Our nucleation tests were carried out in a modified version of the continuously sensitive diffusion cloud chamber described by Schaefer[7]. The chamber, shown in Fig. 1, consists essentially of a vertical column, 50 cm. high, 30 cm. in diameter, cooled at the bottom and held at or above room temperature at the top, where water is evaporated into the chamber to produce a convectively stable, thermally stratified cloud which, in the absence of ice nuclei, exists in the liquid state above the −40° C. isotherm. The lower plate, supported by a solid aluminium block, is maintained at about −60° C. by surrounding the lower part of the apparatus with 'dry ice'. The top plate, when unheated, remains at about 5 deg. C. below room temperature, and the positions of the 0° C. and −40° C. levels are roughly as indicated in the diagram. A water reservoir, sufficient for several days, is mounted on the underside of the top plate and may be electrically heated. The plane, rectangular walls of the chamber are made of 'Perspex'. A deep cold zone is established by the inner copper walls soldered to the base plate. The outer plate glass walls serve to reduce the lateral inflow of heat and to widen the vertical temperature gradient, which is measured

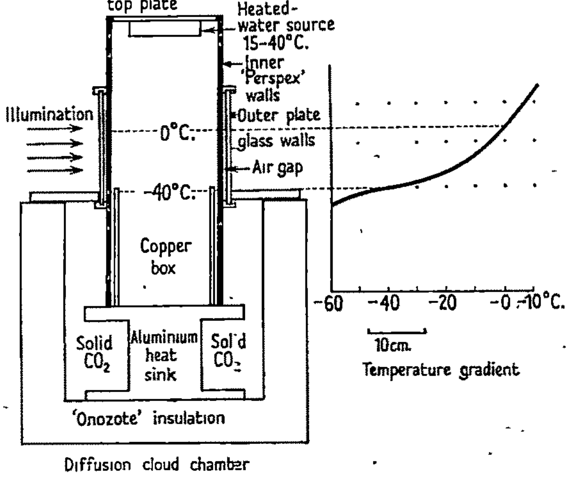

Fig. 1. The diffusion cloud chamber

by a thermocouple attached to a micrometer head. The vertical separation of the 0° C. and $-40°$ C. levels is about 10 cm. A horizontal network of thermocouples serves to check that the horizontal temperature distribution is reasonably uniform.

Before commencing a nucleation test, the chamber is thoroughly cleaned, sealed and left for some hours for any particles present to fall out and leave very clean air in which condensation on the ion-tracks of cosmic rays may be seen. Artificial nuclei are then introduced through valves in the top plate, and their nucleating effects are observed or photographed by viewing normally to an intense beam from a high-pressure mercury lamp passing horizontally through the chamber. Within about one minute of entering the top of the chamber, the nuclei arrive at the 0° C. level, below which one watches for the first appearance of glittering ice crystals, the temperature at this level being measured. The threshold temperature for nucleation will depend upon the quantity of nuclei introduced and the volume of the observational space ; but in these tests we adopted the temperature below which more than one ice crystal appeared among about 10^4 water droplets. The nuclei were produced either by spraying a solution or by vaporizing the substance on an electrically heated wire in an atmosphere of clean nitrogen to prevent oxidation effects. Blank tests were always carried out with the heated wire and with distilled water to check that they produced no effective nuclei.

Because particles, having become centres of condensation, take only about 10 sec. to fall between the 0° C. and $-40°$ C. levels in the diffusion chamber, it might be argued that their failure to produce ice crystals at temperatures above $-40°$ C. might be attributed to their having long activation times. To meet this point, simultaneous tests were also made with a large mixing-cloud chamber of capacity 400 litres, where the nuclei were introduced into a continuously generated supercooled cloud and remained in suspension for some minutes. With this arrangement it was possible to detect whether ice crystals were produced at temperatures above $-20°$ C.

Nucleating Ability of Various Chemicals

In early tests, ammonium iodide, potassium iodide, sodium iodide and iodine vaporized on an electrically heated nickel wire all produced ice crystals in the diffusion chamber at temperatures above $-20°$ C., as reported by other workers. But as the particles, being highly soluble, rapidly went into solution when condensation occurred upon them, it was difficult to understand how they could have acted as ice-forming nuclei. Our suspicions that the iodine compounds were reacting with silver or lead impurities in the nickel wire to produce either silver iodide or lead iodide received support when two such wires were sparked in iodine vapour to give large numbers of ice-forming nuclei active at temperatures above $-15°$ C. When the tests were repeated with spectroscopically pure nickel wire, the four abovementioned substances and also cobalt, mercuric, thallium and stannous iodides did not produce significant numbers of ice crystals at temperatures above $-40°$ C. Similar results were also obtained for sprayed solutions of ammonium, potassium, sodium, cobalt, stannous, magnesium, manganous and nickel iodides and iodine.

The early tests on silver salts (other than silver iodide) did not give consistent results. When smokes or sprays of silver nitrate or sulphate were introduced into a freshly cleaned diffusion chamber, only a very low concentration of ice crystals appeared at first, but the numbers gradually increased, and after about twenty minutes, these salts appeared to have about the same level of activity as silver iodide, with some crystals appearing at about $-5°$ C. and complete glaciation of the cloud occurring at $-15°$ C. Although these results were in accord with those of other workers, it was again difficult to accept them at face value, in view of the high solubility of silver nitrate and silver sulphate. Furthermore, when silver nitrate was sprayed into a large mixing chamber containing supercooled cloud at $-20°$ C., no significant increase in the number of ice crystals occurred. However, on introducing a small iodine crystal for only two seconds, the whole cloud became transformed into ice crystals. This demonstrated, in striking fashion, the influence of small traces of iodine, and we attribute the gradual increase in the number of crystals appearing in the diffusion chamber after the introduction of a silver salt to the slow exudation of iodine adsorbed on the 'Perspex' walls. That minute traces always remained even after the most careful cleaning was demonstrated by sparking two silver wires directly in the chamber ; ice crystals appeared at temperatures below $-5°$ C. and were presumably formed upon nuclei of silver iodide. When the silver nitrate was tested in a glass vessel freed completely of iodine by baking, no ice crystals appeared. From these and other tests, we are convinced that silver nitrate and silver sulphate are not capable of nucleating supercooled water, and that they appeared to be highly effective in other experiments[2,4,6] only because they formed silver iodide in the presence of small quantities of iodine.

Our results for lead iodide confirm those of previous workers in finding it to be a very efficient nucleating agent, producing a significant number of ice crystals in both chambers at $-7°$ C. and complete glaciation at $-15°$ C. ; it is therefore only slightly less effective than silver iodide. On the other hand, both lead nitrate and lead chloride are found to be inactive in the diffusion chamber, and also in the mixing chamber, at temperatures above $-20°$ C. Deliberate contamination with small quantities of iodine, however, brings about rapid formation of ice crystals, presumably through the production of lead iodide.

In all these experiments the presence of ice crystals is inferred solely from the appearance of glittering particles in an illuminated region of the supercooled cloud. That this may not be an infallible test was indicated by the appearance of such particles in the upper, warm regions of the diffusion chamber when smokes and sprays of mercuric chloride, and finely powdered cupric sulphide, stannous oxide and beryllium oxide were introduced. The glittering of the particles was much reduced once they had fallen several centimetres and become involved in condensation, but in the case of cupric sulphide and mercuric chloride, the scintillation increased again below the $-15°$ C. and $-25°$ C. levels respectively. The collection of the crystals formed at these low temperatures and their observed melting under the microscope suggested that ice crystals were being produced. Since the cupric sulphide was only of commercial grade, further tests, including spectroscopic analyses, are being carried out. But a recent report[6] that finely powdered copper sulphide causes complete glaciation of a supercooled cloud at $-6°$ C. may be questioned ; it seems that scintillation of the copper sulphide particles themselves may have been mistaken for the appearance of ice crystals. In the case of beryllium oxide, no crystals were observed between the 0° C. and − 40° C. levels. Sodium chloride, manganese dioxide, manganese chloride and cadmium sulphide were found to be similarly inactive. Introduction of powdered stannous oxide produced a cloud of glittering particles throughout the whole depth of the chamber.

The only chemical compounds which we have found to be definitely active as ice-forming nuclei at temperatures above −40° C. are silver iodide (−5° C.), lead iodide (−7° C.) and mercuric chloride (−25° C.), the temperatures in brackets indicating the threshold limits of activity.

Behaviour of Silver Iodide Nuclei

Silver iodide is certainly the most effective ice-nucleating substance so far discovered. Its efficiency depends very much, however, upon the method of preparation. In fact it occurs in two crystal forms at room temperature—a hexagonal (wurtzite) arrangement and a cubic (zinc blende) arrangement, the cubic form being regarded as the stable form at temperatures below 135° C. The hexagonal form is the thermodynamically stable one between 135° C. and 146° C. Above 146° C. both types may become transformed into a new high-temperature cubic form. The unit-cell dimensions of the three forms are shown in Table 1.

Table 1

Substance	Crystal form	Unit dimensions (A.)
Silver iodide	Hexagonal (wurtzite)	$a = 4 \cdot 58$, $c = 7 \cdot 49$
	Cubic (zinc blende)	$a = 6 \cdot 47$
	'High temp.' cubic	$a = 5 \cdot 03$
Lead iodide	Hexagonal	$a = 4 \cdot 54$, $c = 6 \cdot 86$
Ice	Hexagonal	$a = 4 \cdot 52$, $c = 7 \cdot 37$

When silver iodide is vaporized at several hundred degrees centigrade, X-ray and electron-diffraction patterns of the smoke show that it consists of a mixture of the hexagonal and cold cubic forms, with some indication of the hexagonal form being more dominant the higher the temperature of the source[8]. Whether the hexagonal or the cubic form provides the more efficient ice nuclei has not yet been established, but it is perhaps worth noting that the atomic array in the (111) planes of the cold cubic structure and the (001) planes of the hexagonal form are geometrically identical, the lattice spacing being 4·58 A. in each case.

Silver iodide generators used in cloud seeding utilize silver iodide dissolved with either sodium or potassium iodide in acetone. The solution is sometimes atomized through a nozzle by compressed hydrogen or propane and the spray ignited; alternatively, it is sprayed into a kerosene flame. Another method is to soak coke nuts in the solution and burn these in a ventilated furnace.

Electron-diffraction patterns, taken at the Imperial College by Lisgarten (unpublished), produced by the vaporization of silver iodide–potassium iodide and silver iodide–sodium iodide mixtures, suggest that these techniques may not be the most efficient. The patterns produced by silver iodide–potassium iodide mixtures show little or no trace of either silver iodide or of potassium iodide but suggest that mixed crystals are being formed (see Fig. 2). The silver iodide–sodium iodide mixtures reveal no trace of hexagonal silver iodide but produce patterns consistent with those of either the cubic form of silver iodide or of sodium iodide, which have an almost identical lattice spacing; alternatively, mixed crystals of both substances with unaltered lattice spacing may have been formed. X-ray and electron-diffraction patterns of smokes produced by the vaporization of pure silver iodide crystals include broad, diffuse rings indicative of an amorphous rather than a crystalline structure. It seems that the silver iodide, having become partly decomposed by heating, fails to form good crystals during quenching; certainly electron micrographs show the particles to be malformed, with few well-defined crystalline shapes.

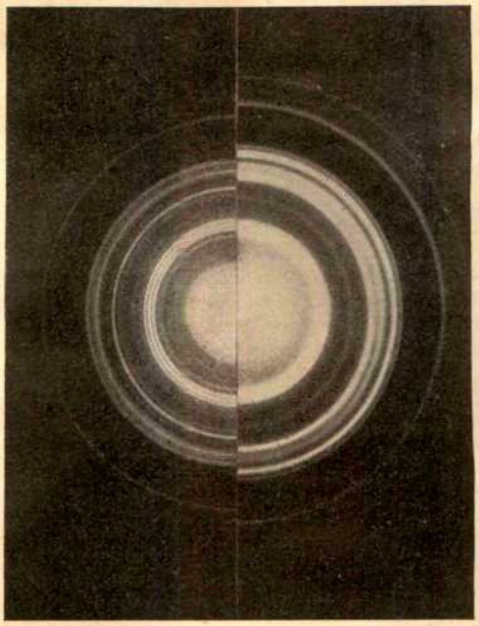

Fig. 2. *Left:* electron-diffraction pattern of a smoke produced by vaporization of a silver iodide–potassium iodide mixture. *Right:* pattern produced by vaporization of silver iodide *in vacuo*. Note that the pattern produced by the mixture shows no rings which can be identified with those of silver iodide. (Photo by N. D. Lisgarten)

If the silver iodide nuclei are produced in a reducing atmosphere such as will be provided if acetone and particularly hydrogen are burned at high temperatures, their surface layers may be reduced to metallic silver and their ice-nucleating ability largely inhibited. This effect appears to be greatly enhanced if the crystals are irradiated with ultra-violet light (cf. the reduction of silver bromide to metallic silver in a photographic emulsion), which explains why silver iodide may quickly lose its ice-nucleating properties when dispersed into the atmosphere during strong sunshine. According to tests made by Smith, Seely and Heffernan[9] the activity of nuclei from a hydrogen burner decays to about a hundredth of its initial value after an exposure of only 15 min.

The discovery of a method for producing large quantities of highly efficient and durable silver iodide particles is of considerable practical importance. Lead iodide, which is not so susceptible to photolytic decomposition, appears to merit further investigation as a possible substitute.

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THE IMITATION OF MENTALITY*

By Dr. W. GREY WALTER
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DURING the past twenty years, electronic methods have revealed many exciting and useful relations between the patterns of electrical activity in the brain and the temperament, mentality and behaviour of human subjects. These discoveries are acknowledged aids to the diagnosis of brain disorders ; but there is still no general theory of normal brain action, nor are there convincing special hypotheses about the relation between the known functions of the brain and thinking. Such theories as have been advanced have been too ambiguous to suggest clear-cut experiments, since their expression in words leaves so much to the imagination. On the other hand, attempts to express notions about the brain in rigorous mathematics are hard for experimentalists to understand. Since the scientific method depends upon the steady development of clear working hypotheses, advances in the understanding of brain function will be slow until this dilemma has been resolved. One method which seems promising is to embody the components of a hypothesis in a working model, observing carefully the rules of parsimony and the test of prediction ; the model must contain no redundant parts and is valid only if its behaviour permits prediction of behaviour beyond that originally intended. A model or analogue of this sort is, in fact, a crystallized hypothesis ; it should be clear and brittle. When it breaks down, as all working hypotheses must, its failure is obvious and explicit ; a verbal hypothesis can yield almost imperceptibly and change its form under the pressure of facts.

From time to time most artificial systems for communication and calculation have been used as models of the brain. Automatic telephones, electronic computers, totalizators have all been invoked in turn to illustrate certain aspects of higher nervous function. None of these, however, serves the purpose, and during the past few years several models have been built specially to illustrate hypothetical mechanisms underlying living behaviour.

The simple concept of reflex action, as defined by Sherrington, is so simple that it scarcely needs illustration ; none the less, the feedback principle of error cancellation, which appears so frequently in modern engineering design, is basically a reflex. It is strange that the power of such a system has only recently begun to be appreciated by engineers. The principle of the automatic governor devised by Watt was analysed by Maxwell before the physiology of reflex action had been worked out ; but it has taken nearly a century for the advantages of negative feedback to be exploited. Nowadays, a modern home is likely to contain at least half a dozen mechanical reflexes, and motor-cars, ships and aeroplanes would be unmanageable without them. The extra-ordinary properties of the reflexive system are seen clearly only when several elements are capable of free interconnexion with one another. In such a complex system, even if the activity is limited to all-or-none binary responses, the number of patterns of interconnexions is enormous ; if the number of modes of connexion be M and the number of elements n, then for values of n greater than 6, M is approximately $2^{(n^2-n)}$. The inferences from this simple relation are encouraging to brain physiologists, who often feel dismayed by the joint challenge of the ten thousand million nerve elements in the human brain and the associated complexity of human mentality. It would be comforting to be able to suppose that the vast congregation of nerve cells in the head might act in large clumps ; obviously it will never be possible to consider the individuality of each nerve cell. Yet large numbers are required for any mechanistic hypothesis of mentality. Fortunately, very large numbers can appear from the free intercommunication of a few elements as suggested above. If we must provide a model capable of forming a fresh pattern every tenth of a second for the span of a long lifetime, we must ask how many elements would be necessary. The answer is : six. In other words, an artificial brain with six freely interacting elements could get into more than ten thousand million different states. It is not suggested that the human brain contains only six functional elements ; what may be important is that, with the several hundred that have already been identified and named, a variety of character and experience could be generated comparable with what we know of human individuality and versatility.

In order to illustrate what sort of behaviour can be derived from reflexive systems alone, a number of models has been built. These contain only two 'nerve elements' in the form of wireless valves and relays, two sense organs (a simple 'eye' and a skin) and two effectors (a motor for crawling and one for steering). As well as this, it is arranged that the eye shall scan in a circular fashion so that it can distinguish and respond to a light signal wherever this may be. One mode of behaviour is this scanning for signals, the next is the positive response to a moderate light which interrupts the scan and leaves the model facing the light and crawling towards it. Another mode is the avoidance of bright light, another again the circumvention of obstacles when the skin is touched. The behaviour of these models is entirely unintelligent and there is no memory or learning ; nevertheless, they behave in a strangely 'purposeful' fashion, find their way out of an enclosure or into their hutch, seek out moderate lights and avoid bright ones. They are capable of a rudimentary form of self-recognition and mutual recognition and can be made to 'feed' themselves. Although anatomically they resemble very primitive creatures—Rotifera—in some respects, they are more sophisticated than lower mammals. Their mock-biological name is *Machina speculatrix*, since, unlike most machines, which are essentially passive tools, they actively investigate and explore their environment. It would seem that spontaneous exploratory activity, self-control, the solution of Buridan's dilemma, moderation, discrimination between end and means, self-recognition, and mutual recognition can appear at reflexive levels and do not require more elaborate anatomy or physiology. An inference from this proposition is that the relative passivity of the mammalian spinal cord (where reflex action has been most thoroughly studied in real animals) is a specialized attribute of animals with highly developed brains, and that the elaborate form of behaviour in sub-mammals known generally as 'instinctive' is a combination of reflexive patterns which have not been subordinated to the learned modes typical of mammals and particularly of primates.

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* Substance of a Friday Evening Discourse at the Royal Institution on March 16.

Another model has been built to show how the characters of the innate releaser mechanism can be achieved in a single mechanism, and how this form of behaviour may vary with activity and be particularly vulnerable to changes in the internal environments such as 'starvation' or 'satiety'.

Of greater relevance to the study of human mentality is the imitation of the process of learning by association or conditioned reflex formation. Analysis of this process as it actually occurs in animals suggested that, in the simplest case, it could be considered as involving a chain of seven distinct operations, known respectively as: (1) differentiation of specific stimuli; (2) extension of neutral stimuli; (3) mixing of (1) and (2); (4) summation of degrees of coincidence achieved in (3); (5) activation of storage system when degree of coincidence in (4) has exceeded chance expectation; (6) storage of the information that the coincidence has exceeded chance expectation; (7) combination of the stored information with a fresh neutral stimulus to provide a novel mode of responding to the previously neutral, now 'conditioned', stimulus.

These operations can be embodied in a working model, and such a model can be seen to 'learn' in the sense that it can discriminate between random events and those which are significantly related, and can then respond to a part of the significant association as if the whole were present. An important inference is that learning in this sense and pattern recognition are essentially the same process. A pattern may be defined as a class of relations between events which is likely to operate a learning mechanism.

The actual models (known as *Machina docilis*) of learning display several peculiarities which at first seemed to be faults but may be instructive. When set up to demonstrate a defensive rather than an appetitive conditioned reflex, it was found that the 'learned' pattern was often self-maintaining; it was not easily extinguished by lack of reinforcement. Reconsideration of animal behaviour and of human neuroses suggests that this may indeed be a property of complex behaviour based on the avoidance of pain, and that the intractability of obsessional and compulsive neuroses may be due to their liability to self-reinforcement. Again, when a neutral stimulus is given to the model in a carefully timed rhythm, the system can be induced to respond as if it had 'invented' a specific stimulus which it had never, in fact, experienced. This rudiment of originality also seemed tiresome at first; but bizarre illusions and fantasies can, in fact, be induced in some human subjects by rhythmic stimuli and it is possible that, as in the model, this effect may be due to the direct activation of a storage circuit by the cumulative action of the imposed rhythm.

The fundamental notion underlying this description of associative thinking is that mentality is based on a statistical or probabilistic analysis of experience rather than a logical or deterministic one. In fact, mentality could be defined as the rate of change of behaviour induced by statistically significant associations. This notion is not so far removed as it may seem from the real problem of brain and its function; a capacity to learn is the diagnostic character of brain, and the hypothesis that a learning brain is perpetually scanning the world of experience for statistically significant information suggests a fresh experimental approach to the problem of how animals learn. In fact, reconsideration of the protocols of conditioned reflex experiments designed to induce 'experimental neuroses' has disclosed a previously unsuspected pattern in those stimulus arrangements which were found to disturb the animals. It looks very much as though an animal—human or otherwise—in a learning situation is acting as if it were a statistical computer set to accept, as significant, odds greater than 1,000 to 1 against chance association. If the basis of learning is the computation of contingency, then most animals are considerably more sceptical than professional statisticians, who generally consider odds of 100 to 1 against chance as indicating significance.

Experiments suggested by these analogies of reflexive and associative behaviour are now in progress. Naturally, the hypotheses will be found inadequate; but there is no reason why other models should not be designed to match observation still more closely. There is even a possibility that, in the more distant future, devices that began as instructive toys may develop into powerful tools. We are already entering a phase of our culture when our arithmetic, algebra and even our material production are being delegated to mechanical extensions of our five wits. Eventually, the mental functions of conjecture and imagination may also be shared with the successors of these humble mechanical 'protozoa'.

OBITUARIES

Prof. H. F. Baker, F.R.S.

Henry Frederick Baker, who was Lowndean professor of astronomy and geometry at Cambridge from 1914 until 1936, died on March 17. His name is chiefly remembered as the founder of a vigorous and distinctive school of geometry, but his influence on the mathematical life of Britain was wider than this.

Baker was born in 1866 and was educated at the Perse School and at St. John's College, Cambridge. His progress as a student was impeccable—joint Senior Wrangler in 1887, first division of the first class in the Mathematical Tripos of 1888, and Smith's Prizeman in 1889, in which year he was elected to a fellowship at St. John's which he held until his death nearly sixty-seven years later. So at the age of twenty-three he embarked on the career of a Cambridge don which he was to follow throughout his life. He did not travel widely; but he had contacts with mathematicians in all parts of the globe, and a visit to Göttingen to study under Felix Klein had a decisive influence on his development as a mathematician. He thus began his work in Cambridge while Cayley, Stokes and Adams were still the dominant influences in Cambridge mathematics. Cayley, who shared with Klein the role of chief formative influence in Baker's mathematics, did not die until 1894. It was very appropriate that, when a lectureship was founded in memory of Cayley, Baker was appointed the first holder, in 1903.

Baker quickly threw himself into the work of a college don, and was soon carrying a load of teaching which would make the modern don shudder. He had to teach all the subjects required for the Mathematical Tripos; but in his formal lectures he specialized in the theory of functions and geometry. His principal interest at this time was the theory of algebraic functions, and in spite of his heavy teaching duties he managed to get through a prodigious amount of reading. His first book, "Abel's Theorem and the Allied Theory" (1897), is a monumental work, and his second book, "Multiply Periodic Functions" (1907), is a thorough study of the theory associated with theta functions of two variables. But his papers cover a much wider range—the theory of functions, continuous groups, multiple integrals, projective and algebraic geometry. While a good deal of his original work of this period has been superseded by modern developments, much of permanent value remains, and I recall the pleasure which it gave Baker, only a couple of years ago, to supply reprints of a paper fifty years old which a leading group of American mathematicians was anxious to obtain.

In 1913, Sir Robert Ball, the Lowndean professor who had followed Adams, died, and early in 1914 Baker was elected his successor. The six previous holders of the chair had all been astronomers, and the University statutes of the period did not explicitly allow the Lowndean professor to specialize either in astronomy or in geometry; so Baker, with a characteristic devotion to duty, immediately offered a course on periodic orbits, not in place of, but in addition to, the lectures on the theory of functions which he had been scheduled to give before his election. He kept up his lectures on dynamical astronomy for many years, and a number of distinguished astronomers have spoken of these lectures in the highest terms. But from 1914 onwards he concentrated more and more on geometry, and for some years before he retired his lectures and writings were all on geometry. During his long retirement he continued to work on geometry, and in 1943 he published "An Introduction to Plane Geometry", followed in 1946 by a Cambridge Mathematical Tract, "A locus with 25920 linear self-transformations"; and only two months before his death he completed, in spite of failing eyesight, a commentary on some of his earlier books.

After the First World War, Baker set about building up a school of geometry, and succeeded so well that the 'Baker school' still has its distinctive character. At first the emphasis was primarily on projective geometry, along the lines of von Staudt and Reye. To this period we owe the first four volumes of his "Principles of Geometry", which became the bible of his followers. This work reaches its climax in the fourth volume, which deals with the numerous special configurations and loci in four dimensions and their relations with classical configurations such as the double-six in three dimensions, with infectious enthusiasm and many characteristic touches. Later, he lectured more on the birational theory of surfaces, as developed by the Italian geometers, and out of these lectures grew the fifth and sixth volumes of his "Principles". His interest in Italian geometry, however, began much earlier, arising naturally from his work on algebraic functions, and in 1912 he made it the subject of his presidential address to the London Mathematical Society, perhaps the most influential single article he ever wrote. But what remains most vividly in the minds of all his pupils is the burning enthusiasm he brought to all his teaching, and the enthusiasm he kindled in his audiences. No one ever attended his lectures on geometry without gaining something which remained with him throughout his life.

W. V. D. HODGE

Prof. Léon Bertin

On February 4, in his sixtieth year, Prof. Léon Bertin was killed in a motor-car accident on the frozen roads outside Paris. He had held the chair of herpetology and ichthyology at the Muséum National d'Histoire Naturelle since the death of Pellegrin in 1944.

Bertin graduated at the École Normale Supérieure of Paris in 1920 and was awarded a bursary to study for a doctorate. Under Prof. Bouvier he had been initiated, as he said, "au dur métier de la systématique" in the field of entomology, and he now took up the study of sticklebacks in a way that would have astonished Mr. Pickwick. Johannes Schmidt had just demonstrated the value of biometry in analysing the races of *Zoarces* and contrasting their diversity with the homogeneity of the populations of the European eel. Bertin applied like methods to sticklebacks and published on them a series of papers culminating in the classical "Recherches bionomiques, biométriques et systématiques sur les Épinoches (Gasterostéidés)" (1925), which won him his doctorate. The three-spined stickleback shows, in the amount of dermal ossification, a diversity which, expressed in the number of lateral shields, lends itself to numerical analysis. By examining ten thousand specimens from forty-five localities in France and North Africa, Bertin was able to correlate the degree of armature with age, salinity and latitude. Although later work by Heuts has shown that his conclusions were over-simplified, Bertin produced order from chaos and laid a firm foundation on which others have built. The French sticklebacks proved to have a life-span of fourteen to eighteen months. Later, Bertin studied large samples from Iceland and Greenland and demonstrated that these do not become sexually mature until their third or fourth summer, and that they thus conform to the rule of longer life-span in higher latitudes.

This work was followed by studies on bathypelagic eels and then on those enigmatic eel-like fishes, the Lyomeri. Bertin was entrusted with rare and precious material of these groups collected during the cruises of the *Dana*. As well as a number of smaller papers, he published three *Dana* Reports on them (the first in collaboration with Roule), and he had work on them in hand at the time of his death.

Throughout his career Bertin was associated with the University of Paris and the Museum. His courses at the University were much appreciated, and that on the eels was published in book form in 1942.

While still 'Sous-Directeur' at the Muséum, Bertin organized and directed the indexing of the rich but neglected departmental library of offprints and journals. He appreciated the effect of environment on his staff no less than on the sticklebacks, and visitors to his laboratory in the Jardin des Plantes after the War were impressed by its pleasing decoration and efficient organization as well as by the ready assistance they received. No longer do we read in ichthyological papers, "Type in Paris; cannot be found". Under Prof. Bertin the types were found and catalogued. Five fascicles of this catalogue have been published by the Museum, and Unesco funds were to have been made available for the rest.

Bertin developed a talent for popularization. The biggest work of this kind from his hand is "La Vie des Animaux" (1949–50). His contribution to the "Traité de Zoologie" is now in the press and due to appear shortly; so, too, is an English edition of "Les Anguilles".

Bertin served his country as a soldier in both World Wars, and received the Croix de Guerre for courage under bombardment in 1940. A man of distinguished appearance, his personality was dynamic and gay, and it is this that gives a special sadness to his sudden and tragic end. He leaves a widow and three children.

E. Trewavas

Prof. E. D. Merrill

Elmer Drew Merrill was born on October 15, 1876, in a village near Auburn, Maine; there he grew up amid country sights and sounds. From the village school he passed to a high school in Auburn, walking the three miles in all weathers; and finally to the State College in Orono, which during his years became the University of Maine. He has written that his biological teacher roused his enthusiasm for field work; but the love of the wilds was already in him: late in life the Maine woods continued to attract him. He was compelled to earn as he learned, serving, for example, as a student-assistant in the botanical laboratory. Having graduated B.S. in 1898, he held a minor appointment until in the next year he was appointed an assistant agrostologist in the Department of Agriculture at Washington.

Merrill's excursions in Maine had provided him with a small collection of about a thousand dried plants; and his first entrances into print were records of Maine plants. Three years at Washington led to half a dozen short papers on grasses, along with a valuable training in method. Unexpectedly, he was offered the post of Government botanist in the Philippine Islands. He demurred as untrained for such a responsibility; but it was pressed on him and he arrived in Manila in March 1902, having visited the botanical establishments in Ceylon and Singapore on the way. His beginnings were certainly an adventure: an unfurnished room awaited him. The herbarium of Philippine plants, made by Vidal and nomenclaturally co-ordinated at Kew, had been destroyed in 1897 by an accidental fire; a second herbarium which would have thrown light on the naming in the third edition of Blanco's "Flora" had been destroyed in the fighting of 1899. Such books as there had been, if not burned, had been purloined; and he started from scratch. In twenty-two years his new herbarium grew into a splendid collection of 270,000 mounted sheets and he would have written a descriptive "Flora" had he been left with the opportunities. He had travelled in all parts of the Archipelago, had had loyal support from forest officers and others interested in plants and had made very effective use of trained Filipino collectors. His office methods were direct and purposeful; and as no flora can be studied profitably in isolation he had extended his collecting of data to surrounding lands. This collection was destroyed by the Japanese. It had held the reference material for a vast output of taxonomic papers; but the magnitude of the loss on its destruction is lessened by the existence of duplicates in many herbaria which he, thinking internationally, had distributed abundantly.

As a prelude to the projected Flora of the Archipelago, he published in 1912 a descriptive "Flora of Manila" to support teaching in the University, and to teach was immediately added to his duties. In 1919 a further portion of his time was withdrawn from botanical research, for he was required to take the post of director of the Bureau of Science. His reaction to added work was to lengthen the day; but he could and did turn the projected descriptive "Flora" into an "Enumeration of Philippine Flowering Plants", which appeared during 1923–26, the fourth and last volume holding a masterly phytogeographical review.

Merrill had married in 1907, and for the sake of the children a home was made in the United States; he spent part of his leave in 1921 with them in California, returning to Manila alone. In 1923 the University of California offered him the appointment of dean of its College of Agriculture. He accepted and served there for five years. Then he was invited to be director of the New York Botanic Garden, and he also served there for five years. In 1935 he was asked to take the post of administrator of the Collections of Harvard University (otherwise director of the Arnold Arboretum), which he held for eleven years. All three posts were difficult by reason of conflicting interests; but he was remarkably successful in all of them. One who knew him intimately wrote of his qualities—quickness of perception, unfailing patience and courtesy, great store of common sense, promptness in taking action, approachableness, and consideration for others. The University of California at Berkeley joked about his early hours used in naming collections that followed him from Manila. His reliability drew unexpectedly large donations towards his projects. In New York during the distressing slump of 1930 as many unemployed stenographers as he could employ were put at his service, and he used their labour for the innovation of incorporating descriptions and illustrations among the herbarium sheets. The Harvard University units that were under his charge were commonly spoken of as the 'orphans'. His first annual report referred to the need of somehow placing them in the 'family'; but re-organization was deferred until after his retirement. His last annual report gives a retrospect of his eleven years and shows the orphans, though still orphans, growing healthily.

In advance of his seventieth birthday Merrill was released on request from administrative duties at the end of the Arboretum's fiscal year (June 30, 1946). He remained Arnold professor of botany and continued his botanical work. The dispersal of cultivated plants had become a major interest. He had criticized in 1920 the extravagant diffusion theories of O. F. Cook, and later, when at New York, had had occasion to attack fresh unsubstantial claims of pre-Columbian transfers of useful plants between the Americas and the rest of the world. In 1950 in Washington anthropological friends asked him to sum up the case against new diffusionists, and shortly afterwards one of the diffusionists challenged him to prove his position. In the next year, being in London and at work on plant distribution, it occurred to him that, as the introduction of weeds offers evidence parallel to the introduction of cultivated plants, he could use the old records in the British Museum for his purpose, and he began to write his last book, "The Botany of Cook's Voyages". Unfortunately he was taken ill and the work was interrupted; he recovered and resumed it, but was taken ill again. At a second resumption he completed the writing, and with the help of others the book was published in the autumn of 1954, by which time he was exceedingly ill; but he lived to February 25 of this year. He had received many honours and had obtained an international position in his own branch of botany that was unmatched. I. H. BURKILL

Sir Cyril Norwood

WITH the death of Sir Cyril Norwood on March 13, at the age of eighty, there passed an outstanding figure in the world of education of the past fifty years. His influence was comparable to that of men like Arnold in the nineteenth century. Norwood, a brilliant classical scholar from Merchant Taylors' School, gained the highest honours at Oxford and spent several years in the Home Civil Service before entering the teaching profession at Leeds Grammar School in 1901. Five years later he became headmaster of Bristol Grammar School, and during fifteen years he transformed its standards and achievements. Then followed nine years, perhaps the zenith of his school activities, as master of Marlborough College, before his migration to the headmastership of Harrow and in 1934 to the presidency of St. John's, Oxford, his former College, from which he resigned in 1946 because of his wife's ill-health.

Throughout his whole educational career, Dr. Norwood brought what has been called the 'modern approach' to bear upon the organization concerned. Without relinquishing his firm belief both in the value of a classical training for the study of language and in the study of ancient history, he was among the first to emphasize the need for a greater emphasis on the teaching of modern languages, geography, science, and later of economics. His underlying aim seemed to be to modify where necessary an existing system of education—sometimes stereotyped or stagnant—so as to meet the needs of a changing world or society, and the present arrangement of the General Certificate of Education examinations owes much to the analysis of the Norwood Report of 1943. The vast impact of the sciences, pure and applied, during the post-war years, came a little too late for him to play an active part; but it might have been interesting indeed to see his outlook upon it.

Norwood had a strong, compelling, even if at times enigmatic personality. In appearance he might have been likened to Lord Kitchener, and the methods of the two men were at times similar. His deep religious beliefs were matched by a conviction of the essential correctness and desirability of his educational policies. This caused him at times to appear despotic and ruthless. He brought criticism upon himself from some by the widespread publicity he gave to his ideas. Yet he did not deliberately seek the publicity which followed as a result of the innate conviction of his mission and his desire for progress. The value of his work was proved by the successes of his pupils and masters alike. His reserve, possibly a shyness, made him appear unapproachable to many; but others learnt to know him as a kindly, human personality and a friend of good counsel. Of all the talks which he gave throughout his life, few could have surpassed in simple, penetrating eloquence that which he delivered in the chapel of his College on the cessation of war in 1945. For him, too, it was to be the epilogue of a life filled with interest and achievement.

Dr. Robert Pohl

OVER a period of fully half a century, developments in the design of rotating electrical machines have been influenced by the work of Dr. Robert Pohl, whose death occurred on March 15. He was seventy-seven years of age.

Born at Hamm, Westphalia, Pohl received his university education at Hanover and his first industrial experience with the firm of Lahmeyer in Frankfurt. At the time at which Pohl entered the electrical industry, direct-current practice was well established and the utilization of alternating current was undergoing intensive development. The dynamo was already an efficient and relatively refined machine awaiting only the devising of means further to improve its commutation. Pohl's first contribution to the advancement of electrical knowledge, made when he was little more than a student, was towards elucidating the mode of action of the interpole or commutating pole then newly invented.

Pohl went to England in 1904 to join the staff of the Phoenix Dynamo Co. of Bradford, and he was appointed chief engineer of the Company at the age of twenty-eight. He was responsible for the production by that Company of the first machine with commutating poles to be built in Great Britain. From 1905 onwards Pohl contributed, except for the period of the First World War, to the literature of electrical machinery. His more important early papers were on direct-current machines, but by 1914 he was writing on turbo-alternators.

Six months after the outbreak of the First World War Pohl was interned. He returned to Germany in 1919, where he became director and chief engineer of the A.E.G. Turbine Works in Berlin. More than thirty papers, published for the most part in *Elektro-Technische Zeitschrift* and *Elektrotechnik und Maschinenbau* between 1919 and 1938, record the contributions which placed Pohl in the first rank of designers of large electrical machines. He made one of the early experiments in the hydrogen cooling of alternators, running a machine in town's gas in Charlottenburg. By 1938 it had become clear to Pohl that he and his family could not much longer escape Nazi persecution. Through the good offices of friends he was able to get away safely to England and was joined by his wife and son. Prof. William Cramp was instrumental in securing the appointment of Pohl to the staff of his department in the University of Birmingham.

The third phase of Pohl's career was to prove no less fruitful than the first two. He brought to his teaching a wealth of practical experience, and he had the power to transmit his ideas. The British Thomson-Houston Co. retained him as a consultant, and it was not long before contributions from his pen began again to appear in the *Journal of the Institution of Electrical Engineers*. This time, inductor alternators and the behaviour of magnetic material in machines claimed much of his attention.

At the time of his retirement from the University of Birmingham Pohl was serving as a consultant in relation to the power supply for the synchrotron which was then under construction, and here again he made a significant contribution.

The outstanding quality of all Dr. Pohl's work is its clear physical insight. Although nearly all his papers involve some mathematical analysis, it is in the originality of his physical concepts that his genius is demonstrated.

Dr. Pohl had an exceptional endowment of fine qualities. He was a man of complete integrity and liberal philosophy. His intellectual distinction he carried lightly, for he possessed a keen and subtle sense of humour which he not infrequently turned against himself. He was musical, a great reader of literature, and he had a critical appreciation of art. Perhaps his most endearing quality was a wonderful capacity for friendship with children. No one could have a more staunch friend, and countless people stand in his debt for help freely given. Pohl was almost too acutely conscious of human suffering and it might be said of him that the sharp distress of the world sometimes pressed upon his keen intellect and sensitive mind to the point of pain. Those who knew Pohl recognized in him a quality of intellect, sympathy, and understanding which is supremely rare.

JAMES GREIG

NEWS and VIEWS

Directorship of the London School of Economics and Political Science :

Sir Alexander Carr-Saunders, F.B.A.

SIR ALEXANDER CARR-SAUNDERS retires as director of the London School of Economics and Political Science at the end of the year, a post he has held since 1937 when he succeeded Sir William (now Lord) Beveridge. There have been only five directors of the School since the beginning in 1895, all of them men of great distinction and breadth of experience, and the present director takes his place as by no means the least distinguished, nor the least successful, of the five. He read zoology at Oxford, but his interests in demographic and social studies led him to accept the offer of the Charles Booth chair of social science at Liverpool in 1923. Since then his contributions to the advancement of social studies and his public services generally have been numerous. He has guided the London School of Economics through what has been perhaps its most difficult period. He found for the School a happy war-time home at Peterhouse, Cambridge, and he leaves it re-established in London, a smooth-running and harmonious institution with an international standing higher than ever before. At the same time, he has been a tireless traveller and an indefatigable worker in the cause of higher education in the Colonies. He was chairman of the two Commissions which led to the creation, first of the University of Malaya, and then of the new University College of Rhodesia and Nyasaland, Salisbury. It is hoped that he will continue to preside over the Inter-University Council for Higher Education Overseas and to give the new universities overseas the benefit of his wise and experienced counsel.

Sir Sydney Caine, K.C.M.G.

SIR SYDNEY CAINE, who succeeds Sir Alexander Carr-Saunders, is well equipped for the task; he brings to his new post an almost unique experience in administration and financial affairs. He is no stranger to the London School of Economics, since he graduated there with great distinction in 1922, and he has served for many years both on the Court of Governors of the School and on the University of London Board of Studies in Economics. Nor is he a stranger to university administration, since he has been a very successful vice-chancellor of the University of Malaya since 1952. Between 1923 and 1952 he built up a high reputation as a Civil servant, first as an inspector of taxes, then for many years in the Colonial Office, and finally in the Treasury. He has served as Financial Secretary in Hong Kong, as financial adviser to the Colonial Secretary, and as head of the Treasury Delegation in Washington. Since he went to Malaya, though giving up a career as public servant, he has not cut himself off from public affairs. He has been concerned with the problems of confederation in the West Indies, and he is at present acting as economic adviser to Mr. Marshall, the Chief Minister in the new administration in Singapore.

Directorship of the Waite Institute, Adelaide :

Prof. J. A. Prescott, C.B.E., F.R.S.

PROF. J. A. PRESCOTT retired from the directorship of the Waite Agricultural Research Institute of the University of Adelaide at the end of January. He had held the Waite chair of agricultural chemistry since 1924 and the directorship of the Institute since 1938. Between 1929 and 1947 he was also chief of the Division of Soils of the Commonwealth Scientific and Industrial Research Organization. For his work in Australian pedology and his studies in agricultural climatology, Prof. Prescott has achieved an international reputation; and on his retirement the University conferred on him the title of professor emeritus.

Dr. James Melville

DR. JAMES MELVILLE, director of the Grasslands Division of the New Zealand Department of Scientific and Industrial Research since 1952, has succeeded Prof. Prescott as director of the Waite Agricultural Research Institute, Adelaide. His interests are broad, but have been concerned particularly with pasture growth and quality in relation to animal production.

New Television Transmitting Station at the Crystal Palace, London

THE first regular daily television service in the world was started from the Alexandra Palace Station of the B.B.C. on November 2, 1936, and with the exception of a break during the war period, this station has provided the service for the London area since that date. On March 28, however, this service was taken over by the new television transmitting station at the Crystal Palace, where the partially completed permanent tower is a notable landmark in south London. A technical description of the new station is contained in a paper presented by Messrs. F. C. McLean, A. N. Thomas and R. A. Rowden at a meeting of the Institution of Electrical Engineers on April 4. The station is planned to have ultimately an effective radiated power of 500 kW., in accordance with the allocation made at the European Broadcasting Conference at Stockholm in 1952. It was decided, however, that the station should open with a power of about 200 kW., but that the building and the power plant should be planned so as to facilitate raising the output to the higher value in the future. A second paper, read at the Institution of Electrical Engineers meeting referred to above, by Messrs. V. J. Cooper and W. J. Morcom (of Marconi's Wireless Telegraph Co., Ltd.) described in detail the television transmitting equipment, which is designed to operate in two parallel chains to ensure the maximum reliability in service.

The station building is buried below the terrace on a two-acre site at the Crystal Palace, and incorporates two vision transmitters of 15 kW. and two sound transmitters of 4 kW., with provision for raising these to 50 kW. and 12 kW., respectively, when necessary. The aerial system consists of eight tiers of dipoles erected around a self-supporting tower, which is tapered to a height of 440 ft. (134 m.) above ground-level, and will later be surmounted by a parallel-sided structure for a further 250 ft. (76 m.) to carry the aerial systems for future transmissions in higher-frequency bands. For the transmission of programmes between Broadcasting House and Crystal Palace, a distance of 9 miles (14 km.), two coaxial cables of 0·975 in. (2·5 cm.) diameter have been provided, for direct transmission between the terminals without intermediate equipment. The cables and their associated terminal equipment are designed for transmission in either direction, since it is proposed to use the Crystal Palace as a pick-up point for television outside broadcasts and carry the signals by the cable to the Broadcasting House switching centre for connexion to the main television network. Full details of this cable link and of its performance are given in a third paper presented at the meeting by Dr. A. R. A. Rendall and Mr. S. H. Padel, of the B.B.C. staff.

Preliminary field-strength measurements made around the Crystal Palace site have confirmed the original theoretical expectations that the population within the service area will be 1·5–2·5 millions greater than the number hitherto served by the Alexandra Palace station. The outer coverage in Kent, Surrey and Sussex is much improved, while only the area immediately surrounding Alexandra Palace and some districts to the north of London experience a decrease in field-strength. Although these areas still receive an adequate service, a minority of viewers may need better receiving aerials.

Future of Colour Television in Britain

AT a meeting of members of the International Radio Consultative Committee, held in London on April 5, Sir Ian Jacob, director-general of the British Broadcasting Corporation, discussed the problem of colour television, with particular emphasis on conditions in Great Britain and the work and future plans of the Corporation. He began by pointing out that the present television programme will soon be capable of being received by 97 per cent of the British population and that there are at present six million television receivers in the hands of the public or, in other words, that 40 per cent of the population have receivers in their homes. The Corporation is conducting a series of technical tests on the N.T.S.C. system of colour television developed by the American radio industry and adopted by the Federal Communications Commission for public use in the United States; for these tests the system has been adapted to the British 405-line television standards, and the object is to determine whether the system gives a satisfactory colour picture without being degraded to any noticeable extent as a black-and-white picture on an existing receiver. The results so far indicate the possibility of a compatible system on 405 lines, and thus it may be feasible eventually to transmit a colour programme on the Band I frequencies that are at present being used and on the Band III ones which are reserved for a future second programme. If, however, a compatible system is not possible, then the only hope for colour television in Britain is to use different transmissions on Bands IV and V frequencies, and this will involve setting up completely new transmitter networks on frequencies which, from the technical point of view, are less favourable; it is not a prospect to be relished.

Turning to the question of reception, Sir Ian pointed out that, besides the technical problems, there are economic and social factors which must inevitably weigh heavily on any decision by the Government with regard to the development of colour television. He is not convinced that a colour receiver has yet been developed, even in the United States, which is satisfactory for large-scale production. The cost of such receivers still seems to be prohibitively high, and the present economic situation is such that the Government wants to restrict home demand and to limit capital expenditure. Sir Ian doubts if all the information is yet available to arrive at any national policy for colour television; but he put in a special plea that the representative bodies of the various countries of the world should keep in close touch with one another so as to secure the greatest possible amount of international standardization.

Institute of Wood Science

IN view of the widespread interest in the technical aspects of wood, it has been felt for some time that there is a need in Great Britain for a national body with the avowed object of advancing scientific knowledge of wood and allied subjects, and as a result of a number of discussions held during the past year an Institute of Wood Science has been formed, with Mr. David D. Irvin, deputy chairman of the Timber Development Association, Ltd., as chairman of the Council and honorary secretary of the Institute. The main purpose of the Institute is "to advance the scientific, technical, practical and general knowledge of persons interested in the study of wood and allied subjects", and it is proposed to interpret this in the broadest possible sense. Thus, besides the study of the anatomy and chemistry of wood, etc., the words ". . . and allied subjects" are intended to include such subjects as wood adhesives, the chemistry of preservatives, pulp, woodworking machinery and similar matters which involve wood indirectly. An immediate objective of the Institute is to start a journal, and Prof. A. R. Gemmell, of the University College of North Staffordshire, has been appointed as editor.

The Institute intends to concern itself directly with education in timber technology or wood science, and ultimately it hopes to become the examining body in at least the senior examinations in this subject. Other aims and activities include the organization of meetings, lectures and excursions, co-operation with other bodies having similar objects and the establishment of branches in various parts of Britain. The various grades of membership of the new Institute will be as follows: fellows (who will be entitled to use the letters F.I.W.Sc. after their names); associates (A.I.W.Sc.); certificated members; ordinary members; junior members; and patrons. The conditions for associateship include the higher certificate of the Timber Development Association, Ltd., or the appropriate certificate of the Institute, or, at the discretion of the Council, a university degree in science, and also three years of experience in wood science; fellowships will be granted to associates at the discretion of the Council. The main condition for certificated membership is the third-year certificate of the Timber Development Association, Ltd. The subscription (which will include receipt of the journal) will be 3 guineas a year for fellows, associates and ordinary members; 2 guineas a year for certificated members; and 1 guinea a year for junior members. Firms, associations or corporations may become patrons by supporting the Institute financially, as also may individuals if they wish to subscribe more than the normal membership fee. Further information can be obtained from the honorary secretary of the Institute, c/o the Timber Development Association, Ltd., 21 College Hill, London, E.C.4.

Higher Technological Education in London and the Home Counties

THE seventh annual report of the London and Home Counties Regional Advisory Council for Higher Technological Education, covering the year ended August 31, 1955 (pp. 40; from the Council, London; 1956), welcomes the Minister of Education's remark to the annual conference of the Association of Education Committees that he would not allow local feelings to spoil higher technical education, and points out that the Council's limited experience so far of planning courses in particular subjects regionally has not been discouraging. In several instances, two or more authorities have jointly examined a known industrial demand and achieved a significant economy with greater efficiency. At the annual meeting of the Council, Sir Hugh Linstead criticized the Minister's proposal to upgrade some twenty or thirty colleges and doubted particularly the possibility of providing even fifteen hundred additional technologists a year from the existing colleges and the possibility of properly staffing and equipping as many as twenty or thirty colleges at the higher level; these criticisms and the subsequent discussion are summarized in the report. The Council has appointed Mr. L. C. Wooder to undertake a research project into the distribution of courses of higher technological education in the region, including an industrial survey of the region, surveys of technical education, communications in relation to the situation and 'catchment' areas of colleges and population trends, and a comparative study of those factors in relation to the distribution of courses. The Council has also recommended to local education authorities which are in membership that a college should not initiate a sessional course of higher technological education unless it has every reason to suppose the course will continue to the end of the session and that if, owing to unforeseen circumstances, the course is terminated before the end of the session, the college should arrange for students to complete the course elsewhere with a minimum of inconvenience to the student. Figures supplied by the Minister of Education for full-time degree and higher diploma students in technical colleges over the three years 1952–55 indicate a marked increase in those attending higher diploma courses in engineering, and the number working for M.Sc. or Ph.D. (internal) degrees during the period rose from 59 to 116. The numbers of students for internal degrees fell from 1,641 to 1,369 and for external degrees from 761 to 544.

Parliamentary and Scientific Committee: Report for 1955

THE annual report for 1955 of the Parliamentary and Scientific Committee (pp. 22; from the Committee, 31 Palace Street, Westminster, London, S.W.1; 1956) provides the usual convenient record of the activities of the Committee during the year, including a list of addresses given to the general committee. Particular attention is given to problems connected with higher technological education and scientific man-power. During the second reading of the Agricultural Research Bill on December 13, representations regarding the present organization of veterinary research were made on behalf of the Committee by Mr. A. J. Champion, its joint honorary secretary, and by Mr. M. Philips Price, and further consideration will be given to this subject by the Committee this year. In view of the alarm expressed by several organizations as to the effect of the higher postal rates for scientific journals and publications, a questionnaire is being sent to all scientific organizations affiliated to the Committee to permit an assessment of the general position with a view to a formal and more detailed statement. During the passage through Parliament of the Rating and Valuation (Miscellaneous Provisions) Bill, the views of the scientific bodies were brought to the notice of the Government, and because of dissatisfaction about the rating position, expressed at a meeting of the Committee on July 12, it was agreed to prepare a comprehensive report for the Government on the rating position of research associations and scientific societies.

Expenditure on Government Information Services

A WHITE Paper on "Government Information Services: Statement showing Estimated Expenditure, 1955–56" (Cmd. 9591. Pp. 4. London: H.M.S.O., 1955; 4*d.* net) gives the expenditure on home services as £2,245,100, compared with £2,333,600 in 1954–55, and on overseas services as £10,495,950, compared with £10,231,700. Of this sum, £741,150 is carried on the Central Office of Information's Vote, of which £150,250 and £156,250 are for the Air Ministry and the War Office, respectively; these two Departments account for £246,700 and £359,850 of the total, respectively. Estimated expenditure for the National Savings Committee (£277,200) and the Road Fund of the Ministry of Transport and Civil Aviation (£213,000) also exceeded £200,000. Of the Overseas Estimate, £4,755,000 is on account of the B.B.C. External Services as grant-in-aid from the Post Office, £1,757,400 as Foreign Office grant-in-aid to the British Council and £2,289,800 on behalf of the Foreign Office, including the German Section. £538,800 goes to the British Council for the Colonial Office, and a further £381,700 for the Commonwealth Relations Office, while expenditure on behalf of the Colonial Office and the Commonwealth Relations Office is estimated as a further £259,800 and £494,700, respectively.

Scottish Field Studies Association: Report for 1955

THE annual report of the Scottish Field Studies Association for 1955 records the progress the Association has made under difficult conditions and indicates what could be achieved if the Association had a centre of its own. During the year the number of students who attended the Field Studies Centre at Garth showed a considerable increase over the previous year, while groups under their own staff attended from a number of schools and university departments. During this year six courses at Garth are planned as follows: May 18–21, outdoor art; August 11–18, introduction to plant ecology; August 18–25, grasses, sedges and rushes; September 7–14, mosses and liverworts; September 14–17, autumn birds; and September 21–24, higher woodlands. The difficulties at Garth, which is primarily organized as a Youth Hostel Association Centre, prevent the development of the Association's activities; and it has now been decided that, when money becomes available, the Glencoe area has considerable advantages of hill and sea, moor and crags, for botanists, geologists, zoologists and others and that a centre should be established there. Particulars about the courses may be obtained from the honorary secretary and treasurer, B. W. Ribbons, Department of Botany, The University, Glasgow.

Populations of House-Mice

SOME observations with house-mice have been carried out at the University of Wisconsin by R. L. Strecker under the guidance of John T. Emlen, jun. (*Scient. Amer.*, December 1955). The investigators first wished to find out whether the mice lived in compact communities or drifted about at random among the college buildings. Trappings showed that the mice were content to live within a narrow range so long as they had plenty of food and shelter. Limiting the population's food supply revealed that, as a food shortage approached, migration from the colony increased sufficiently to 'tap off' mice as quickly as new ones were born. Reproduction apparently continued normally and the remaining population showed no unusual features with regard to sex or age composition. In a further series of experiments the food supply was drastically limited, but the mice were prevented from escaping. As starvation approached, reproduction stopped completely. These investigations on house-mice show that the determining factors in population studies can be examined individually. They should lead eventually to a clearer picture of the parts played by various influences on the abundance and scarcity of animals.

A Flowering Inhibitor in *Kalanchoe*

RECENT experiments with *Kalanchoe blossfeldiana*, by W. W. Schwabe (*Ann. Bot.*, 20, 77, 1; 1956), indicate that a flowering inhibitor may be produced by long-day exposures. He has shown that single long days intercalated between numbers of short days have a positive inhibitory effect on flower initiation and are not merely ineffective. The inhibitory effect expressed as the number of inductive cycles annulled is approximately additive, provided the long days are interspersed with short days, but not if several long days are given consecutively. On the average, one long day is capable of annulling the flower-promoting effect of about 1½–2 short days. To a first approximation, flower numbers in *Kalanchoe* increase exponentially with the number of inductive cycles given—up to at least twelve short days. The inhibitory effect of long days interspersed with short days also fits an exponential curve; that is, the inhibition is roughly proportional to the amount of previous photo-periodic induction. A light break of as little as thirty seconds duration given in the middle of a long dark period is as inhibitory as a long day. If followed by a long dark period the inhibition of an intercalated long day is almost completely neutralized; a long dark period preceding it has no such effect. These results have been interpreted as due to the interaction of a flowering inhibitor with a reaction leading to flowering. A mechanism involving competitive inhibition of an adaptively formed enzyme has been described as a possible example of the kind of reaction which could account for the results presented.

The National Museum of Wales

THE forty-eighth annual report (1954–55) of the National Museum of Wales is a record of steady non-spectacular but important work. Although plans for the much-needed building extensions are still in abeyance, valuable discussions have taken place regarding the proposed new department to illustrate the special industries in Wales. The Welsh Folk Museum deals with rural industries; but the Council considers it urgent that the history of industries and their present practices should be included in the Museum. Especially is this the case in a technological age and when material and information are being lost almost week by week. As usual, the staff have taken their full share of extra-mural activities within the Principality as, for example, the keeper of geology as president of the South Wales Caving Club taking part in negotiations with the view of preserving a cave threatened by quarrying, and the keeper of botany continuing his researches on atmospheric pollens and spores.

Iron and Steel Institute: Forthcoming Meetings

THE eighty-seventh annual general meeting of the Iron and Steel Institute will be held at the Royal Institution (Albemarle Street, London, W.1) and at the offices of the Institute (4 Grosvenor Gardens, London, S.W.1) during May 16–17. On the evening of May 15 a Bessemer Centenary Lecture will be given at the Royal Institution by Mr. James Mitchell, past president of the Institute, and on the morning of the next day the new president, Dr. H. H. Burton, will take office and deliver his presidential address. Following this, Prof. N. F. Mott, Cavendish professor of experimental physics in the University of Cambridge, will give the ninth Hatfield Memorial Lecture, his subject being "The Fracture of Metals".

During June 5–14 the Institute will hold a special meeting in France in association with the Chambre Syndicale de la Sidérurgie Française and the Société Française de Métallurgie. During June 5–11 the meeting will be in Paris, and the remainder of the time will be spent on three excursions to iron and steelmaking areas in eastern, central or northern France. Further information on the meetings can be obtained from the Secretary of the Institute at 4 Grosvenor Gardens, London, S.W.1.

Fifth World Power Conference, Vienna

THE Fifth World Power Conference will be held in Vienna during June 17–23, the headquarters of the

Conference being at the Konzerthaus, Lothringerstrasse 20, Vienna III. The theme of the Conference is "World Energy Resources in the Light of Recent Technical and Economic Developments", and the technical programme will consist of six divisions, at which the following topics will be discussed: the present status and development of power production and utilization in individual countries; the preparation and conversion of fuels; utilization of primary sources of energy; purification of waste water and exhaust gas in the production and use of energy; international co-operation in the production and use of energy. Short excursions will be available in Austria during the Conference, and afterwards a number of extensive tours of hydroelectric stations, power stations, etc., have been arranged in Austria, Yugoslavia, Italy and southern Germany. Further information is available from the various national committees, the British one being at 201–202 Grand Buildings, Trafalgar Square, London, W.C.2. Otherwise, all inquiries should be addressed to the Oesterreichisches Nationalkomitee der Weltkraftkonferenz, Vienna I, Schwarzenbergplatz 1.

Chemical Society: Officers

Officers of the Chemical Society have been elected as follows: *President*, Prof. E. L. Hirst; *Vice-Presidents*, Sir Ian Heilbron, Sir Cyril Hinshelwood, Prof. C. K. Ingold, Dr. W. H. Mills, Sir Eric Rideal, Prof. W. Wardlaw, Prof. E. D. Hughes, Prof. E. R. H. Jones, Dr. R. P. Linstead, Prof. H. W. Melville, Prof. M. Stacey and Sir Alexander Todd; *Honorary Treasurer*, M. W. Perrin; *Honorary Secretaries*, Dr. L. E. Sutton, Prof. F. Bergel and Dr. J. Chatt; *New Members of Council*, Prof. R. M. Barrer, Prof. A. G. Evans, Prof. L. Hunter, Dr. G. W. Kenner, Prof. B. Lythgoe, Dr. A. Maccoll and L. A. K. Staveley.

University of Birmingham

The following have been appointed Research Fellows in the University of Birmingham: D. B. Holt (physical metallurgy) and Dr. G. Hübscher (pharmacology). The University has received from Ciba, Ltd., of Basle, a Ciba research scholarship for three years of £700 a year for the work and training of a graduate in the techniques of organic chemistry; in the first instance, the scholar will work on the synthesis of new halogen-containing organic compounds under the direction of Prof. M. Stacey. A grant of £900 has been made by the Electrical Research Association to the Department of Electrical Engineering of the University for the continuation of research work on electric discharges in liquids.

Announcements

Dr. J. S. D. Bacon, senior lecturer in biochemistry, University of Sheffield, has been appointed head of the new Department of Biochemistry at the Macaulay Institute for Soil Research, Aberdeen, as from September 1 next.

The forty-first annual conference of the Textile Institute will be held in Blackpool during May 22–25, the subject for discussion being "New Yarns and Fabrics". Further information can be obtained from the Institute at 10 Blackfriars Street, Manchester 3.

An international conference on "Nuclear Reactions", organized by the Nederlandse Natuurkundige Vereniging, will be held in Amsterdam during July 1–7. Among the topics discussed will be elastic and inelastic scattering, capture and photo reactions, stripping and pick-up reactions and fission. Further information can be obtained from the secretary of the conference committee, Dr. S. A. Wouthuysen, Zeeman Laboratorium, Pl. Muidergracht 4, Amsterdam (*C*).

A symposium on the methods, materials and processes involved in the uses of high temperatures in science and industry, organized jointly by the Stanford Research Institute and the University of California, Berkeley, will be held in Berkeley during June 25–27. Further information can be obtained from Dr. Nevin K. Hiester, manager of the Chemical Engineering Section, Stanford Research Institute, Menlo Park, California.

The Second World Congress on Fertility and Sterility, sponsored by the International Fertility Association, will be held in Naples during May 18–26, the scientific sessions being held at the Palazzo Mostra di Oltremare and the inaugural session at the Castel Angioino. Simultaneous translations in English, French, Spanish and Italian, with the use of head-phones, will be available. In addition to the human aspects of the subject, there will be sessions on animal fertility and sterility. Further information can be obtained from Prof. G. Tesauro, Faculty of Medicine, University, Naples.

A symposium on molecular structure and spectroscopy will be held in the Department of Physics and Astronomy of the Ohio State University during June 11–15. Both the interpretation of molecular spectroscopic results as well as methods for obtaining them will be discussed. The Joint Commission on Spectroscopy of the International Union of Pure and Applied Physics and the International Astronomical Union will meet concurrently with the symposium. Further information can be obtained from Prof. H. H. Nielsen, Department of Physics and Astronomy, Ohio State University, Columbus 10, Ohio.

The annual meeting of the Société de Chimie Physique will be held in Paris during May 29–June 1, when the subject, "Superficial Reactions of Gases on Metals", will be discussed. All the fundamental phenomena affecting the development and structure of thin films formed by gases on metal surfaces will be considered, with the exception of pure absorption and catalysis. Further information can be obtained from Prof. G. Emschwiller, École Supérieure de Physique et Chimie, 10 rue Vauquelin, Paris 5e.

The Fourth International Congress on Fruit Juices will be held in the Killesberg Park, Stuttgart, during May 28–June 2, the organizers being the Zentralverband der Sussmost- und Obstgetrankein-Industrie. The Congress is under the auspices of the International Federation of Fruit Juice Producers (Paris), and official representatives of the food and health services of twenty countries, as well as industrialists, exporters and importers, will be attending. The programme will include fifteen general reports and forty-four special reports, dealing with problems both from the point of view of medicine and hygiene and from the scientific, technical and practical angles; international questions referring to production, conditioning, sales and outlets will also be considered. Further information can be obtained from the office of the Congress at Bachstrasse 26, Bonn Rhein, Germany.

MATHEMATICAL EDUCATION IN SOUTH ASIA

AN international conference on mathematical education, with special reference to countries of South Asia, was held in Bombay at the Tata Institute of Fundamental Research during February 22–28, under the presidency of Prof. K. Chandrasekharan, of the Tata Institute.

In his presidential address, Prof. Chandrasekharan suggested that difficulties in South Asia stem from an inadequate recognition of the value of creative intellectual activity as part of the drive towards prosperity, and put forward five proposals to enable the creative scientist to come into his own. First, the gifted research worker must be given a suitable working atmosphere and adequate financial support; this might be done through a system of research contracts set up by a government and administered by a national committee for mathematics. Secondly, the facilities for training students in advanced mathematics must be increased, by providing graduate schools for advanced study. Thirdly, courses of study must be integrated, and the present very rigid examination system radically modified. Fourthly, the teaching staff in colleges must be reinforced, and the teacher must be given more leisure, more encouragement, and more opportunity for keeping in touch with new ideas in mathematics. Fifthly, suitable text-books must be provided; if need be, a national text-book committee, equipped with adequate funds, must be set up to seek out competent authors and induce them to write the much-needed books. Finally, the school course must be revised and rendered more elastic, since creative mathematics cannot prosper fully unless the foundations are firmly laid in the schools.

Invited addresses were given to the conference by Prof. A. D. Alexandrov (U.S.S.R.), Prof. E. Bompiani (Italy), Prof. T. A. A. Broadbent (United Kingdom), Prof. G. Choquet (France), Prof. H. Freudenthal (The Netherlands), Prof. E. Marczewski (Poland), Prof. A. Oppenheim (Malaya), Prof. M. H. Stone (U.S.A.), Prof. Hsio-Fu Tuan (China). Some of these addresses dealt with the problems of mathematical education arising in the speaker's country, and described methods which are being used in the solution of such problems. Others dealt with the application of new methods in psychology to mathematical education, with new ideas in teaching arithmetic, and with the best way of beginning the teaching of geometry.

For detailed discussion of special questions, and particularly of the five points raised in the presidential address, members of the conference were divided into three working groups, one for the school stage, one for the bachelor's or master's degree stage, and one for the postgraduate stage. Each group discussed, in its relevant context, the aim of mathematical education, the ideal scope and content of the course, the recruitment, maintenance and training of the teacher, the mode of selection of the students at the higher levels and maintenance of such students, and the necessary facilities and equipment to be required. It was concluded that, at the schools, instruction should be closely related to the needs, the capacity and the interests of the pupil, and an integrated and simplified course, including some statistics as well as the traditional subjects, should be offered. At the universities, the degree course should meet the requirements of society in general, should train those intending to teach mathematics in schools or universities, and should begin the training of the professional mathematician. The postgraduate training should fit students for research and for the teaching of advanced mathematics; here a course of lectures in the most recent developments is essential, though no formal examination should be imposed. Examinations at the lower levels should be more flexible, no student should be asked to stake his whole career on the results of a single examination, written examinations should be supplemented by oral examinations and by an evaluation of the student's total performance; where possible, teachers should participate in the examination of their own students. The provision of text-books, scholarships, summer schools and seminars, and research contracts, was examined in detail, and specific recommendations were made.

The working groups reported interim progress to plenary sessions, from which further instructions were received. Finally, the findings of the working groups were incorporated in a set of resolutions presented to and unanimously adopted by the last plenary session of the conference. This session further resolved to set up a permanent small committee for mathematics in South Asia, under the chairmanship of Prof. Chandrasekharan; this committee would bring the resolutions of the conference to the notice of responsible educational authorities in South Asia, and press for the rapid implementation of these proposals. It is hoped to have on this committee representatives of India, Pakistan, Burma, Ceylon, Indonesia, Malaya-Singapore, and Thailand.

No member of the conference could fail to be impressed by the vast problems confronting the teachers of mathematics in South Asia, the urgent needs of the students in those countries, and the enthusiasm of their teachers. Perhaps because of the magnitude of the problems, the conference worked harmoniously, national and sectional interests seldom being allowed to intrude. But above all, the success of the conference was due to the knowledge, skill, organizing ability and driving force of the president, Prof. Chandrasekharan. He focused attention on special problems, induced strong and definite resolutions, and left no doubt in members' minds that great efforts will be made to have these proposals accepted and implemented by the appropriate authorities in the countries of South Asia.

SCIENCE AND PEOPLE

IN his presidential address to the American Association for the Advancement of Science at Atlanta on December 28, 1955, Dr. Warren Weaver, of the Rockefeller Foundation, examined the influence of science on people (*Science*, 122, No. 3183).

Science, he said, has impressively proved itself to be a powerful way of dealing with certain aspects of our experience. These are, in general, the logical and quantitative aspects, and the method works superbly for linear and stable physical problems in two or three variables. The physical universe seems to be put together in such a way that this scientific approach is exceedingly successful in producing a good, workable, initial description. With that kind of solid start, physical science can then safely proceed to elaborate more sophisticated theories.

How far these methods will be successful in the world of living things is not yet known. The successes to date are very impressive. One feature after another that previously seemed to fall in a special 'vital' category has usefully yielded to biochemical or biophysical attack. As yet only a beginning has been made. How far the logical quantitative method will succeed here, it would be rash to forecast, although the prospects seem extremely promising.

Small beginnings at extending the scientific method into the social sciences have been made. In so far as these fields can be dealt with in terms of measurable quantities, they seem to present closely intercoupled situations that can very seldom usefully be handled with two or three variables and often require very many—for example, W. Leontief's input–output analysis of the United States economy deals with some fifty variables and regrets that it does not handle more. Science has, as yet, no really good way of coping with these multivariable but non-statistical problems, although it is possible that ultra high-speed computers will inspire new sorts of mathematical procedures that will be successful in cases where the effects are too numerous to handle easily but not numerous enough or of suitable character to permit statistical treatment. If we try to avoid the many-variable aspect of the social sciences by using highly simplified models of few variables, then these models are often too artificial and over-simplified to be useful. The statistical approach, on the other hand, has recently exhibited—for example, in the stochastic models for learning—new potentialities in the field of human behaviour.

It is not at all necessary that the particular analytical techniques of the physical sciences be forced upon biological or social problems with the arrogant assumption that they can and should make unnecessary other types of insight and experience. During the Second World War, an extremely useful collaboration was developed, known often as operations analysis, in which reasoning of a mathematical type was applied to certain aspects of very complicated situations, but with no expectation that judgment, experience, intuition, or a vague sort of general wisdom would be displaced or superseded—rather only that these would be aided by whatever partial light could be furnished by quantitative analysis.

An important characteristic of science is its incapacity to be impractical. The most far-reaching discoveries and the most widespread useful applications flow regularly out of ideas that initially seem abstract and even esoteric.

Science presents the kind of challenge that attracts to it young men and women who tend to have a rather high degree of a certain kind of intelligence. But scientists are not special creatures: they are people. The great majority of scientists have the same distribution of moral and intellectual characteristics as other educated people.

If scientists are human, so also is science itself. For example, science does not deserve the reputation it has so widely gained of being based on absolute fact, of being wholly objective, of being infinitely precise, of being unchangeably permanent, of being philosophically inescapable and unchallengeable. There seem still to be persons who think that science deals with certainty; it deals with probabilities.

The ablest scientists themselves realize the postulational and provisional character of science. Perhaps not so widely recognized or accepted is the extent to which the development of Western science has been influenced by the general nature of Græco-Judaic culture, including especially the standards, arising within that tradition, of what is interesting and important.

The previous comments concerning general characteristics of science suggest that science is a very human enterprise, coloured by general ideas, changeable as any human activity must be, various in its possible forms, and a common part of the lives of all men.

Even the impressive methods that science has developed involve only improvement of procedures of observation and analysis that the human race has always used.

These comments do not support the concept of science as some sort of super creed. This point of view does not justify the notion that science is so special as to be unique, as well as so curious as to be incomprehensible. This does not depict scientists as strange creatures who are in one sense so objective, judicial and precise as to be incredible, and in another sense so apart from life as to be selfish and sinister. This does not set up quantitative analytical Western science as the only valid way in which man may approach and interpret experience.

These descriptive comments picture science as the servant of man, not his master; and as a friendly companion of art and of moral philosophy.

The lack of general comprehension of science is dangerous both to science and to the public, these being interlocked aspects of the common danger that scientists will not be given the freedom, the understanding and the support that are necessary for vigorous and imaginative development.

TECHNICAL INFORMATION SERVICES IN EUROPE

UNDER the title "Technical Information Services in Europe", the European Productivity Agency of the Organization for European Economic Co-operation has published a report on the second meeting of technical information officers, held in Frankfurt-am-Main during May 2–6 last (from the Organization, 2 Rue André Pascal, Paris, 16e). The conference, which included delegates from twelve different countries, was intended to give participants an insight into the functioning of the technical information services which are an integral part of the German Productivity Centre at the Rationalisierungskuratorium der Deutschen Wirkschaft in Frankfurt, and the first section of the report outlines the services, activities and relations of this body. It is a private organization which has as its aim the rationalization of the entire German economy and increased productivity, and in this task representatives of science and engineering, of industry, and of trade, commerce and crafts, of trade unions and of government agencies are co-operating with it. It is organized both on a regional and on a subject basis and has a priority programme covering those fields where it is believed that an actual increase in productivity can be achieved. In referring to information services, Dr. Magnus, of the board of directors of the Rationalisierungskuratorium, emphasized the importance of bringing the inquirer to formulate his question correctly. Besides describing the activities of the information service, which up to April 1955 had answered more than ten thousand questions, this section of the report gives a brief account of information and documentation in Germany, including the work of the German Society for Documentation, the Association of German Engineers, and the Association of German Mechanical Engineering Firms and the Prior Art Information Service, Treuhandstelle Reichspatentamp, Berlin, and also of the operation in Germany of the Documents Exchange Scheme of the Organization for European Economic Co-operation.

The second section of the report deals with the activities and projects of the European Productivity Agency in the field of technical information, including Dr. A. King's address on the general policy of the Agency, which emphasizes that, to be efficient, the Agency must concentrate on work that is better done on an international basis than nationally. Much of the Agency's work next year will be devoted to encouraging relations between the various national productivity centres and to services which may be of use to them all. Dr. King also emphasized the importance of forward thinking on productivity matters and of providing a forum for the discussion of particular topics which may be only germinating in the minds of men in individual countries, so that understanding can be reached which will lead to international attack on a problem and accelerated action. In this connexion he said that the Agency had appointed a working party to consider automation and particularly its human relations and economic problems and the relation of the whole subject to the future industrial pattern of European countries. The Agency has also been considering the economic switch-over which the introduction of automation will entail. Dr. King thought that in the past technical information work was too narrowly conceived and that its main task is to serve industry with the object of increasing productivity levels. He urged a closer relation between management and human relations and labour, on one hand, and the technological and technical information activities, on the other, and that at present not enough technical information of the less technological type is disseminated. Much new work is required of a research, survey and experimental nature in connexion with the social problems of technical innovation.

Suggestions made at the conference for future activities included the recommendation that the work of national technical information centres be undertaken for the general needs and within the scope of the overall productivity programme of the countries and productivity groups, and that the European Productivity Agency should intensify its relations with international vertical organizations and other international organizations in the field of technical information. The Agency was also asked to consider extending its system, in co-operation with the national technical information services, to include problems on management, human relations and similar topics. It was agreed that national technical information services should be encouraged to adopt the field officer method of providing technical information and that, while the Documents Exchange Scheme should not be regarded as a substitute for personal, organizational or multilateral contacts, which the national centres should encourage, it should include as much unpublished material as possible; in general, such centres should help each other with material which it is difficult to obtain. The conference suggested that those countries in which 'technical information days' have not yet been organized should make use of this idea, and that the European Productivity Agency and national centres should use every kind of publicity and publication to spread knowledge about technical information services.

COMMONWEALTH FUND, NEW YORK

ANNUAL REPORT FOR 1954–55

THE thirty-seventh annual report of the Commonwealth Fund, New York, covering the year ended June 30, 1955*, records that forty-one Fellows were appointed to hold fellowships in the United States during 1955–56, and another sixteen will be in residence on second-year extensions, bringing the total of Fellows elected since 1925 to 729. This figure includes 550 scholars appointed on applications through universities in Great Britain, and 139 Civil servants, of whom forty-two were from the Home Civil Service and ninety-seven from the Dominion and Colonial Services. It also includes thirty-three scholars from Western Europe in a programme of Continental fellowships which was started in 1952. Of the total appropriation of 3,469,972 dollars during the year, 1,954,071 dollars was in the field of medical education, including research in educational environment and procedures and the evaluation of educational experiments, while a further 210,000 dollars was appropriated for advanced medical fellowships, and 206,650 dollars for advanced nursing education, including twenty-one new and five extended awards as well as block grants to five institutions. Appropriations of 887,926 dollars for medical research were voted for nine projects, four of which were for studies of organism-environment interaction, two for studies of integrative processes within the organism and three for studies in basic biology. Ten other projects have continued to receive support from appropriations voted in previous years. Grants for experimental health services totalled 137,750 dollars, including a renewed grant of 118,250 dollars to the Hunterdon Medical Centre, New Jersey, to underwrite, for the next three years, two-thirds of the cost of the Centre's community mental-health programme and 19,500 dollars to the Tennessee Medical Foundation for operating costs during the next two months. The Fund's publication programme continues to provide, in conjunction with the Harvard University Press, for the publication of manuscripts and books emanating from projects supported by the Fund in the field of health.

The appropriations for medical education went to twenty-seven institutions, six appropriations being grants for new projects and ten being extensions of assistance to old ones, while fifteen institutions received assistance from previous appropriations. Four of the new projects reflect the increased collaboration between medicine and social science. A three-year grant to Yale University was for an experimental graduate training programme in the social aspects of medicine, in which the experience with health and medicine will come in the last two years of a four-year period of graduate study. At the University of North Carolina a two-year grant will permit further joint research between the Division of Health Affairs and the Institute for Research in Social Science. A two-year grant to the Bureau of Applied Social Research of Columbia University and the University of Pennsylvania School of Medicine is to extend to the study of the influence of environmental factors upon the educational process which occur in the last four years of medical studies. The University of Kansas received a two-year grant for the Department of Psychology to pursue an investigation of the doctor–patient relation in a rural community, and a two-year grant to the University of Florida is to assist in making the Health Centre, which includes the Medical School, an ntegral part of the University.

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* Commonwealth Fund Thirty-seventh Annual Report for the Year ending June 30, 1955. Pp. vii+46. (New York: Commonwealth Fund, 1955.)

A grant to the Western Reserve University, Cleveland, was to complete the revision of the entire curriculum of the four years of the medical school, and a separate grant was made for the continuing evaluation of the students' progress. Terminal grants were made to the University of Colorado School of Medicine for the support of the General Medical Clinic at Denver General Hospital and for research in education and the cure of patients. An appropriation was made to McGill University for a two-year survey of the medical curriculum, and a new programme of instruction at the Department of Pediatrics, Harvard University, will emphasize growth from the pre-natal period to physical maturation, preventive aspects of pediatrics, and service and teaching, which include the home and community environment and effective patient–doctor relation.

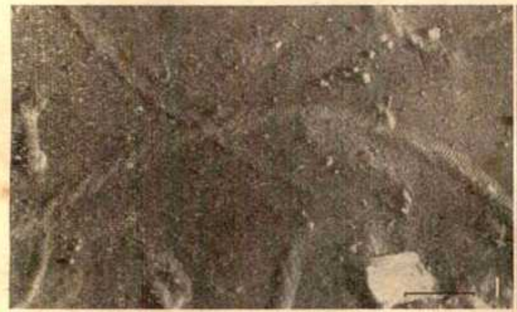
HELICAL NATURE OF THE COLLAGEN FIBRIL

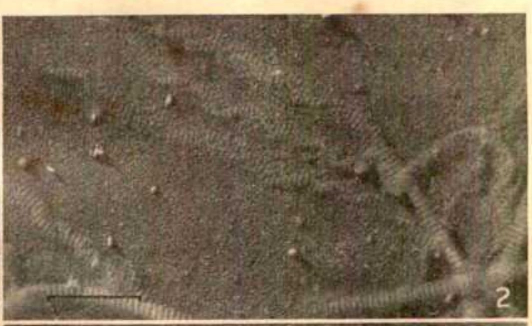
By Dr. R. REED, Miss M. J. WOOD and Dr. M. K. KEECH
Department of Leather Industries, Department of Medicine,
University of Leeds

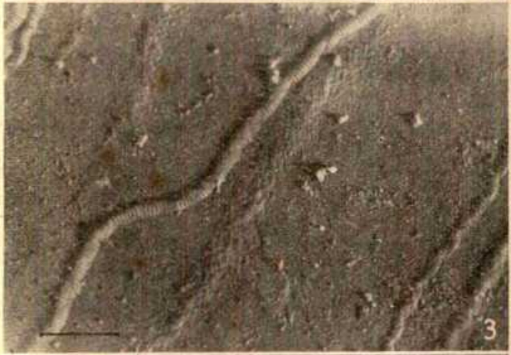
THE electron microscope has provided much information regarding the structure of the collagen fibril. In the main, however, it has proved difficult to correlate such information with that obtained from other fields of investigation. X-ray diffraction studies have indicated that the polypeptide chains in collagen are likely to have a helical configuration, and recent work[1] has been concerned with deciding which particular form of helix best fits the diffraction data. We wish to report certain electron microscope findings which indicate a helical arrangement of filaments, that is, *bundles* of polypeptide chains, within the collagen fibril.

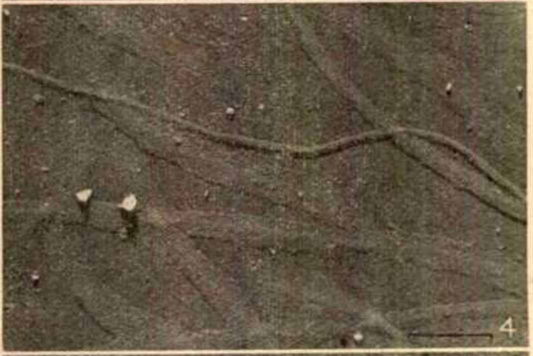
During a study of the effect of various reagents on collagen fibrils over the pH range 1–12·5 and at temperatures between 25° and 37° C., we have observed that the fibrils often assume a helical form (Figs. 1–8). This helical form usually occurs in the early stages of reaction; with longer reaction times this may disappear and more deep-seated changes may set in, characteristic of the reagent used. The fibril, in assuming the helical form, is transformed into a series of structures with tapering ends, to which we give the name 'helical tactoids'. These vary in length from 6000 to 12,000 A. and are 1000–2000 A. in width (Figs. 1, 2, 5, 8 and 10). They tend to become shorter as the pH value increases, and their angle of inclination to the fibril axis varies with the degree of swelling. The helix determined by these tactoids has no preferred direction, for both left-hand and right-hand forms are observed; Fig. 1 shows that both forms may occur at different regions in a single fibril. Subdivision of the helical tactoids into thinner structures may occur, especially under highly acid conditions, and this process does not radically affect the characteristic cross-striations, which lie at right-angles to the fibril axis (Figs. 2 and 3). With increasing subdivision of the helical tactoids, the fibril loses cohesion, becomes flattened and ultimately gives rise to a system of crossed filaments (Figs. 3, 6 and 7), in which the outlines of the cross-striations can still be seen. Depending on the conditions, the filaments vary in width over the range 200–500 A. With some reagents at pH 2·0, and which produce rapid swelling and disintegration, the fibrils become ribbon-like, with a raised helical centre portion (Figs. 4 and 6). Helical tactoids have also been observed[2] during the thermal shrinkage of tanned collagen fibrils (Fig. 9).

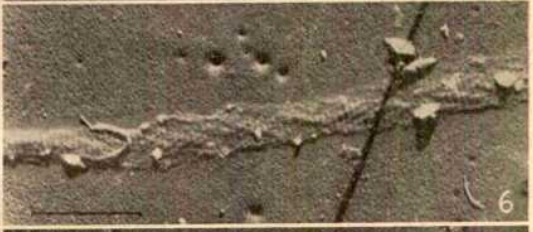
In view of these observations, we propose a fibril architecture based on two regular helical systems of filaments. These helices, determined by the filaments, are equivalent in every respect, except that one is right-hand in direction, the other left-hand. Such cross-helical systems are often observed in the electron microscope (Figs. 3, 6 and 7) and are also suggested by the presence of both helix directions within the same fibril. To account for the helical tactoids, we propose that certain filaments in the cross-helical array are more sensitive to heating and chemical reagents than are the other filaments. In other words, we suggest that helical tactoids indicate a cross-helical array of filaments, but which are not all of the same chemical composition. At the level of organization of the polypeptide chains, coiled-coil configurations based on a unit of three polypeptide chains have recently been proposed[1] by workers in the field of X-ray diffraction. As Cowan, McGavin and North[1] have pointed out, however, if one accepts such a three-chain unit, the chemical data lead directly to the concept of mixed-chain types. For one of the three chains in the unit to contain the sequence —pro—hypro—gly— to any large extent (as indicated by sequence studies[3]), from the number of residues available it must also contain the bulk of the prolyl and hydroxyprolyl residues. Thus these workers imply that the collagen fibril is built from a unit of three polypeptide chains, one of which is different in chemical composition from the other two. While agreeing that mixed polypeptide chains are likely to exist within the collagen fibril, we do not think that such a unit would account for the electron microscope observations. Indeed, we consider that the fibril architecture is better accounted for in terms of 'filaments' of differing chemical composition. Thus we suggest that various types of filaments are present, each based on different chain types, any single filament, however, containing

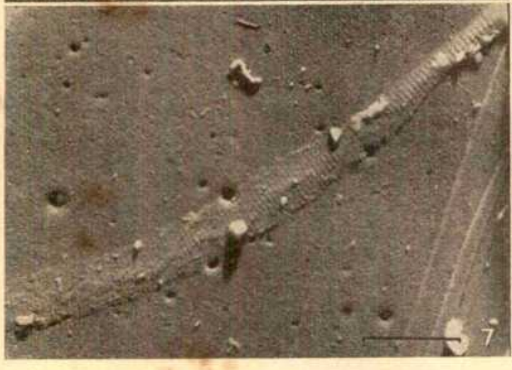












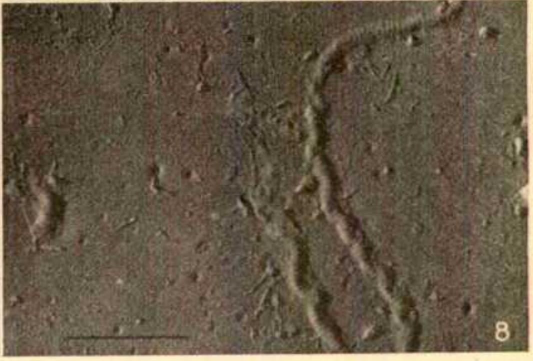


Fig. 1. Human dermal collagen fibrils after 30-min. exposure at 25° C. to an aqueous solution, pH 1·8, containing 1 per cent periodic acid and 1 per cent sodium chloride. Note left and right helices within the same fibril

Fig. 2. Same as Fig. 1, showing subdivision of helical tactoids

Fig. 3. Same as Fig. 1, showing system of crossed filaments in which the cross-striations can still be seen

Fig. 4. Different sample of same substrate used in Figs. 1–3 after 5-min. exposure at 37° C. to a 1 per cent solution of performic acid. Highly swollen, ribbon-like fibrils with raised, helical central portion and reduced band spacing

Fig. 5. Same substrate after 1-hr. exposure at 25° C. to a 10 per cent solution of calcium chloride at pH 7·0

Figs. 6 and 7. Effect of dichloracetic acid on a collagen fibril showing crossed helical system of filaments with persistence of cross-striations

Fig. 8. Same substrate as Figs. 6 and 7 after 18-min. exposure at 37° C. to a carbonate buffer solution, pH 10·4

chains of the same type. Thus, if the chains rich in hydroxyproline were concentrated into one filament, and the series of hydroxyproline-rich filaments were regularly distributed along the fibril, the helical tactoids could arise by such filaments becoming detached from the cross-helical array. This would mean (referring to Fig. 10) filaments rich in hydroxyproline along the lines *A–A*. To account for the observed subdivision of the tactoids, there must also be thinner but similar filaments along the lines *B–B*, for example. The details of the distribution of the filaments within the fibril, however, still need to be worked out. Thus it is not impossible that the fibril consists of two equally large strands, which spiral around each other. In turn, this cross-helical system is spirally covered, either in the left- or right-hand direction, with filaments which contain the bulk of the chains rich in hydroxyproline. By removal of the spiral covering of filaments (rich in hydroxyproline) the fibril would assume a two-strand form, similar to that in Fig. 9.

Such filaments, rich in hydroxyproline, could account for the preferential liberation of hydroxyproline-rich fragments from disks of collagen, when alkaline buffer solutions are forced through them[4]. Further, they might also determine the stability of the fibril by being more sensitive towards heat than the other filaments, as indicated by the work of Gustavson[5], who has shown that the hydroxyproline content of various forms of collagen fibrils is an index to their thermal stability.

Since the cross-striations of the collagen fibril tend to persist in spite of radical subdivision of the helical tactoids (Figs. 2, 3, 6 and 7), the material of which they are built possibly differs in chemical composition from that removed from the fibril when the tactoids are formed. Thus to some extent the tactoids appear to be separate from the cross-striations, as though the latter acted as restraints for the filaments within the fibril and were a means of controlling their lateral cohesion[6].

The proposed model affords a basis for investigating the physical and chemical behaviour of collagen fibrils. Swelling and shrinkage could be interpreted in terms of the cross-helical systems of filaments moving with respect to each other, so that they made a larger angle with the fibril axis (see Fig. 10). This process would lead to a stretching of the characteristic cross-striations and, at the same time, bring them closer together. Such effects have been observed both in native collagen and in tanned collagen fibrils (Figs. 4, 7 and 9). Keech[7] has shown that collagenase breaks down collagen into short lengths with tapering ends (tactoids). The helical model now proposed for the fibril offers a more rational explanation for such tactoids than the flat type illustrated in Fig. 32*c* of her paper.

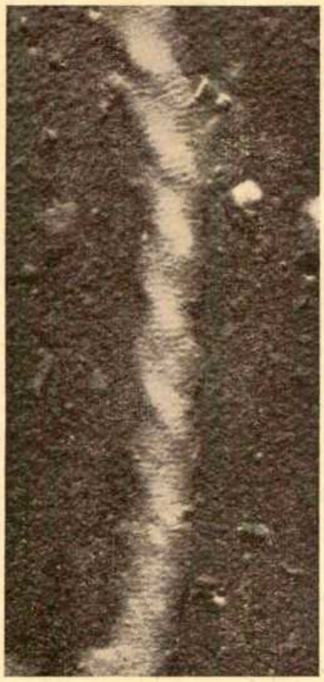


Fig. 9. Oil-tanned collagen fibril from chamois leather after 1-min. heating in water at 70° C., showing helical tactoids and contraction of the band spacing

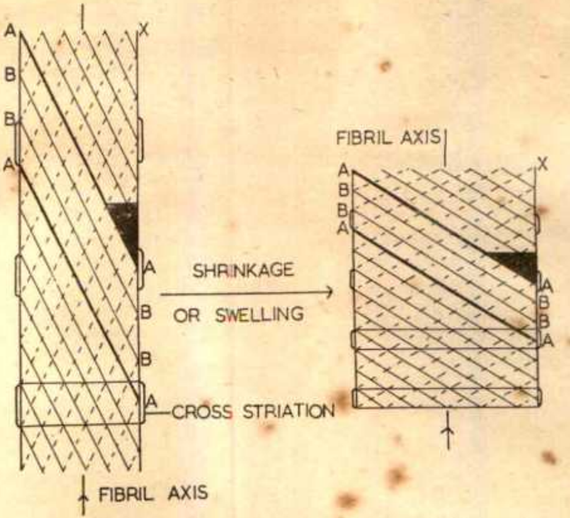


Fig. 10. Diagrammatic representation of the cross-helical system within a collagen fibril, showing helical tactoids *AAAA*. Also change of angle *AAX* and reduction in band-spacing with swelling and shrinkage,

Helical structures in the collagen fibril have been observed previously by electron microscopists. Wyckoff[8] published, but did not comment upon, a cross-helical structure in the fibril following the action of dilute acetic acid. Stromberg and Swerdlow[9] consider that the cross-striations follow a helical course around the fibril. Further, they relate this helical form to an additional one, similar to that described by us. However, as we have pointed out, and indeed, as Fig. 7 in their paper illustrates, the cross-striations appear to be independent of the helical tactoid structures. These workers studied only aqueous suspensions of collagen, whereas our work has included a wide range of reagents acting both on native and on tanned collagen.

To summarize, we feel that an architecture of the collagen fibril based on a system of filaments in a regular cross-helical array best accounts for the helical structures observed in the electron microscope. Moreover, since the polypeptide chains in the fibril probably differ in chemical composition, these filaments, that is, bundles of polypeptide chains, may consist almost entirely of one type of chain, and thus they also may differ in their total chemical composition. We wish to emphasize that the helical structures based on filaments are observed at the electron microscope level of organization, and that it is still possible for the filaments to have an internal coiled-coil structure, as suggested by the X-ray diffraction studies[1]. [Dec. 19

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Oxytocin as Stimulator for the Release of Prolactin from the Anterior Pituitary

AT the present time there is reason for believing that the suckling stimulus influences the mammary gland in two ways. First, there is abundant evidence (see ref. 1 for review) that suckling or other conditioned stimuli can evoke the release, from the neurohypophysis, of oxytocin, which in turn causes contraction of myoepithelial cells associated with the alveoli, resulting in ejection of stored milk from the alveolar tissue (the milk-ejection reflex). Secondly, according to the theory proposed by Selye[2], the suckling stimulus causes release, from the anterior hypophysis, of prolactin which participates in the maintenance of secretion and of the functional integrity of the mammary alveolar tissue. These facts suggested to us that the primary effect of impulses reaching the brain as a result of the application of the suckling stimulus is to activate the neurohypophysis, causing the release of oxytocin, which, by a route that need not be discussed here, reaches the anterior pituitary and stimulates the latter to release prolactin.

In order to test this hypothesis we utilized a phenomenon, first demonstrated by Selye[2], who showed that in the lactating rat the involution of mammæ, the suckling of which was prevented by the surgical removal of the nipples, was markedly retarded, provided suckling of other intact nipples in the same animal was continued. Selye's contention that this was due to the release of prolactin in response to the suckling of the intact nipples was later confirmed by Williams[3], who was able to retard mammary involution in non-suckled lactating mice, by injections of prolactin.

We have therefore studied the effects of injections of oxytocin on the course of mammary involution in lactating rats from which the litters were removed at the fourth day of lactation. Fig. 1 shows a section (*b*) from an abdominal mammary gland of a lactating rat whose litter was removed at the fourth day of lactation and which thereafter received 1·0 international unit of oxytocin intraperitoneally, three times daily, until autopsy at the thirteenth day. Comparison with the section (*a*) taken from a control rat which, instead of oxytocin, received injections of saline, shows that mammary involution was markedly retarded by the oxytocin treatment. These results are typical of most animals of the three short series (see Table 1) receiving oxytocin which we have so far studied.

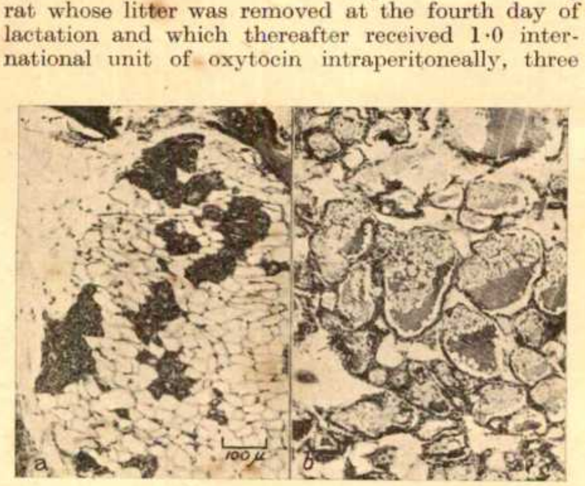

Fig. 1. Abdominal mammary glands of lactating rats from which the pups were removed at the fourth day, the mother thereafter receiving intraperitoneal injections of (*b*) 1·0 I.U. oxytocin three times daily for nine days, and (*a*) 1·0 ml. saline three times daily for nine days. Sections were cut at 7 μ, stained with hæmatoxylin-eosin and photographed at the same magnification

Table 1

Group	Dose of oxytocin	Number of animals	Mean alveolar diameter with stand. error (μ)
A	controls	5	15·5 ± 1·8
B	0·25 I.U. three times daily	4	24·6 ± 7·5
C	1·0 I.U. three times daily	4	65·7 ± 10·6
D	1·5 I.U. three times daily	4	57·9 ± 15·6*
B + C + D		12	49·4 ± 8·1

* This high standard error is due to the fact that one rat completely failed to respond.

Estimations of the mean alveolar diameter have been made measuring a hundred alveoli selected at random from each rat. The figures so obtained are summarized in Table 1. It is clear that in accord with the sections illustrated in Fig. 1, the alveoli of the treated rats were significantly larger than those of the untreated controls, particularly in the groups receiving the highest two dose-levels. This difference may be ascribed to the continuing secretion in the glands of the treated animals in contrast to the absence of secretion and subsequent general involution in the mammæ of the untreated animals. The results of these preliminary experiments indicate that the release of prolactin (and perhaps other anterior-pituitary hormones concerned in lactation) can be stimulated by treatment with oxytocin.

That neurohypophysial hormones may be concerned in the control of adenohypophysial secretion has been suggested previously by a number of workers (see Scharrer and Scharrer[4] for review; also Martini and Morpurgo[5], and Shibusawa *et al.*[6]) but principally with relation to the secretion of adrenocorticotrophic hormone.

Even if our results are fully confirmed in further experiments which are now under way, they cannot in themselves be taken as proof that the release of prolactin is evoked by oxytocin under conditions of normal suckling, but they are nevertheless consistent with this view. We consider it unlikely that the results are due to a direct effect of oxytocin on the mammary gland, because Bradley[7] in this laboratory has recently found that prolactin, alone of a number of anterior and posterior-pituitary principles tried, including oxytocin, had a localized lactogenic effect when injected intraductally into the mammæ of suitably prepared rabbits.

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Absorption of Vitamin B_{12} from the Rat Intestine

MANY animal tissues contain specific protein-like substances that combine with vitamin B_{12}. The availability of the vitamin in this bound form when given by mouth to animals depends on the origin of the binding material. Homologous bound forms are fully available, whereas a similar preparation from a different species may not be[1].

To study the importance of 'binding' in the absorption of vitamin B_{12}, it was necessary to use animals deprived of that portion of their gut where binding substances are located. The following technique was devised to allow the retention of a small amount of labelled vitamin B_{12} in a section of the small intestine for some hours without its being influenced by secretions from the stomach or duodenum. Stock-colony rats weighing approximately 200 gm. were starved overnight. The abdomen was opened under ether anæsthesia to expose the small intestine. A ligature was made near the ileo-cæcal junction and the intestine was cut above it. A similar ligature was placed near the lower end of the duodenum and the intestine cut just below this point. The cut portion of intestine was washed through with 100 ml. warm saline to remove any binding materials remaining in it and the lower end was tied off. ½ ml. saline, containing the dose of labelled vitamin B_{12} with or without binding material, was introduced from a syringe fitted with a blunted needle into the upper end of the cut intestine, which was tied off as the needle was withdrawn. The gut was replaced and the incision closed.

The whole operation was performed as rapidly as possible with the minimum of handling in order to prevent damage to the absorbing surfaces and to retain as nearly as possible a normal blood supply to the cut segment. The rats were kept without food in a glass metabolism cage for 20 hr., and urine and fæces were collected on filter paper. At the end of this period, the rats were anæsthetized and about 5 ml. of blood withdrawn from the heart. The tied-off portion of intestine was carefully removed and dissolved by heating with 25 ml. of 4 N sodium hydroxide. The liver was treated similarly, and the remaining carcass and the filter paper containing urine and fæces were separately ashed. The ash was prepared for measurement of radioactivity by dissolving in the minimum volume of concentrated hydrochloric acid. All samples were counted in a liquid counter (20th Century Electronics type $M6$). Since this type of counter responds to traces of radioactivity present in animal tissues, corresponding organs from untreated rats were submitted to the same procedure and the counts subtracted from those of the experimental rats for calculation of the amount of vitamin B_{12} absorbed. Except for the carcass, these counts were not significantly above background. Typical figures for the radioactivity of the carcasses, after subtracting the background count (19 counts/min.) were: untreated rat, 16 counts/min.; rat given free labelled vitamin B_{12}, 54 counts/min.

Each rat received 60 mμgm. vitamin B_{12} labelled with cobalt-57 (2·5 mc./mgm.), either alone or with the precise amount of the test preparations required to combine with this quantity of the vitamin. The substances given with the vitamin were a saline extract of rat stomach, a crude intrinsic-factor preparation from pig pyloric mucosa ('Bendogen', G.E.A., Copenhagen) and a preparation of the binding protein isolated from 'Bendogen' by continuous electrophoresis[2]. The radioactivity found in the tissues of each rat, calculated as vitamin B_{12}, is shown in Table 1.

Table 1. ABSORPTION FROM THE RAT INTESTINE OF 60 mμgm. VITAMIN B_{12} GIVEN ALONE AND WITH PREPARATIONS OF BINDING PROTEINS. Values given in mμgm. vitamin B_{12}

Binding preparation given with the vitamin B_{12}	Exp. No.	Tissues examined				Total amount of vitamin B_{12} absorbed
		Liver	Carcass	Urine and fæces	Gut and contents	
None	1	1·4	4·6	0·4	45·1	6·4
	2	1·6	7·7	2·4	44·4	11·7
	3	0·9	4·5	0·2	47·2	5·6
	4	1·2	3·8	0·2	42·1	5·2
	Mean	1·3	5·2	0·8	44·7	7·3
Saline extract of rat stomach	1	1·1	14·3	0·2	34·0	15·6
	2	—	—	—	—	—
	3	1·2	12·1	0·3	38·0	13·6
	4	1·6	11·0	0	35·4	12·6
	Mean	1·3	12·5	0·2	35·8	14·0
Crude intrinsic factor ('Bendogen')	1	—	—	—	—	—
	2	0·2	3·4	0·5	45·0	4·1
	3	—	—	—	—	—
	4	0·4	2·0	0·1	39·8*	2·5
	Mean	0·3	2·7	0·3	42·0	3·3
Binding protein from 'Bendogen'	1	—	—	—	—	—
	2	0·2	1·4	1·5	44·4	3·1
	3	—	—	—	—	—
	4	0	1·4	0·3	44·5	1·7
	Mean	0·1	1·4	0·9	44·5	2·4

* This figure is unaccountably low.

The content of labelled vitamin in the blood was too low to be detected by our equipment. Only small amounts reached the liver or were excreted, and the greatest proportion of the absorbed vitamin was found in the carcass. An appreciable proportion of the free vitamin was absorbed in 20 hr., but this is not surprising in view of the large dose, 0·06 μgm., that had to be used to obtain significant counts. However, addition of the saline extract of rat stomach doubled the amount of vitamin absorbed. This effect was not observed with 'Bendogen', which is known to facilitate the uptake of vitamin B_{12} in human pernicious anæmia. In fact, 'Bendogen' decreased absorption, and the binding protein prepared from it behaved similarly. Our direct demonstration of the effect of binding substances on the uptake of vitamin B_{12} is in agreement with indirect findings of other authors. Chow *et al.*[3] measured in gastrectomized rats the fæcal excretion of orally administered labelled vitamin B_{12}, and showed that intrinsic factor preparations from the pig hindered the absorption of vitamin B_{12}. Similarly, Latner[4] cites unpublished observations by Clayson, Latner and Schofield showing that human gastric juice and pig intrinsic factor inhibited absorption of vitamin B_{12} in the normal rat. Watson and Florey[5] found that rat stomach extract decreased the fæcal excretion, that is, increased the absorption of vitamin B_{12} in gastrectomized rats. Although in our own experiments vitamin B_{12} was given at more than the physiological level, the results are in agreement with those quoted above, in that rat stomach extract helped the absorption of the vitamin, whereas its absorption was hindered by a foreign binding protein.

Whatever the mechanism by which the rat stomach extract facilitated absorption of vitamin B_{12}, we showed by ultrafiltration[6] that the vitamin had entered into combination with protein. It was similarly bound to the crude and purified pig pyloric preparations, but these hindered absorption. From these experiments it is not clear whether or not combination with a binding protein is the essential part of the mechanism of absorption of vitamin B_{12}. If it is, clearly the protein concerned is not the same for all animals. If the binding process is not essential, then some other factor necessary for absorption must also differ from one type of animal to another. Finally, it may well be that several factors, including perhaps the binding protein, are involved, and that any or all of these may be peculiar to a given species or group of animals.

These experiments were made possible by a generous gift of radioactive vitamin B_{12} from Dr. D. L. Mollin, of the Postgraduate Medical School of London.

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Infectivity of Ribonucleic Acid from Tobacco Mosaic Virus

In their experiments with bacteriophages, Hershey and Chase[1] have shown that only the nucleic acid component plays a part in the intracellular multiplication. There are also indications that in simple viruses containing ribonucleic acid the nucleic acid plays a dominant part in the infection. Thus, experiments with tobacco mosaic virus have shown that the protein can be changed chemically without affecting the activity and the genetic properties[2]; recently, it was even found[3] that part of the protein can be removed from tobacco mosaic virus without destroying the activity.

We have now obtained evidence that after complete removal of the protein, the ribonucleic acid itself is still infectious.

The protein was extracted from tobacco mosaic virus with phenol by a procedure elaborated by Schuster, Schramm and Zillig (to be published). After a short treatment at low temperatures, a preparation of ribonucleic acid is obtained which has a high molecular weight during the first few hours but depolymerizes in the course of time. Its physical properties will be described elsewhere.

A solution of 10 per cent tobacco mosaic virus in 0·02 *M* phosphate buffer of *p*H 7·3 is shaken for 8 min. at 5° C. with an equal amount of water-saturated phenol. The aqueous phase which contains the ribonucleic acid is separated by centrifugation, and the process of extraction with phenol is repeated at least twice for 2 min. The phenol is then extracted by ether from the aqueous phase. The whole procedure is carried out at 5° C. and takes about 50 min.; it is followed immediately by testing the infectivity.

For that purpose, five to ten plants of *Nicotiana glutinosa* with five leaves each were inoculated with a diluted solution of the ribonucleic acid, and an equal number of plants with a standard solution of tobacco mosaic virus. The number of local lesions produced by ribonucleic acid and tobacco mosaic virus are compared in Table 1. It is found that 10 μgm. of ribonucleic acid produces about the same number of lesions as does 0·2 μgm. tobacco mosaic virus. The infectivity of the ribonucleic acid preparation is thus about 2 per cent of that of the native virus.

Table 1. Comparison of the Infectivity of Ribonucleic Acid and Tobacco Mosaic Virus in 0·1 *M* Phosphate Buffer

	Ribonucleic acid		Tobacco mosaic virus	
*p*H	μgm./ml.	lesions	μgm./ml.	lesions
6·1	10	153	0·09 0·8	95 445
7·3	10	815	0·27	1,048
7·3	1	524	0·05	795
7·5	10	998	0·27	685

The following experiments, the results of which are collected in Table 2, have been carried out to show that the infection is due to the nucleic acid rather than to contamination of the ribonucleic acid with native virus.

(*a*) In the ribonucleic acid solution protein was not detectable by chemical methods (Schuster, Schramm and Zillig, unpublished work); thus the amount must be less than 0·4 per cent of the ribonucleic acid content. By serological methods (complement fixation) it was shown that the ribonucleic acid contains less than 0·02 per cent of native tobacco mosaic virus protein.

(*b*) Treatment of both the ribonucleic acid and tobacco mosaic virus with normal rabbit serum (concentration 3×10^{-3}, applied for 10 min. at 4° C.) somewhat reduces the infectivity. There is no significant further reduction if the ribonucleic acid is treated with the same amount of tobacco mosaic virus antiserum, whereas with antiserum the infectivity of the virus itself is almost completely destroyed.

(*c*) Incubation of the stock solutions of ribonucleic acid (0·3 per cent) and tobacco mosaic virus (0·06 per cent) with 2 μgm. per ml. of ribonuclease at 4° C. for 10 min. reduces the activity of the ribonucleic acid to 0, whereas that of the virus remains almost unaffected.

(*d*) The sedimentation constant of the ribonucleic acid is 12–18 *S*, compared with 180 *S* for tobacco mosaic virus. We have centrifuged the stock solution of ribonucleic acid for 30 min. at 50,000 rev. per min. and found the supernatant liquid to be only a little less active than the original solution. If the solution of the virus is treated in the same manner, the activity of the supernatant liquid is very low.

(*e*) The ribonucleic acid is known to be unstable; and, as would be expected, its infectivity is much reduced after 48 hr. at 20° C., whereas that of the virus is much less affected.

These experiments show that protein, if present at all, is only there in very small amounts and does not resemble closely the native protein of tobacco mosaic virus. We are thus led to conclude that the infectivity is due to the nucleic acid itself.

Table 2. Comparison of Ribonucleic Acid (10 μgm./ml.) and Tobacco Mosaic Virus (0·27 μgm./ml.) in 0·1 *M* Phosphate Buffer of *p*H 7·3
(Infectivity expressed as lesions per 30 leaves)

	Ribonucleic acid	Tobacco mosaic virus
Normal	488	629
With normal serum	180	117
With antiserum	145	0
With ribonuclease	0	473
After ultracentrifugation	367	31
After 48 hr. at 20° C.	2	130

The infectivity of the ribonucleic acid preparation is about 0·1 per cent of that of the same amount of ribonucleic acid contained in native tobacco mosaic virus. Whether this relatively low value is due to a large inactive fraction of the ribonucleic acid preparation, or to low efficiency of the mechanism of infection, has still to be determined.

Studies on the combination of the ribonucleic acid with proteins are being carried out and may elucidate the connexion between our findings and the reactivation experiments of Fraenkel-Conrat and Williams[4], of Lippincott and Commoner[5], and of Hart[6].

We are much indebted to Prof. H. Friedrich-Freksa for helpful discussions, to Mr. R. Engler and Dr. H. Schuster for their co-operation, and to Miss A. Kleih for assistance.

A detailed account of this work will be published in the *Zeitschrift für Naturforschung*.

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A Possible Mode of Action of 2 : 4-Diamino-5-phenyl-thiazole Hydrochloride (Daptazole or Amiphenazole)

SOME pharmacological properties and clinical uses of 2 : 4-diamino-5-phenyl-thiazole hydrochloride (daptazole or amiphenazole) have been previously considered elsewhere[1]. It often appears to exert a mild respiratory stimulant effect in both unnarcotized and narcotized patients and animals. It has been used clinically as a buffer to depressed respiration in such conditions as pneumonia, asphyxia neonatorum and in the relief of respiratory depression following anæsthesia. It has further been employed in the treatment of barbiturate intoxication (usually in combination with ββ-methyl ethyl glutarimide (*NP*13, megimide or bemegride)) and opiate overdosage, and has been administered in combination with large doses of morphine in the relief of severe and prolonged pain. When used in this latter manner, it has appeared to minimize the onset of tolerance or addiction to morphine. It is effective both orally and parenterally, and has a high therapeutic index (greater than 10). Therapeutic doses (5–50 mgm.) are almost completely devoid of side effects, and large doses (more than 200 mgm.) have been safely tolerated by unnarcotized volunteers. In small doses (20–40 mgm.) it often appears to improve the mental outlook of depressed patients.

The fact that daptazole has such widespread activity and that such large doses have been safely tolerated has suggested that this substance may fit into some fundamental physiological process.

As the structures of daptazole and the thiazole moiety of thiamine (4-methyl-5-hydroxy-ethyl-thiazole) show some similarity and, further, as thiamine appears to be the only substance occurring naturally in the body which contains the thiazole nucleus, experiments were performed in which rats (40–50 gm.) on a thiamine-free diet were given daily intraperitoneal injections of daptazole and the pyrimidine moiety of thiamine (2-methyl-4-amino-5-brom-methyl-pyrimidine dihydrobromide) to see if the combination of these two drugs would produce a substance capable of entering into thiamine metabolism[2].

Table 1

All rats on a thiamine-free diet. 10 animals in each group

Group	Drugs administered (mgm./kgm. intraperitoneally)			Period of adaptation (days)	Onset of thiamine-deficiency symptoms	Reversal by vitamin B_1
	Daptazole	Pyr. B_1*	Frequency			
Control	—	—	—	—	2–3 weeks	+
1	10	2·5	three times daily	7–10	None for 9 weeks	−
2	50	12·5	daily	—	10 days to 2 weeks	+
3	50	—	daily	—	4–5 weeks	+
4	—	12·5	daily	—	3–4 weeks	+

* Pyr. B_1 = 2-methyl-4-amino-5-brom-methyl-pyrimidine dihydrobromide.

Preliminary results (Table 1) indicate that rats, maintained on low doses of these drugs (10 mgm./kgm. daptazole hydrochloride; 2·5 mgm./kgm. 2-methyl-4-amino-5-brom-methyl-pyrimidine dihydrobromide given intraperitoneally three times daily), after a period of adaptation (seven to ten days), showed no signs or symptoms of thiamine avitaminosis nine weeks after the commencement of the treatment, whereas their controls were clearly deficient in thiamine in three weeks and had all died in five weeks.

The results also indicate that the symptoms of thiamine deficiency developed in rats maintained on a thiamine-free diet could be reversed by similar administration of these doses of daptazole and the pyrimidine moiety of thiamine. However, the daily administration of larger doses of daptazole (50 mgm./kgm.) and the pyrimidine moiety of thiamine (12·5 mgm./kgm.) to such rats appeared to bring about a more rapid induction of thiamine avitaminosis which could be reversed by the administration of thiamine. This more rapid onset of thiamine avitaminosis was not produced when either drug was given alone in these larger doses, and indeed the condition of these animals seemed better than that of their control groups. These observations suggest that daptazole may enter into the pathway of processes involving thiamine. This may be one of its modes of action, and could serve to afford some rationale for its wide sphere of clinical and pharmacological actions in apparently unrelated and diverse processes which may be dependent on thiamine.

This hypothesis is now being investigated and a full account will be published elsewhere.

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The Leydig-cell Homologue in Certain Teleost Fishes

THE male sex gland of the Craniata is, like other endocrine organs, extremely ancient in origin. It occurs in the Agnatha (for example, *Petromyzon*) and throughout the gnathostome series with relatively little recorded variation except in the Urodela. With the above exception, and another about to be described, the interstitial gland is characteristically composed of aggregations of modified connective tissue cells which occupy interstices between the seminiferous tubules of the testis. These secretory Leydig cells have a generally similar appearance, and exhibit certain common histochemical properties, in both jawless fishes and, for example, man. The interstitial aggregation of Leydig cells may constitute either a permanent secretory unit (as in most mammals) or may be renewed at the end of each breeding rhythm as in seasonal birds[1].

In the latter case, there is an annual development of large lipoidal cholesterol-positive Leydig cells from minute interstitial connective tissue cells. Unless appropriate histological methods are employed, it is impossible to distinguish connective tissue cells from immature Leydig cells. This is generally responsible for the not-infrequent claim in the literature of breeding seasons that interstitial cells were absent at a stated period of the sexual cycle of some particular bird.

In studies of fishes also, Leydig cells have often been said to be absent, or, on the other hand, have not been mentioned at all. The reason for this may sometimes lie in the fact that two strikingly distinct endocrine arrangements occur in the testes of fishes. The first (Fig. 1) is the typical vertebrate interstitial gland (Leydig cell) pattern and is found in common teleosts such as the three-spined stickleback (*Gasterosteus aculeatus*)[2], *Tilapia* spp., and the sprat (*Clupea sprattus*). This arrangement occurs also in the choanate *Latimeria* and in the widely unrelated selachians *Scyliorhinus* and *Chimaera* (unpublished work). The second (Fig. 2) and less-obvious type, arising not in the interstices but in the lobule walls, we now show to occur in the pike (*Esox lucius*), char (*Salvelinus willughbii*), and *Labeo* (sp. ?). Judged by published illustrations[3], it probably occurs in the salmon (*Salmo salar*) as well.

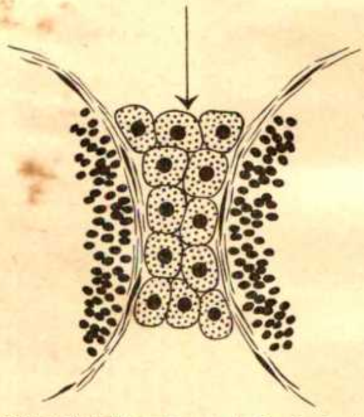

Fig. 1. Typical vertebrate arrangement of endocrine interstitial Leydig cells

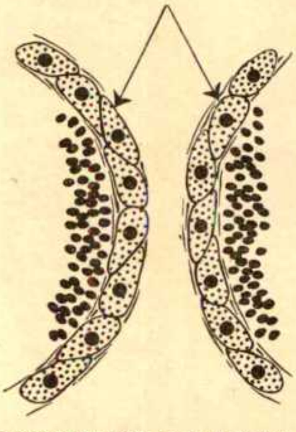

Fig. 2. The Leydig cell homologue in the lobule walls of certain teleost fishes

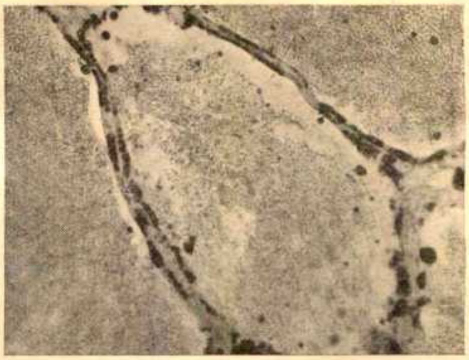

Fig. 3. Lobule boundary cells in the pike (*Esox lucius*) in March. (Formal–calcium fixation, sudan-black colouring at 10μ. × 300)

As is well known, the lobule or crypt wall in the teleost testis is, like the walls of seminiferous tubules in tetrapods, composed essentially of fibroblasts. In both pike and char these, in the absence of a secretory interstitium, become seasonally modified into lipoidal, cholesterol-positive gland-cells similar to the interstitial cells of tetrapods. We provisionally name these 'lobule boundary-cells' (Fig. 2).

The annual boundary-cell cycle is essentially similar to that of the interstitial cycle in seasonal birds. After spermatozoa are shed, the lobule contents metamorphose and the resultant sudanophil material becomes cholesterol-positive. The spent lobules are now bounded by unmodified fibroblasts. These grow, and become lipoidal and cholesterol-positive at about the same time that the sudanophil material within the lobules disappears. It is almost certain that the lobule boundary-cells have the same endocrine function as interstitial Leydig cells. They finally expend their cholesterol at the pre-spawning period in April, after which the cycle begins anew. Most histological techniques permit the loss of vital cytoplasmic lipids from boundary-cells and render them difficult to distinguish from ordinary fibroblasts; but the use of sudan dyes demonstrates their presence with unmistakable clarity (Fig. 3).

However distinct at first sight, the two types of endocrine cells are morphogenetically very similar. In most vertebrates, gonadotrophic influences operate on intertubular connective tissue and produce sexual function. In the few exceptional fishes mentioned above, the influences are on peri-lobular connective tissue, apparently with a similar result. In addition to the typical vertebrate interstitial Leydig cells in the anuran *Rana temporaria*, and in the reptile *Vipera berus*, a few tubule-wall fibroblasts may be modified in much the same way as occurs in pike and char.

In some fishes, however, the phenomenon is constant. The only interlobular elements seen by us have been blood-vessels, lymph spaces and their contents, and during the first few weeks after spawning, what appear to be primary germ cells.

It will be interesting to discover whether the distribution of interstitial Leydig cells on one hand, and the boundary-cells on the other, falls into line with current teleost taxonomy. Both char (family Salmonidae), which has lobule boundary-cells, and the sprat (family Clupeidae), which has Leydig cells, belong to the same order (Isospondyli) as at present constituted.

A more extensive account of the sexual cycle of the pike and further information on the distribution of lobule boundary-cells will appear elsewhere. We are grateful to Prof. H. Brattstrom (Bergen), Messrs. R. S. A. Beauchamp and Humphry Greenwood (Uganda), Prof. J. Millot (Madagascar), and particularly to Mr. G. J. Thompson (Windermere) for helping us to obtain study material.

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Proposed Terminology for Wool Follicles in Sheep

The terminology proposed by Wildman and Carter[1] for hair follicle types in Mammalia has been widely used in studies on sheep, although it is in some respects unsuitable for certain other species[2,3]. However, recent workers[4-6] on the histology of sheep skin have independently extended this terminology, but not always consistently, so that confusion has arisen. To overcome this a unified system of terms and symbols for wool follicles in sheep is here proposed. Based on that of Wildman and Carter, with the major division into primary and secondary follicle types, it provides for a recent contribution to the study of the development of the wool follicle, namely, the distinction between original secondary follicles which arise directly from the epidermis, and derived secondary follicles which arise from them by branching[7,8].

The terms and symbols used in the classification of wool follicles into types are set out in Fig. 1 and defined below.

P is primary follicle, and S is secondary follicle as defined by Wildman and Carter[1], and Carter[9].

PC is central P, and PL is lateral P of a trio group as defined by Carter[9] (= P_C and P_L respectively of Fraser[5]).

PCX is member of first-formed PC, PCY is member of later-formed PC, PLx is PL associated with PCX, and PLy is PL associated with PCY. (The symbols X, Y, x and y are used in the same sense as by Wildman and Carter[1], and Carter[9].)

SO is original S, and SD is derived S as defined by Hardy and Lyne[7,8].

SOU is unbranching SO, and SOB is branching SO as defined by Hardy and Lyne[8].

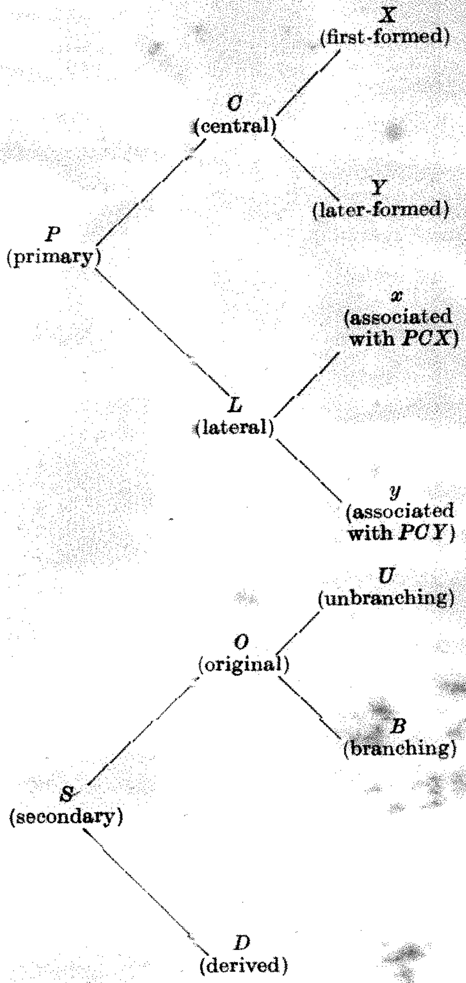

Fig. 1. Key to the classification of wool follicles

Within each follicle type three states of follicle development or activity are distinguished.

i is an incompletely developed follicle at any stage prior to the formation of a keratinized fibre, that is, at any stage from $F1$ to $F5$, as defined by Hardy and Lyne[7,8]. (Carter and Hardy[10] used the symbol p for primary follicles in this state, and s for secondary follicles. Fraser and Hamada[6] used S_U for secondary follicles. Burns[4] referred to two groups of stages of incompletely developed follicles as 'plugs' and 'news'.)

f is follicle containing a fibre, that is, stage $F6$ as defined by Hardy and Lyne[7,8] or any later stage up to and including that in which a fibre has ceased growing but remains in the follicle. (Carter and Hardy[10] used P and S respectively for primary and secondary follicles in this state. Fraser and Hamada[6] used S_F for secondary follicles.)

The symbols for the state of follicles should follow those for follicle types. Different combinations of symbols may be used for different purposes. Thus, while it is frequently necessary only to distinguish P from S, sometimes PC must be distinguished from PL[5,6], and in the early stages of follicle development PCX needs to be distinguished from PCY[8,10]. In any study of follicle development in early postnatal life, Si and Sf must be separated[11,12].

For quantitative work, such symbols have frequently been used for representing numbers of follicles. With the above symbols, any ratio of numbers of follicle types may conveniently be expressed. Thus S/P (or more strictly nS/nP) is the ratio of secondary to primary follicles, while Sf/Pf (nSf/nPf) is the ratio of secondary follicles containing fibres to primary follicles containing fibres.

In the nomenclature described above, terms and symbols which have been found useful for different purposes are combined in a single system in which there are no overlapping categories. Expansion within the system is possible if required. All the symbols except the previously defined X, Y, x and y are mnemonic, and for ease of type-setting, superscript and subscript letters have been avoided.

We would like to thank the following members of the Commonwealth Scientific and Industrial Research Organization for helpful discussions on these proposals: Mr. P. G. Schinckel, Dr. B. F. Short and Dr. K. A. Ferguson, of the Sheep Biology Laboratory, Prospect, Mr. R. H. Hayman, of the F. D. McMaster Field Station, Badgery's Creek, Miss A. G. Culey, of the McMaster Laboratory, and Dr. A. S. Fraser, of the Section of Animal Genetics, University of Sydney.

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Ciliary Feeding Mechanisms of Brachiopods

At the suggestion of the late Prof. J. H. Orton, I undertook a comparative study of the ciliary feeding mechanisms of brachiopods, after Richards[1] had reported a new method of ciliary feeding in *Neothyris*, which suggested that the main food and respiratory currents were produced by different methods in different brachiopods. Owing to the difficulty of obtaining diverse living material, it may be some time before the work can be completed and published; a mechanism has been discovered, however, which probably accounts for the differences in the descriptions by Orton[2] and Richards[1] of feeding in *Crania* and *Neothyris* respectively.

In Orton's account of the ciliary feeding mechanism of the inarticulate *Crania*, with spirolophus lophophore, it was shown that the lateral cilia beating across the length of the filaments created the main water current passing through the mantle cavity, the inhalant apertures being lateral and paired and the exhalant anterior and single. The frontal cilia passed food particles to the bases of the filaments and so into the food grooves leading to the mouth.

Richards, in her work on the articulates *Neothyris* and *Terebratella*, with plectolophus lophophores, although agreeing with Orton in the position of the inhalant and exhalant apertures, found that both lateral and frontal cilia beat toward the tips of the filaments, and that the inhalant current entered the lophophoral spaces of the lateral arms against the beat of these cilia. To account for this she was obliged to formulate the hypothesis that the inhalant current was produced by cilia lining the exhalant chamber and the spiral arm. She considered that their action caused a volume of water to be discharged through the anterior exhalant opening, and that to replace this, water was drawn into the inhalant chamber through the lateral inhalant openings. From the spiral arm water was discharged through the inter-filamentary spaces into the exhalant chamber.

Of the articulates, I have so far studied the terebratuloids, *Terebratulina retusa* and *Gryphus vitreus*, and the terebratelloid, *Macandrevia cranium*; of the inarticulates, only *Crania*. In all these, the lateral cilia, beating across the length of the filaments and from the inside to the outside of the lophophoral spaces, create the main water current, which in the adults, whether with plectolophus or spirolophus lophophores, enters laterally and leaves the shell anteriorly. In young stages (*Terebratulina retusa* seen so far) with simple circular lophophore (trocholophus) and with slight anterior indentation (early schizolophus), the inhalant current is single and median, setting into the bell-shaped lophophore, while the exhalant current escapes between the filaments all around, but leaves the shell chiefly laterally and ventrally, for the lophophore lies nearer the brachial than the pedicle valve. As the anterior indentation increases with age, two lateral arms being formed, the median inhalant current becomes divided into two.

The frontal currents in all the species examined are capable of reversal. Small particles are conveyed by the frontal cilia toward the bases of the filaments and eventually reach the mouth; large particles and collections of particles are conveyed to the tips of the filaments and are finally rejected from the shell. In a thick culture of *Chlorella* or other small organisms, the frontal cilia beat toward the tips of the filaments. This reversal of the frontal currents of the filaments appears to be due to reversal of the ciliary beat and not to adjacent tracts of cilia beating in opposite directions as in certain bivalves[3]. Orton[2] observed only the feeding reaction of the frontal cilia of *Crania*, while Richards[1] evidently saw only the rejection reaction of these cilia in *Neothyris* and *Terebratella*. *Neothyris* and *Terebratella* are sufficiently close allies of *Macandrevia* to make it very probable that reversal of the frontal cilia occurs in them as in *Macandrevia*. It is understandable that Orton and Richards failed to see the full behaviour of the frontal cilia, for reversal is not a consistent reaction in the opened animal and on small pieces of lophophore.

Change in direction of beat of the lateral cilia has not been observed, and it is difficult to account for Richards's statement of the direction of their beat in *Neothyris*; but the following observations may have some bearing on this. The lateral cilia sometimes have the appearance of beating somewhat obliquely, as in the ectoproct Polyzoa[4]. Also, in an opened animal, on portions of lophophore and detached filaments, these cilia are frequently more or less inactive and masked by the continuous beat of the long frontal cilia; there is little difference in length of lateral and frontal cilia in brachiopods.

In *Terebratulina retusa*, *Gryphus vitreus* and *Macandrevia cranium*, abfrontal cilia are present on the filaments and these beat continuously toward their tips.

From work now in progress, it would seem that Orton[2] was justified in his general inference from a detailed knowledge of *Crania*, and a limited knowledge of *Gryphus vitreus* (= *Terebratula vitrea*) and *Argiope*, that "the main current through the mantle cavity in brachiopods is produced chiefly by the lateral cilia on the gill filaments". It would also seem probable that reversal of the frontal currents on the filaments will be found in brachiopods generally.

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Reversal of Mating Preference by Crossing Strains of *Drosophila melanogaster*

Sexual selection may be an important component of the selection pressures determining changes of gene frequency in Mendelian populations, and a number of studies of *Drosophila* have been made with the object of assessing degree of competition for mates (see, for example, refs. 1 and 2) and have led to the conclusion that, while male vigour is an important factor, discrimination and preference between genotypes do occur and seem to be largely female attributes. In an attempt to assess the importance of mating preference as a factor affecting changes of gene frequency in some experimental populations described elsewhere[3], we have come across a phenomenon which, as far as we can discover, has not been reported before.

We wished to test the preference of w/w, w^a/w^a and w/w^a females for w^a or w males in two separate environments (one constant 25° C., the other 25° during the day and 15° during the night). The flies were obtained from stock cultures, the w/w^a females by crossing. Each female to be tested was placed in a food tube with one male of each kind for two days, and her offspring were grown and classified according to genotype of father. Failures were ignored and double matings were scored $\frac{1}{2}$. Three replicate tests gave the combined results shown in Table 1.

Over all the experiments, the two types of male have equal success ($\chi^2_{(1)} = 0{\cdot}3810$, p, $0{\cdot}7$–$0{\cdot}5$); but there is significant heterogeneity within the data ($\chi^2_{(6)} = 18{\cdot}843$, $p < 0{\cdot}01$). All this heterogeneity is associated with the degree of freedom for difference between the w/w^a females and the two homozygous female types ($\chi^2_{(1)} = 13{\cdot}660$, $p < 0{\cdot}001$; residual $\chi^2_{(5)} = 5{\cdot}183$, $p \simeq 0{\cdot}3$), and the difference is in the direction that w/w^a females prefer w males, whereas both w^a/w^a and w/w females prefer w^a males. The respective degrees of preference are about equal: 0·7 of the w/w^a matings were with w, 0·6 of the w^a/w^a matings were with w^a and 0·7 of the w/w matings were with w^a.

Table 1

Environment:	25° C.			15–25° C.			Total		
Successful male:	w	w^a	Total	w	w^a	Total	w	w^a	Total
Type of female									
w/w	7·0	19·0	26·0	10·0	17·0	27·0	17·0	36·0	53·0
w^a/w^a	14·5	14·5	29·0	9·0	19·0	28·0	23·5	33·5	57·0
Total	21·5	33·5	55·0	19·0	36·0	55·0	40·5	69·5	110·0
w/w^a	18·0	10·0	28·0	21·5	8·5	30·0	39·5	18·5	58·0
Total	39·5	43·5	83·0	40·5	44·5	85·0	80·0	88·0	168·0

There is thus a remarkable difference between the mating preferences of the two types of stock female and the females produced by crossing these stocks. We cannot, of course, associate it with the marker locus, for it may be associated with genes or gene complexes anywhere in the chromosome complement. However, the observation that mating preference may be reversed by hybridization, even though the types hybridized have similar preferences, is striking. If such reversal of preference were associated with a single locus or small block of chromatin it could, in certain circumstances, be responsible for a stable polymorphism.

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A Simple Potometer for measuring Rate of Water Uptake by Small Seeds

The usual method of measuring rate of water uptake by seeds is to weigh samples after different periods of imbibition. This method is not free from errors as the seeds have to be freed from adherent water before weighing, which cannot be done accurately, and, during handling and weighing, loss of water always occurs by evaporation. Furthermore, different lots of seeds have to be used for the various measurements, which is cumbersome and a disadvantage in cases where only small amounts of seeds are available.

Kruyt[1] measured water uptake by enclosing the seeds in a water-filled bottle, through the stoppered mouth of which protruded a capillary tube. By watching the fall of the water column in this capillary, water uptake was measured. In this method the seeds are totally submerged, and no attention is given to volume changes of the seeds due to swelling.

In order to determine germination-rate or metabolic changes in small and quickly germinating seeds, the seeds are usually not submerged, but are placed on wet filter paper. When water uptake has to be correlated with findings obtained by this method, the seeds ought not to be submerged, as this treatment changes their germination behaviour. The potometer described here allows water uptake to be measured in a single lot of seeds imbibing on wet filter paper during a prolonged period of time without weighing.

The edge of a Petri dish is ground and a hole blown in the middle of the bottom. A capillary tube about 65–70 cm. long is sealed to the hole and bent

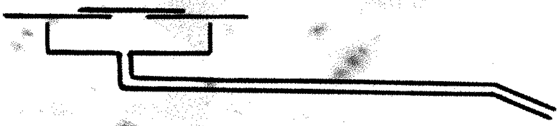

Fig. 1. Diagram of potometer for measuring rate of water uptake in small germinating seeds (not drawn to scale)

as shown in Fig. 1. A ground-glass plate with a small opening in the middle, and a cover-glass or a glass slide to cover up the opening are used to close the potometer.

Before use the capillary is filled completely with water from a pipette through the Petri dish, and the free end of the capillary inserted into a beaker filled with water. A fitting filter paper is quickly inserted into the Petri dish and will absorb water from the capillary. By lifting the free end of the capillary from the beaker, an air-bubble can be introduced into the capillary, which is then lowered again. The potometer is then left open until the bubble has risen to the horizontal part of the capillary. Now the potometer is made air-tight with the cover using any sealing agent and left until the bubble has come to a standstill, indicating that the air inside the Petri dish has been saturated with water vapour. The cover is removed, a measured amount of seeds speedily spread on the filter paper and the cover instantly replaced. When a cover without an opening is used, the air pressure in the Petri dish might be increased by the closing procedure, which will result in a backward move of the air bubble, but when an opening is made in the plate, it can be quickly put in place. The opening has to be immediately closed by sliding the cover-glass smeared with 'Vaseline' sideways over it. Rate of water uptake is determined by reading the movement of the air bubble against a millimetre-scale behind the capillary.

It is advisable to have the potometer in a fixed position in a constant-temperature room and do the handling with the help of forceps and not by hand, in order to avoid temperature changes.

In our laboratory water uptake in photo-sensitive lettuce seeds has been determined by this potometer. The results will be published elsewhere.

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A Slide-trap Method for the Isolation of Soil Fungi

THE slide-trap method of isolating actively growing soil fungi, described by C. J. La Touche[1], was used in an investigation of the fungus flora of a podsolized *Calluna*-heathland soil. The method was found to be highly selective of rapidly growing species and indeed, with very few exceptions, only permitted the isolation of *Trichoderma viride* from the surface soils. A modified slide-trap was designed which greatly reduced this selectivity and permitted the isolation of a wide range of species.

The modified slide-trap consisted of a shallow chamber (Fig. 1, *Y*) covered by a glass microscope slide (Fig. 1, *X*). A 'Perspex' strip (3 in. × 1 in. × $\frac{3}{32}$ in.) formed the base of the chamber, narrow lengths ($\frac{1}{8}$ in. × $\frac{3}{32}$ in.) of the same material formed the four walls and the chamber was divided into two unequal parts by a crosspiece. Chloroform was used for joining the 'Perspex' surfaces.

The chamber was stored in alcohol and sterilized by flaming when required. Melted agar was introduced into the larger section of the chamber by means of a sterilized pipette, where it spread evenly to form a thin layer (Fig. 1, *Z*). The chamber was then covered by a sterilized glass slide, which was firmly fixed in position by two wire paper clips when the agar had solidified. All manipulations were carried out under a sterile hood in an inoculating room.

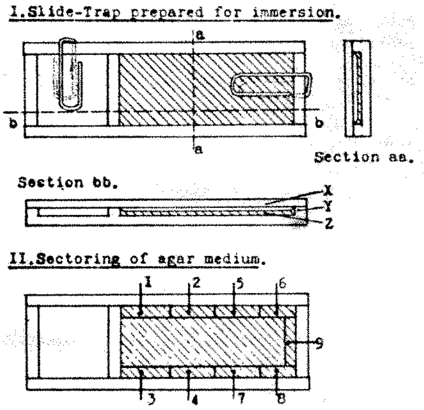
I. Slide-Trap prepared for immersion.
a
a
b
b
Section aa.
Section bb.
X
Y
Z
II. Sectoring of agar medium.
1
2
5
6
9
3
4
7
8

Fig. 1. Modified La Touche slide-trap

Slide-traps were immersed vertically into the soil to such a depth that the larger portion of the chamber was completely buried. The slot-shaped hole to receive the slide-trap was conveniently prepared with a square-ended chisel blade. Traps were buried in groups and were protected from rain by an inverted U-shaped piece of zinc sheeting.

After a suitable period of incubation in the soil, during which fungal hyphæ penetrated between the glass and 'Perspex' surfaces and colonized the agar medium, the slide-traps were returned to the laboratory. In routine isolation work the slide-traps were opened and portions from the edges of the agar medium were removed and plated. Usually nine small sectors of agar were removed, four from the upper part of the isolation chamber (Fig. 1, II, 1–4) and five from the lower part. These two groups of agar strips were plated separately, thus enabling a rough distinction to be made between those mycelia which penetrated the traps from the upper and lower levels of the soil sampled. Generally, two, three or four species were isolated from each slide-trap.

These modified slide-traps were economical of time and materials and were simple to use; the results obtained by their use were in close agreement with those obtained by the immersion tube method[2] and will be discussed in greater detail elsewhere.

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Heat Treatment and Tissue Culture as a means of freeing Potatoes from Virus Y

A NUMBER of workers have shown an effect of high temperatures on plant viruses. By heat treatment, potato tubers have been freed from leafroll[1] and witches'-broom[2]; but as yet there has been no reported success with heat treatment as a means of freeing potatoes from virus Y.

The most important potato variety grown in New Zealand, Aucklander Short Top, has been shown to be 100 per cent infected with potato viruses X and Y[3]. Therefore, efforts have been directed towards eliminating virus from selected tubers, which would then become the foundation for improved seed stocks.

Table 1

Treatment	Material	Apices detached	No. surviving	No. free from virus Y
38° C.; 28 days	3 tubers	16	6	0
38° C.; 21 ,,	1 ,,	14	2	0
38° C.; 15 ,,	2 ,,	10	0	0
38° C.; 7 ,,	2 ,,	12	7	4
35° C.; 7 ,,	1 ,,	10	2	1
35° C.; 7 ,,	2 ,,	7	3	0
35° C.; 16 ,,	9 cultures	9	6	5
35° C.; 14 ,,	2 ,,	2	1	1

Tubers were sprouted in darkness and when sprouts were 1–2 cm. long, the tubers were removed to incubators kept at either 35° C. or 38° C. for varying periods (Table 1). After treatment, the terminal 5 mm. of each sprout was detached and surface-sterilized with a 25 per cent solution of commercial sodium hypochlorite with the addition of a small amount of detergent. The shoot tips were recovered in test-tubes on White's media[4] containing 0·7 per cent agar with the addition of pantothenic acid[5]. Cultures were placed in a glasshouse. When sufficient growth had been made, the rooted plantlets were transferred to John Innes compost in pots. They were each tested at least twice for virus content—when 2–3 in. high and when fully grown—by sap inoculation to *Datura stramonium* L. and *Nicotiana tabacum* L. (var. White Burley). If symptoms of virus Y failed to develop on the tobacco plants, they were re-inoculated with a severe strain of virus Y to test for the presence of mild strains.

In another experiment, sprout tips were established in culture under glasshouse conditions and later transferred to the incubator at 35° C. During treatment, these cultures developed some new etiolated growth which was removed and recovered in culture.

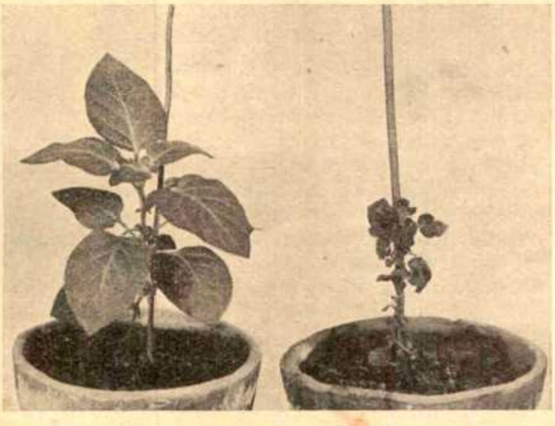

Fig. 1. Left: virus X only; right: viruses X + Y

Although in most cases heat-treated tubers failed to germinate when planted, all those that did proved to be infected with viruses X and Y. However, of eighty apices detached, twenty-seven survived for testing. All showed virus X reaction, but eleven plants failed to give a virus Y reaction.

The plants which were apparently free from virus Y will have to be tested over an extended period before they can be definitely regarded as free. However, under glasshouse conditions, they are much more vigorous than the plants infected with virus X and Y (Fig. 1).

Similar tuber treatments have been carried out on another important variety, Dakota Red, which is wholly infected with virus X. All of thirty-four surviving plants reacted at first test on *D. stramonium*.

This work is being extended.

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Diffusion of a New Habit among Greenfinches

Daphne mezereum L. is a compact, pink, pre-vernal shrub, smothered with a profusion of fragrant blossom in March or earlier, and often planted near a living-room window to cheer one up at that season. It has a natural temperate distribution from the Atlantic to the Altai Mountains[1]. *Chloris chloris* L., the greenfinch, has a distribution which, apart from introductions, is somewhat similar[2]. Thus the two species have probably shared a large geographical area for some ten thousand years, apart from earlier Pleistocene migrations. On the borders of calcareous woods there is an overlap between their natural habitats, and they have been together in gardens for several centuries. During the past fifty years no distinctive association between the two species appears to have been reported[2,3].

The fruit of *D. mezereum* is a 10-mm. scarlet drupe, with an internal structure like that of the plum, *Prunus*. It is effectively adapted to alimentary dispersal by such birds as *Turdus merula* L., the blackbird. But in recent years[4] certain greenfinches have obtained a new source of nutrition, at the same time wrecking the life-cycle of *Daphne*. A pair of birds, usually, will visit and strip the bush in May or early June, and while the fruits are still green. They can then crack the immature stones and devour the large seed. Often, no doubt, this considerably assists the feeding of the first brood of nestlings[2,5].

Preliminary reports[4] show that this new behaviour is increasing rapidly in frequency, with 42 per cent of cases occurring only within the last two seasons. I should be very grateful for further information, by postcard, about: (*a*) the location of any *D. mezereum* bush under observation; (*b*) whether or not this despoliation has occurred, and (*c*) the year of first occurrence.

Further information which may help to elucidate the origin and spread of the phenomenon would be welcome. For example: (*d*) For how many years was an observed *Daphne* bush at first free from attack? (*e*) Did the attack have a different pattern in the first year from that of subsequent years? (*f*) How many adult or juvenile birds take part? (*g*) After the first season of despoliation, was the bush ever spared? The opening of milk bottles by tits (*Parus*)[7] was preceded by the introduction of milk bottles; there is no equally clear initiating factor in this instance.

It is hoped that the survey will provide information as to how far *de novo* discoveries by individual birds, on one hand, and cultural diffusion, on the other, have contributed. Besides recent instances, positive and negative, information from earlier years and from outside Britain would be especially appreciated. Appropriate lines of protective action by the horticulturist are discussed elsewhere[6].

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Colour Illusions and Aberrations during Stimulation by Flickering Light

The production of illusions of colour by intermittent visual stimulation has been familiar since the description of the 'artificial spectrum top' by Benham[1] in 1895; but with the traditional arrangement of rotating black-and-white chequered disks the subjective sensations are not particularly vivid. Since the introduction of the electronic stroboscope to psychophysiological experiment by Walter, Dovey and Shipton[2] in 1946, thousands of normal and clinical subjects have been subjected to intensive visual stimulation by flickering white light, and all report sensations of pattern, movement and colour. The descriptions vary greatly from subject to subject; in some, the impressions are particularly intense only at certain frequencies. Most subjects have no difficulty in recognizing the illusory character of the colours: Margiad Evans[3] describes them as ". . . pure ultra unearthly colours, mental colours, not deep visual ones. There was no glow in them but only activity and revolution". None the less, the colours are 'real' enough to act as conditioned stimuli, for Brady[4] has shown that subjects who have been conditioned to give a psycho-galvanic skin response to red light will give the 'red' response when stimulated with white light flickering at a particular frequency and at multiples of the critical rate.

The relation of these phenomena to the various theories of colour vision is by no means clear, and a few simple experiments have been made to see whether the illusory colour sensations affect the results of tests for colour blindness administered to normal persons. The hidden-figure colour mosaic cards devised by Ishihara (English edition)[5] were presented successively to a number of subjects and were viewed only by the light of an electronic stroboscope giving blue-white flashes lasting about 20 μsec. and with a peak illumination of about 80,000 ft.-candles. The flash-rate was set at 1 flash per sec. and the subject was asked to comment on the pattern seen, the flash-rate being increased gradually after each comment. In general, the subjects found no difficulty in identifying the figure in the orange-grey contrast cards (Nos. 1 and 32), but were confused and often mistaken when viewing the more complex brown-green and blue-yellow cards. Several subjects with full normal colour vision by steady light gave a number of 'colour-blind' responses during flicker at less than 20 flashes/sec., suggesting various degrees of temporary protanopia or deuteranopia depending on the flicker-rate. The relation between the aberration of colour vision and flicker frequency was not consistent, though most subjects gave particularly erratic reports at frequencies between 5 and 10 flashes/sec. One subject, for example, viewing card 2, saw a 3 (the red-green blind response) at 9 flashes/sec. and an 8 (the normal response) at 12–15 flashes/sec. The same subject gave fifteen other 'colour-blind' or anomalous responses to the thirty-two cards; the commonest effect was a combination of the normal and colour-blind responses to provide an 'original' response; for example, a card containing the figure 5 for normals and 2 for colour-blind was seen as a 3.

In the absence of a rigorous and detailed neurophysiological theory of colour vision, it is difficult to account for this effect; but in view of the dramatic and often paradoxical effects of rhythmic as opposed to steady stimuli[6], it is not surprising that the visual channel should give an equivocal output when supplied with intermittent signals. Careful analysis of the effect should, however, provide a clue to the code relations between the retinal colour analysers and the cerebral receiving zones.

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Structure of Collagen

An arrangement of three non-coaxial helical chains linked to one another by hydrogen bonds approximately perpendicular to the length of the chains was suggested as the basis of the structure of collagen two years ago[1]. This structure explained the occurrence of a fraction of more than one-third of glycine residues and could readily accommodate proline and hydroxyproline residues, besides explaining the infra-red dichroism. The exact nature of the helices (namely, three residues per turn) was later found not to be quite correct for collagen, the X-ray pattern of stretched collagen[2] indicating the occurrence of $3\frac{1}{3}$ residues per turn[3]. The presence of such a non-integral number of residues per turn required that the three chains must all be further coiled around. The coiled-coil structure[4] retained the essential features of the earlier one as regards the location of amino-acid residues and the orientation of the NH- and CO-bonds. However, it is interesting to note that the simpler non-coiled-coil structure has been found to be the basis of the arrangement of polypeptide chains in polyproline[5] and in polyglycine II[6]. Thus, it appears that the triple chain structure, with minor modifications, is a configuration which might be found also in other proteins and polypeptides. There is, in fact, good evidence to show that elastin belongs to this type[7].

Recently, two interesting articles have appeared[8,9] which discuss the polypeptide chain configuration in collagen. Rich and Crick[8] have criticized the revised structure proposed from this laboratory[4], on considerations of stereochemistry and amino-acid sequence. Both these difficulties were known to us and were in fact considered in a paper[10] discussing this structure in detail. It was found impossible to avoid short contacts if two good interchain hydrogen bonds were to be formed for every three residues. Consequently, models were built up which were stereochemically more satisfactory. It was then found, as Rich and Crick have found, that only one hydrogen bond can be formed for every three residues in each chain of the triple chain. However, two configurations are possible, both of which are quite satisfactory so far as the backbone of the structure is concerned. The two structures may be called the plus and the minus structures, since they could be obtained from the one described earlier[4] by rotating the minor helices about their own axes through a positive or negative angle (ψ say). These two possibilities are respectively similar to the structure I and structure II of Rich and Crick[8] and the anti-clockwise and clockwise structures of Cowan, McGavin and North[9].

In each case, the best arrangement was determined using the graphical method[10], but retaining the condition of exact coiled-coiling. If the major helix radius is denoted by R, the best values were found to be:

For the plus structure: $R = 2{\cdot}85$ A., $\psi = +40°$.
For the minus structure: $R = 2{\cdot}78$ A., $\psi = -15°$.

Of the two, the minus structure was preferred, as its properties were similar to those of the earlier structure[4,10] except that there were no short contacts of any type. The hydrogen bond length is 2·76 A. and the angle between NH and N....O is about 15°. Every third residue in each chain must be of the G-type, but the other two residues R_2 and R_3 in the sequence —G—R_2—R_3— can accommodate a pyrrolidine ring without strain. Thus, the sequence gly-pro-hypro can readily occur in this structure. The position R_3 is assigned to hydroxyproline, the hydroxyl group of which links through a hydrogen bond to a carbonyl oxygen in another triple-chain rod. The distance between these rods could be equal to 12 A., the value found for dry collagen, unlike the value 11·5 A. required earlier.

Both Rich and Crick[8], and Cowan *et al.*[9], have favoured the other possibility, namely, the configuration analogous to our plus structure. However, the minus structure appears to be more probable for the following reasons.

(*a*) The Fourier transform of the minus structure agrees better with experiment than the other one. (The optical transform was obtained by Drs. Rich and Crick and by Drs. Cowan and McGavin, and I am very grateful to them for this.)

(*b*) If an exact coiled-coiling is assumed and hydroxyproline residues occur in position R_3, then the distance between some of the carbon atoms in the pyrrolidine ring and the carbonyl oxygen of a neighbouring chain are found to be too short in the plus structure. Rich and Crick (personal communication) have overcome this by not insisting on an exact coiled-coiling and also by making one of the chains slightly different from the other two. Although the effect of these may not show up in the X-ray pattern, such a modification should obviously be attempted only if other approaches fail.

(*c*) In the plus structure, the G-type α-carbon atom can readily accommodate a methyl group in its side-chain with a slight strain, so that an alanine residue could occur in this position. On the other hand, it would appear that every third residue in collagen must be a glycine residue, because such residues are never found to be less than one-third in number and since no sequence of three residues has been found which does not contain a glycine residue[11,12] (with one solitary exception).

(*d*) Studies carried out in this laboratory on the effect of tanning at different *p*H's and of certain salt solutions on the wide-angle pattern of collagen indicate that the hydroxyproline cross-linkages are external to the triple chain.

There seems to be no reason why the structure should be based on an exact coiled-coil, as was assumed in our studies. The X-ray pattern only demands that every third residue must occur on a simple helix of pitch 85·8 A., with thirty residues per turn, in each of the three chains. If only this condition is put in, then almost straight hydrogen bonds can be formed in the minus structure, and yet having no short van der Waals contacts. Although there are thus various points in favour of the minus structure, a second set of hydrogen bonds cannot be formed and a number of imino-hydrogens are systematically not hydrogen-bonded. This is not really satisfactory. It is possible, however, for these hydrogens to be bonded to a carbonyl oxygen in another chain of the same triple chain through a water molecule. It is probable that water exists in such a firmly bound form in collagen (McGavin, S., personal communication), but a careful study is required of this question.

The work reported here has been done in collaboration with Messrs. Y. T. Thattachari, V. Sasisekharan and M. S. Santhanam, and I wish to acknowledge their valuable assistance. Fuller reports will be published elsewhere.

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Diffraction from Dislocations

Wilson[1] has calculated the nature of the diffraction from a cylindrical crystal with a single axial screw dislocation. Diffraction from an edge dislocation is more difficult to treat theoretically, because of the more complex nature of the elastic field surrounding the dislocation. An approximate treatment has been given by Wilson[2], who assumed that the displacements of the atoms were parallel to the Burgers vector. We have succeeded in solving the diffraction problem for a cylindrical crystal with an axial edge dislocation, in which the displacements correspond to isotropic elastic theory. Two independent methods were used: straightforward calculation (by T. S.), and direct observation in a Lipson diffractometer of the optical diffraction pattern of a two-dimensional grating representing the crystal (B. T. M. W.). In Fig. 1 we reproduce the optical diffraction pattern given by a grating representing (*a*) a perfect crystal (no dislocation) and (*b*) a simple-cubic crystal with an edge dislocation normal to the plane corresponding to the plane of the grating.

Our results can be summarized as follows. The h-axis in reciprocal space is parallel to the slip direction (Burgers vector) and the l-axis to the axis of the dislocation. (1) Any spreading of the diffracted intensity in reciprocal space is confined to the planes $l = 0, \pm 1 \ldots$, and the intensity within these planes is independent of l. (2) The $h0l$ reflexion is broader and weaker than the $0kl$ reflexion for equal values of h and k. (3) The maxima of the $h0l$ reflexion are displaced from the ideal reciprocal lattice point by an amount that increases linearly with h; the maxima of the $0kl$ reflexion are also displaced, but the displacement is roughly independent of k for small k. (4) The intensity at the ideal $h0l$ and $0kl$ lattice points is zero for $h,k > 4$. (5) The form of the distribution of intensity around an ideal reciprocal lattice point depends on its co-ordinates in reciprocal space, on the strength of the dislocation and on the value of Poisson's ratio, but not otherwise on the crystal structure. In contrast with the case of a screw dislocation[1], the spread of intensity around the ideal reciprocal lattice point is not of circular symmetry.

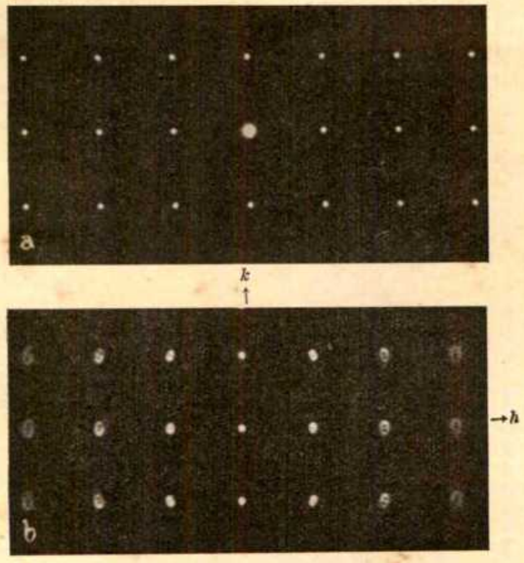

Fig. 1. Diffraction patterns from gratings representing (*a*) perfect crystal, (*b*) crystal with dislocation. The horizontal axis in (*b*) corresponds with the slip direction

These results were obtained using an average value of 0·3 for Poisson's ratio. It is clear that the diffraction pattern is quite different from that proposed by Wilson on the basis of the more approximate theory[2].

Our thanks are due to Prof. F. C. Frank for discussion of this problem, and to Dr. J. Thewlis, who suggested the use of the optical method for its solution.

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Galvanic Measurement of Dissolved Oxygen

An exceedingly sensitive static[1] as well as continuous[2] method for determining molecular oxygen in the gas phase has been described by Hersch. This discovery has led to the development of a reliable commercial instrument for the continuous indication and recording of oxygen in gases. Hersch has also proposed[2] the application of this method to oxygen dissolved in boiler water, effluents, biofluids, and fermentation media by driving the oxygen into an inert carrier.

The measurement of oxygen in an aqueous phase by polarographic or amperometric means has been often described, but the sensitivity of these methods is limited by the value of the oxygen diffusion current. Moreover, reducible constituents other than oxygen can interfere, while salt deposits and adsorbable organic material progressively block the cathode[3]. The application of the Hersch galvanic system to liquids in the way suggested would largely eliminate these drawbacks.

We have experimented with a simple apparatus designed to adapt the method described by Hersch to the measurement of dissolved oxygen, which has proved effective and reliable.

We used demineralized water 'scrubbed' by means of hydrogen passed via a 'Deoxo' purifier through a sintered glass disk at the bottom of a reservoir. The water is fed, at constant flow-rate determined by a static head, to a glass vessel having an outlet at the bottom into a vertical tube via a constriction constructed in such a way that a vortex is formed. The vessel contains oxygen-free hydrogen which is sucked into the vortex and flows in a series of bubbles with the water down the vertical tube, taking from the water a proportion of the dissolved oxygen. We have found it surprisingly easy to establish conditions in which the proportion of oxygen transferred to the hydrogen in this 'oxygen exchange column' remains constant. At the bottom of the column, the water/hydrogen mixture runs into a vessel of larger diameter where the water separates from the gas and flows out through a constant-head device, while the gas flows upwards over a Hersch dry cell which measures its oxygen content. The hydrogen then passes via a small 'Deoxo' purifier to remove the residual oxygen, back to the water inlet vessel.

Calibration has been done (*a*) by bleeding in a measured quantity of air-saturated water and (*b*) electrolytically by passing a known d.c. current between a pair of platinum electrodes immersed in the inlet pipe. Excellent agreement was achieved. Using a flow-rate of 10 litres an hour, and an oxygen exchange column 6 in. long, the cell gave an electrical output of up to 5 μamp. for 1 vol. of gaseous oxygen dissolved in 10^6 vol. of water, that is, 5 μamp. per vol. per million (v.p.m.) ($1 \cdot 4 \times 10^{-9}$ gm./gm.), and the electrical output was linear up to at least 20 v.p.m. (28×10^{-9} gm./gm.).

If the 'Deoxo' purifier be omitted from the hydrogen return circuit, the oxygen content of the circulating gas builds up to a figure which approaches static equilibrium with the water, and the electrical output from the cell is thereby increased several times to between 15 and 20 μamp. per v.p.m., but the time taken to reach equilibrium is increased. Incidentally, we have shown the effectiveness of scrubbing with 'Deoxo' purified hydrogen. We could, without difficulty, reduce the oxygen content of our water supply to less than ½ v.p.m., as indicated by the Hersch cell.

The method appears to have many advantages over those previously described. (*a*) Its response is rapid (5–10 sec.); (*b*) it gives a continuous indication and/or record; (*c*) it requires no addition to the water other than oxygen for calibration, and this can readily be done electrolytically; (*d*) it is unaffected by the presence of dissolved salts in the liquid.

We are investigating the effect of dissolved gases other than oxygen; for example, carbon dioxide, sulphur dioxide and ammonia, but it is believed that none of them will present an insurmountable problem.

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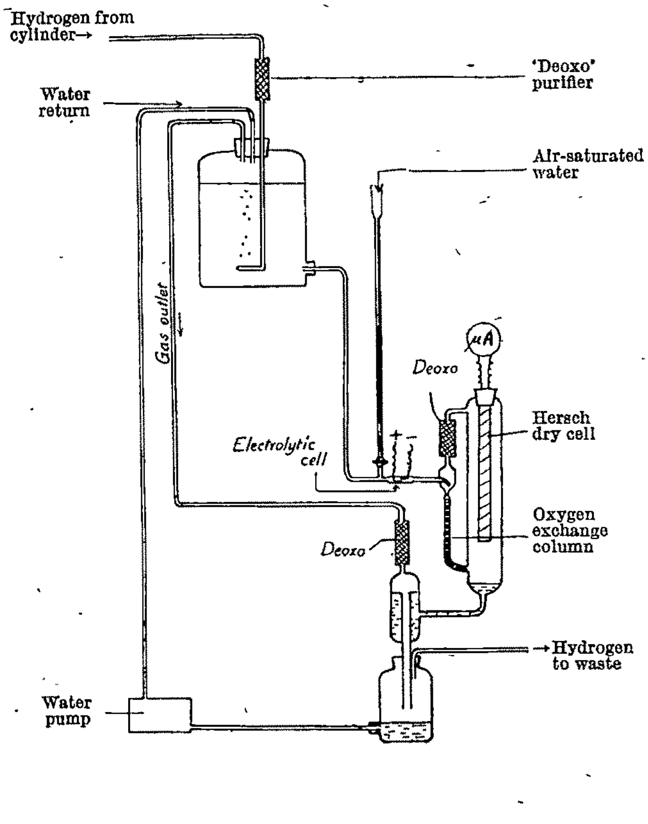

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A New Alumina Trihydrate

During the development of a platinum-alumina catalyst, X-ray studies have revealed that, in addition to the well-known gibbsite and bayerite, a third crystalline form of $Al(OH)_3$ exists. Pure samples of this new trihydrate have not been obtained. It is generally accompanied by bayerite, often by both bayerite and gibbsite In samples where this new crystalline trihydrate is the major component, it has been possible to determine its chemical composition as $Al(OH)_3$ and to resolve its X-ray diffraction pattern. This pattern of the new phase (as recorded with a Geiger counter spectrometer using copper *Kα* radiation) is:

Spacing	Intensity	Spacing	Intensity
4·785 A.	100	3·18 A.	11
4·33	20*	2·39	15
4·20	15	2·26	15
4·15	13	2·01	11
3·89	7	1·898	11
3·60	7		

* Intensity uncertain—overlap with bayerite

Preparations in which this new phase is encountered start with either aluminium chloride or nitrate solution. Ammonium hydroxide is added to precipitate an alumina hydrogel. This gel is washed with ammoniacal water, then adjusted to *p*H 7·5–9 with ammonium hydroxide, in which condition the gel is gradually converted to crystalline trihydrate. Nitrogen, chloride and other impurities in the dried product are all less than 0·1 per cent. It frequently contains all three trihydrates, the relative proportions depending upon *p*H, ionic concentration, seeding and temperature. Crystallite sizes are of the order of 1000 A.

The strongest diffraction line of each of the three phases is in the vicinity of 4·8 A. (18–19° with copper *Kα* radiation). The integrated intensities of these three lines appear identical for 100 per cent of the phase (when preferred orientation effects are overcome). The spacing 4·785 A. for the new phase is midway between that for gibbsite, 4·843 A., and that for bayerite, 4·720 A. These patterns for three samples are shown in Fig. 1.

The gibbsite structure, as described originally by H. Megaw[1], is a layer lattice, the packing of layers being such that hydroxyl groups in one layer are directly above the neighbouring hydroxyls in the next layer. Bayerite, as described by A. Unmack[2], has the same layers as gibbsite, but the packing resembles that of brucite with the hydroxyl groups from contiguous layers in a close-packed array. The 4·843 A. gibbsite

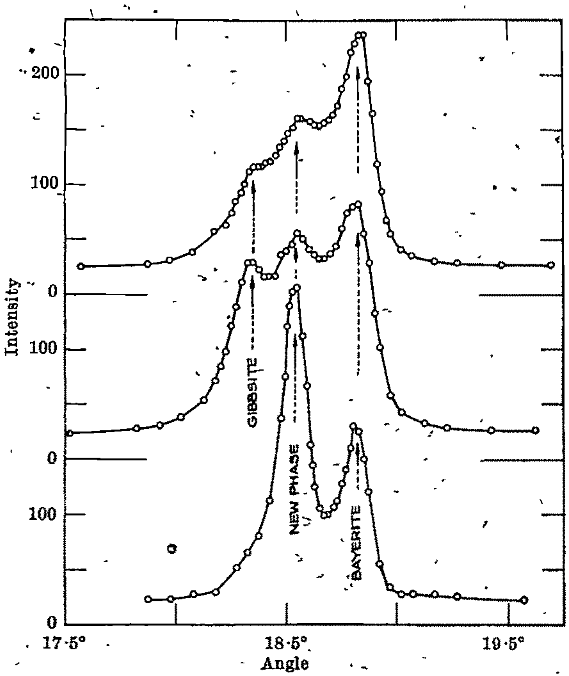

Fig. 1. X-ray diffraction patterns of samples consisting of mixtures of the three alumina trihydrates

and the 4·720 bayerite lines are basal reflexions. The same may be assumed for the 4·785 A. line from the new phase, in view of its proximity and identical intensity. It would appear that the new phase with a 'layer spacing' equal to the average of the gibbsite and bayerite spacings may be a structure wherein the two types of packing alternate. This should lead to a weak X-ray reflexion corresponding to a two-layer periodicity for the new phase. No such reflexion has been observed. If present, its intensity is less than a thousandth of that of the 4·785 A. line.

The requirements cited by F. C. Frank[3] and V. Vand[4] for polymorphism arising from screw dislocations are fulfilled, namely, two closely related types of packing, the gibbsite and the bayerite types. There seems to be a good chance that the new phase is a screw dislocation polymorph, similar to the silicon carbide polymorphs. In the new phase the Burgers vector or height of the spiral growth step may be considered as two layers. The interface between these two layers would probably be a gibbsite-type interface. The interface between the stationary surface and the growing surface would be of bayerite type. Bayerite itself might then be looked upon as a screw dislocation growth form in which the Burgers vector was one layer—the constraint imposed during this type of growth may prevent the gibbsite-type packing, permitting instead a simple close-packing of the brucite type. Growth habits of these three phases seem to support this hypothesis. Electron microscopy and preferred orientation effects in X-ray diffraction indicate that gibbsite usually grows as platelets parallel to the layers of its layer lattice. Bayerite appears as rods or tapered rods the long direction of which appears roughly perpendicular to the layers of the layer lattice. The new phase appears intermediate, showing neither preferred orientation nor preferred growth directions.

The dehydration of all three trihydrates occurs at about 200° C., gibbsite yielding χ-alumina and boehmite; bayerite and the new phase yielding η-alumina. These distinctions are based upon the nomenclature of H. C. Stumpf *et al.*[5].

Throughout our catalyst development programme the name 'randomite' was attached to this phase, as at first it was thought to be a random stacking structure. In view of the complete X-ray pattern now available, it is clear that this nomenclature is inappropriate. We suggest that it be called bayerite-II, the original bayerite to be distinguished where necessary by Roman numeral as bayerite-I. Several reasons exist for suggesting a name showing its relationship to bayerite, including structure and growth features, conditions favouring formation, and dehydration products.

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[5] Stumpf, H. C., Russell, A. S., Newsome, J. W., and Tucker, C. M., *Indust. Eng. Chem.*, **42**, 1398 (1950).

Self-inflation in a Gobioid Fish

THE ability to inflate the body-cavity by pumping in air or water through the mouth is found in several groups of fishes, chiefly highly specialized and otherwise rather degenerate types such as the well-known puffers, in certain forms from deeper waters and in some small sharks.

Mr. W. O. Mylo, of South-West Africa, recently sent me a small fish which was caught in a tide pool near Swakopmund, and which after capture blew itself up in the same fashion as a Tetraodon. On examination, this fish proved to be *Gobius bibarbatus* von Bonde, 1923. Although rather desiccated, it was plain that the abdomen had been considerably distended. On soaking, the fish became pliable and it was possible to estimate the degree of inflation that had been attained. In its distended condition the skin of the abdominal region bore scales, but each completely isolated in its own pocket. In the uninflated fish the abdomen is completely covered by normally imbricating scales. On distension these must slide apart leaving bare patches of translucent skin between. A skin structure of this type is unusual and would merit closer study in fresh material.

This is apparently the first case of a self-inflating mechanism to be reported in fishes of this type. Although generally placed in the broad genus *Gobius* Artedi, 1792, *bibarbatus* is distinguished from all other South African gobies by having what have generally been described as two 'barbels' beneath the chin. Examination reveals that these are not true barbels, but the briefly prolonged lateral apices of a low transverse mental skinny flap. This structure and the power of self-inflation clearly merit generic distinction for this fish, and *Sufflogobius* new genus is now proposed for it, genotype *bibarbatus* von Bonde.

J. L. B. SMITH

Rhodes University,
Grahamstown,
South Africa. Jan. 9.

FORTHCOMING EVENTS

Monday, April 16

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m —Mr. G. Spencer Brown: "Paradoxes of Probability".

Society of Chemical Industry, Pesticides Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m. —Annual General Meeting. Dr. R. A. E. Galley: "Pesticides in Retrospect and Prospect".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. H. G. Taylor: First of Three Cantor Lectures on "Modern Welding". (Further Lectures on April 23 and 30.)

Tuesday, April 17

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C 2), at 5.30 p.m.—Mr. F. C. Widdis: "The Indirectly Heated Thermistor as a Precise A C./D.C. Transfer Device"; Mr. A. M. Thompson: "A Bridge for the Measurement of Permittivity".

Scientific Film Association (joint meeting with the Federation of Film Societies and l'Institut Francais, at Institut Français, Queensbury Place, South Kensington, London, S.W.7), at 6.30 p.m.—"Films in the Popularization of Science".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. E. L. Ripley: "Investigation of Aircraft Accidents".

Tuesday, April 17—Saturday, April 21

Institute of Metal Finishing (at the Norbreck Hydro, Blackpool)—Annual Conference.

Wednesday, April 18

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m —Dr. Cyril Bibby: "T. H. Huxley and Technical Education".

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p m.—Meeting on "Relative Movement and the Collision Problem".

Royal Meteorological Society (at 49 Cromwell Road, London, S W.7), at 5 p.m.—Annual General Meeting. Dr. R. C. Sutcliffe: "The Moisture Balance of the Atmosphere" (Presidential Address).

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. B. P. Emmett: "The Television Audience in the United Kingdom".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5 30 p.m.—Annual Corporate Meeting.

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. J. Goldacre: "Simple Micromanipulators".

Society of Chemical Industry, Corrosion Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m. —Annual General Meeting. Dr. U. R. Evans, F.R.S.: "Pitting and Cracking" (Spring Lecture).

Royal Aeronautical Society, Graduates' and Students' Section (at 4 Hamilton Place, London, W.1), at 7.30 p m.—Mr. R. M. Fitzgerald: "Gas Turbines—Propeller or Jet?"

Thursday, April 19

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Meeting on "Biological Work at the Forest Products Research Laboratory, Princes Risborough".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p m.—Prof. H. W. Melville, F.R S.: "Addition Polymerization" (Bakerian Lecture)

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. F. D. Richardson and Mr. J. C. Billington: "Copper and Silver in Silicate Slags"; Mr. A. Alec Jones: "Underground Mining in the Frodingham Ironstone".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. Ledermann: "The Multiplicator of a Group".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p m.—Lt.-Col. Charles E. Yeager, U S.A.F.: "High Speed Experimental Test Flying".

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall, Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 6 p.m.—Annual General Meeting. Dr. A. R. Lee and Mr. H. G. Barnes: "Dense Tar Surfacing".

British Institute of Radiology, incorporated with the Röntgen Society (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p m.—Ordinary Meeting, followed by Prof. George de Hevesy. "Application of Radioactive Tracers in Radiobiology" (Thirty-fifth Silvanus Thompson Memorial Lecture).

Thursday, April 19—Friday, April 20

Institution of Chemical Engineers, Graduates and Students Section (at Nutford House, Brown Street, London, W.1)—Symposium on "Recent Developments in Effluent Disposal".

Friday, April 20

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4 15 p.m.—Geophysical Discussion—"Improvements in Seismic Prospecting". Chairman: Mr. B. C. Browne. Speakers: Prof. Russell Rait and Dr. S. Wyrobek.

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. D. L Marples, Mr J. F. A. Radford and Mr. J. L. Reddaway: "An Approach to the Techniques of Graduate Training".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Theories of Electromagnetic Induction". Opening Speaker: Prof. G. W. Carter.

Austrian Institute (at 28 Rutland Gate, London, S.W.7), at 6.30 p.m.—Prof. E. Schmid (University of Vienna): "The Influence of Structural Ordering on the Properties of Metallic Materials".

Society of Chemical Industry, Fine Chemicals Group (in the William Beveridge Hall, Senate House, University of London, W.C.1), at 7 p.m —Debate on a motion "That Science Can Provide as Good an Education as the Humanities". Speakers: Dr. R. P. Linstead, F.R S., Prof. A. R. Ubbelohde, F R.S., Mr B. L. Hallward and Mr. H. D. P. Lee. Chairman: Sir William Ogg.

Saturday, April 21

British Interplanetary Society (in the York Hall, Caxton Hall, Caxton Street, London, S.W 1), at 6 p m.—Annual General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Statisticians (with a degree in statistics, or in mathematics with appropriate qualifications in statistics, and preferably with some experience in the application of statistical techniques (including punched cards) to practical problems) in the Statistics Branch of the National Coal Board in London—The National Coal Board, Hobart House, London, S.W.1, quoting SS/247 (April 27).

Research Assistant in Biochemistry at the University College of the West Indies, for duties which include research on malnutrition problems and possibly some teaching and chemical pathological work for the University College Hospital—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 27).

Lecturer in Pure Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (April 28).

Assistant in Mathematics—The Secretary of University Court, The University, Glasgow (April 30).

Assistant in the Department of Geography in St. Salvator's College—Joint Clerk to the University Court, College Gate, St. Andrews (April 30).

Assistant Lecturer or Lecturer in Zoology—The Secretary and Registrar, University College of North Wales, Bangor (April 30).

Herdman Postgraduate Student in Marine Zoology, to undertake research work at the Marine Biological Station, Port Erin, Isle of Man—The Registrar, The University, Liverpool (April 30).

Lecturer (Grade II) in the Department of Botany—The Registrar, The University, Bristol (April 30).

Pig Husbandry Research Officer (graduate in science or agriculture, with postgraduate experience), for duties which will include experimental work, management of the pig unit, and some teaching—The Registrar, Wye College, near Ashford, Kent (April 30).

Research Fellow in Mathematics—The Secretary of University Court, The University, Glasgow (April 30).

Bleacher's Association Ltd. Fellow (with a leaning towards physical or physical-organic chemistry) in the Department of Textile Industries, for research on cellulosic fibres—The Registrar, The University, Leeds 2 (May 1).

Reader in Roman-British History and Archæology tenable in the Newcastle Division of the University—The Registrar, University Office, 46 North Bailey, Durham (May 5).

Assistant Lecturer in Chemistry and an Assistant Lecturer in Geography—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 7)

Lecturer in Applied Mathematics—The Secretary and Registrar, The University, Southampton (May 7).

Microbiologist (with a first- or second-class honours degree, and preferably with postgraduate research experience in bacteriology or allied fields) for basic research at Aberdeen on the taxonomy and biochemistry of marine bacteria—The Superintendent, Torry Research Station, Aberdeen (May 8).

Lecturers in Botany, Zoology, Chemistry, Physics and Mathematics at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 10)

Lecturer in Engineering—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 12).

Lecturer (with special qualifications in economic geography) in Geography—The Secretary, Queen's University, Belfast (May 15).

Chair of Mathematics at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 18).

LECTURER IN EDUCATION at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 18).

LECTURER IN AGRICULTURE (Animal Husbandry) at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 21).

LECTURER (preferably able to teach mycology) IN BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 21).

COATS FELLOW (graduate in science of at least one year's standing of a British university) IN CHEMISTRY or PHYSICS, to undertake research in chemistry or physics (excluding nuclear physics)—The Clerk of Senate, The University, Glasgow, W.2 (May 31).

LECTURER IN VERTEBRATE ZOOLOGY at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, May 31).

LECTURER or ASSISTANT LECTURER IN EDUCATION at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

LEVERHULME STUDENT for research in CHEMICAL ENGINEERING—The Registrar, Imperial College, London, S.W.7 (July 1).

RADIATION LTD. RESEARCH FELLOW in gaseous fuels and combustion—The Registrar, Imperial College, London, S.W.7 (July 13).

ENGINEER or PHYSICIST (with a first- or second-class honours degree or equivalent in physics or engineering and preferably with a knowledge of modern computing methods) at the Ministry of Supply London Headquarters, to co-ordinate development work on high precision electromechanical and electronic control instruments and systems for guided weapons undertaken by government establishments and industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/6A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 950. Vol. 248 (26 January 1956): Effective Procedures in Field Theory. By A. Fröhlich and J. C. Shepherdson. Pp. 407–432. 8*s.* 6*d.* No. 951, Vol. 248 (26 January 1956): The Interaction of Two Identical Spherical Colloidal Particles. 1: Potential Distribution. By N. E. Hoskin. 2: The Free Energy. By N. E. Hoskin and S. Levine. Pp. 433–466. 10*s.* 6*d.* (London: Royal Society, 1956.) [311

Department of Scientific and Industrial Research Forest Products Research Bulletin No. 34: The Strength Properties of Timber: the 2-CM Standard for Tests of Small Clear Specimens. By F. H. Armstrong. Pp. iv+27+2 plates. (London: H.M. Stationery Office, 1955.) 2*s.* 6*d.* net. [311

The Cocoa, Chocolate and Confectionery Alliance in association with the Office International du Cacao et du Chocolat. Report of the Cocoa Conference held at Grosvenor House, London, W.1, 13th to 15th September, 1955. Pp. xiv+150+27 plates. (London: Cocoa, Chocolate and Confectionery Alliance, 1956.) 30*s.* [311

The Engineer Buyer's Guide. 1956 edition. Pp. 832. (London: *The Engineer*, 1956.) [311

Imperial College of Science and Technology (University of London). The Forty-eighth Annual Report of the Governing Body of the Imperial College of Science and Technology, 1954–1955. Pp. 81. (London: Imperial College of Science and Technology, 1956.) [311

The Rationalist Annual, 1956. Pp. 96. (London: C. A. Watts and Co., Ltd., 1956.) 3*s.* 6*d.* [311

The Study of Plant Anatomy. By Dr. D. J. B. White. (Modern Science Memoirs, No. 35.) Pp. 11. (London: John Murray (Publishers), Ltd., 1955. Published for the Science Masters' Association.) 1*s.* net. [311

Privy Council. Medical Research Council Special Report Series No. 290: Lung Function in Coalworkers' Pneumoconiosis. By J. C. Gilson and P. Hugh-Jones, in collaboration with P. D. Oldham and F. Meade. Pp. xii+266+15 plates. (London: H.M. Stationery Office, 1955.) 21*s.* net. [311

National Museum of Wales. Forty-eighth Annual Report, 1954–55. Pp. 64+4 plates. (Cardiff: National Museum of Wales, 1955.) [311

SS News Letter on Non-Destructive Testing. No. 1 (January, 1956). Pp. 11. (London: Solus-Schall Limited, 1956.) [311

British Electrical and Allied Industries Research Association. Technical Report V/T116: Bridge for the Measurement of the Admittance of Electrical Insulation at Very-Low Frequencies. By G. Mole and D. C. G. Smith. Pp. 11+12 figures. 12*s.* 6*d.* Technical Report L/T320: The Effect of Dipoles on Electric Strength. By H. Pelzer. Pp. 7+2 figures. 7*s.* 6*d.* (Leatherhead: British Electrical and Allied Industries Research Association, 1953 and 1954.) [311

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 3 (No. 19): The Late-Glacial History of the Highlands and Islands of Scotland. By Prof. J. K. Charlesworth. Pp. 769–928+1 folding map. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 42*s.* 3*d.* [311

Federation of British Industries. Fuel Economy Review. (34th year.) Pp. 122. (London: Federation of British Industries, 1956.) 5*s.* [311

Telling Industry's Story Overseas: a Guide prepared by the Publicity Committee of the F.B.I. to Channels available for Distributing Industrial Information Overseas. Pp. iv+61. (London: Federation of British Industries, 1955.) 3*s.* 6*d.* [32

Department of Scientific and Industrial Research. Working Metals by Electro-Sparking. By A. V. Nosov and D. V. Bykov. (An abridged translation from the Russian.) Pp. iii+66. (London: H.M. Stationery Office, 1956.) 5*s.* net. [32

International Tin Research Council. Annual Report, 1955. Pp. 36 (Greenford, Mddx.: Tin Research Institute, 1956.) [32

Ministry of Agriculture, Fisheries and Food: Fishery Investigations. Series 2, Vol. 20, No. 1: A Triple Frequency Echo Sounder. By D. H. Cushing and I. D. Richardson. Pp. 18+4 plates. 3*s.* net. Series 2, Vol. 20, No. 2: The Depth of the Wind-Produced Homogeneous Layer in the Oceans. By J. R. Lumby. Pp. 12. 3*s.* net. Series 2, Vol. 20, No. 3: Environmental Factors Governing the Infection of Mussels, *Mytilus edulis*, by *Mytilicola intestinalis*. By B. T. Hepper. Pp. 21. 3*s.* net. (London: H.M. Stationery Office, 1955.) [32

National Parks Commission. The Country Code for Visitors to the Countryside. Pp. 20. (London: H.M. Stationery Office, 1953.) 4*d.* net. [32

Liverpool Observatory and Tidal Institute. Annual Report, 1955. Pp. 15. (Liverpool: Liverpool Observatory and Tidal Institute, 1956.) [32

Map of Roman Britain. Third edition. Pp. 43+1 map. (Chessington: Ordnance Survey, 1956.) Paper, flat, 3*s.* 3*d.*; folded, with text 7*s.* 6*d.*; text only 3*s.* [32

Annual Report of the National Oceanographic Council, 1 April 1954–31 March 1955. Pp. v+38. (Cambridge: At the University Press, 1956.) 5*s.* net. [72

London School of Hygiene and Tropical Medicine (University of London), incorporating the Ross Institute. Report on the work of the School for the year 1954–1955. Pp. 128. (London: London School of Hygiene and Tropical Medicine, 1956.) [72

Other Countries

World Health Organization. Technical Report Series No. 99: Joint FAO/WHO Expert Committee on Meat Hygiene. First Report. Pp. 52. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 2 Swiss francs; 3*s.* 6*d.*; 0.60 dollars. [311

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi. 1: Kaniama (Haut-Lomami). A, B et C. Notice Explicative de la Carte des Sols et de la Vegetation. Par A. Focan et W. Mullenders. Pp. 53+8 photographs+3 cartes. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 150 Belgian francs. [311

Coryndon Memorial Museum. Occasional Paper No. 4: Reports on New and Little Known Insects from East Africa. Pp. 43+4 plates. (Nairobi: Coryndon Memorial Museum; Cambridge: Deighton Bell and Co., 1956.) 7*s.* 6*d.* [311

State of California: Department of Fish and Game. Marine Research Committee. California Cooperative Oceanic Fisheries Investigations—Progress Report, 1 July 1953 to 31 March 1955. Pp. 52. (Los Altos: Department of Fish and Game, Marine Research Committee, 1955.) [311

Journal of the Faculty of Science, University of Tokyo. Section 2: Geology, Mineralogy, Geography, Geophysics. Vol. 9, Part 3: The Ordovician Fossils from the McKay Group in British Columbia, Western Canada, with a Note on the Early Ordovician Palaeogeography. By Teiichi Kobayashi. Pp. 255–493+9 plates. (Tokyo: The University, 1955. Sold by Maruzen Company, Ltd.) 300 yen. [311

Proceedings of the American Academy of Arts and Sciences. Vol. 84, No. 1: Effects of Pressure on Binary Alloys. By P. W. Bridgman. Miscellaneous Effects of Pressure on Miscellaneous Substances. By P. W. Bridgman. Pp. 130. (Cambridge, Mass.: American Academy of Arts and Sciences, 1955.) 2.35 dollars. [311

Science Reports of the Society for the Research of Theoretical Chemistry. Vol. 1, No. 1 (December, 1955). Pp. i+13. (Osaka-fu: Society for the Research of Theoretical Chemistry, Kinki University, 1955.) [311

Jac. Berzelius: Brev till medlemmar av familjen Brandel om resan till England 1812 och till Frankrike 1818/19. Utgivna av Arne Holmberg. (K. Svenska Vetenskapsakademiens Årsbok för år 1955.) Pp. 38. (Stockholm: Almqvist and Wiksells Boktryckeri AB, 1955.) [311

Bulletin of the American Museum of Natural History. Vol. 108, Article 1: Revision of the Jurassic Ammonite Fauna of Mount Hermon, Syria. By Otto Haas. Pp. 210+30 plates. (New York: American Museum of Natural History, 1955.) 4 dollars. [311

Museum of Comparative Zoology at Harvard College. Breviora. No. 49: Three New Shark Records from the Gulf of Mexico. By Henry B. Bigelow, W. C. Schroeder and Stewart Springer. Pp. 12. No. 50: New Frogs of the Genera *Asterophrys* and *Oreophryne* from New Guinea. By Arthur Loveridge. Pp. 5 (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [311

The Market for Apples and Pears in O.E.E.C. Countries. Pp. 41. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 150 French francs; 3*s.*; 0.50 dollars. [311

Transactions of the American Philosophical Society. New Series. Vol. 45, Part 5: The Jātakastava or "Praise of the Buddha's Former Births". Indo-Scythian (Khotanese) Text, English Translation, Grammatical Notes, and Glossaries. By Prof Mark J. Dresden. Pp. ii+397–508. (Philadelphia: American Philosophical Society, 1955.) 2 dollars. [311

The Positive Contribution by Immigrants. (A Symposium prepared for Unesco by the International Sociological Association and the International Economic Association.) Pp. 203. (Paris: Unesco; London: H.M. Stationery Office, 1955.) 600 French francs; 12*s.* 6*d.*; 2.25 dollars. [32

Government Pressures on the Press (International Press Institute Survey No. 4.) Pp. 130+6 plates. (Zurich: International Press Institute, 1955.) [32

East Africa High Commission. East African Fisheries Research Organization Annual Report, 1954/1955. Pp. iv+40. (Jinja: East African Fisheries Research Organization, 1955.) [32

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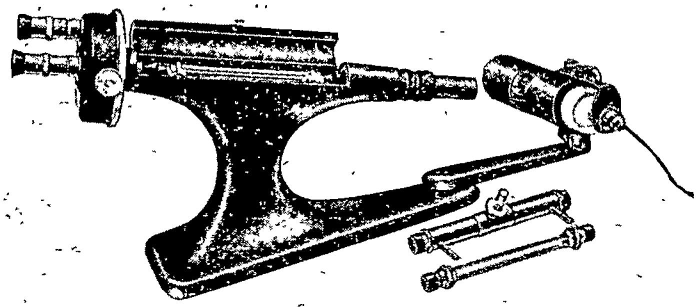

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COPYRIGHT AND SCIENTIFIC DEVELOPMENT

QUESTIONS of copyright were raised at the Royal Society Scientific Conference held in 1948, and in consequence the Council of the Royal Society issued in the following year a Declaration of Fair Copying, to which in the course of a few months more than seventy other societies and publishers in Great Britain had subscribed. The Copyright Bill*, which was read for the first time in the House of Lords on October 26 and after a lengthy examination in committee and on report received its third reading on March 22, is thus of special interest to the scientist and technologist. The Bill illustrates the complications which may arise out of the impact of technological advance and block attempts to adjust the law to the new conditions created. As the Lord Chancellor, Lord Kilmuir, explained in moving the second reading of the Bill on November 15, 1955, it is a comprehensive measure which, when enacted, will contain all the law of Britain on copyright matters. It will replace the Act of 1911, in which the British law of copyright was first codified, and three minor measures which were left unrepealed at that time; but it leaves unrepealed those sections of that Act (15 and 34) which relate to the receipt by certain libraries of free copies of books published in the United Kingdom. Those provisions are not matters of copyright and, as the Lord Chancellor said, are best dealt with otherwise than in a copyright statute.

The present Bill is designed to give effect to the report of the Copyright Committee, of which Lord Reading and Sir Henry Gregory were successively chairmen, issued in October 1952. In accordance with that report, the rights of an author, dramatist, composer or artist in his work are dealt with in one part of the Bill, while those rights given to other forms of copyright, such as sound recordings, broadcasting programmes and the like, are dealt with separately in Part II. So far as possible, the Bill also deals with the rights given to different kinds of works and the acts which constitute infringement in different sections; thus artistic works, for example, are dealt with in a different section from literary, dramatic and musical works—a procedure which, while promoting clarity, also makes the Bill longer and in itself extended the proceedings in the House of Commons.

Apart from restating the law of copyright in a different form, the Bill makes considerable changes in the present law. These, in the main, fall into two categories. First are those which will enable Britain to ratify two international conventions for the protection of copyright. In particular, by omitting the qualifications in the 1911 Act that during the past twenty-five years of the copyright life of a published work that work can be re-published as of right by any person who pays to the copyright owner the statutory royalty of 10 per cent, and the power of the Judicial Committee of the Privy Council at any time after the death of the author of a work which is being published or performed in public to over-ride any refusal of the copyright owner to permit re-publication, it will enable Britain to adhere to the revised convention of the Berne Copyright Union. The Copyright Committee in its report urged that the advantages of continued adherence to the Berne Union were overwhelming and greatly outweighed any disadvantages attending the repeal of these provisions. In particular, as was noted by Lord Conesford as well as the Lord Chancellor, the United States, which has hitherto abstained, has now signed and ratified the Universal Copyright Convention, and this came into force on September 16, 1955. Ratification of the Convention will therefore offer great advantage to British authors and publishers and to British export trade in books.

The second group of changes arises from the scientific advances which have been made in the fields of photo-copying, recording and broadcasting. It is here that the major difficulties arise, and the division of opinion which was manifested in the discussions in Parliament on the Bill was not entirely reconciled. Lord Kilmuir dealt first with the changes that have been required by the improvements in photo-copying, for example, microfilming. These provisions relating to the copying and publication of copyright works in libraries and archives are set forth in clause 7. Such methods have been of great advantage to students, but have placed libraries in jeopardy of actions for infringement. Lord Kilmuir said with justice that it would be helpful if statutory authority were given to libraries to provide methods for copying and also to deal with unpublished manuscripts, of which the ownership of the copyright might be unknown. He claimed that the clause was designed to help the student who needed photocopies for his own use, with the minimum of disturbance to the rights of the copyright owner, and that it also facilitated publication of ancient unpublished manuscripts in public archives where the copyright owner could not be traced.

The clause provides that the copyright in an article contained in a periodical publication is not infringed by making or supplying a copy of the article, if the copy is supplied by a library of a class prescribed by the Board of Trade by regulations made under the clause. The regulations apply solely to libraries not established or conducted for profit, and copies may only be supplied to persons who satisfy the librarian that they are required solely for private study or research, that not more than one copy of the same article is supplied to any one person, nor more than one article in any one publication is copied, and that the costs of production, including a contribution to the general expenses of the library, are met by the persons to whom the copies are supplied.

This clause thus gives force of law, by and large, to the Royal Society's fair copying declaration, but only so far as periodical literature is concerned.

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* Copyright Bill (H.L.) (As amended on Report.) Pp. 78. (London: H.M. Stationery Office, 1956.) 2s. 6d. net.

Copying from books is dealt with in separate subsections which cover the librarian of such non-profit libraries if he is unable by reasonable inquiry to identify the owner of the copyright in the book it is proposed to copy. It may be doubted, however, whether the Bill distinguishes any more clearly than the report the essential character of the scientist's need for copying. The Lord Chancellor, in moving the second reading in the House of Lords, spoke of the requirement to help those who contribute to the advance of the spiritual side of man, and at the report stage in particular Lord Mancroft, the Joint Parliamentary Under-Secretary of State for the Home Department, was most emphatic as to the need to respect the point of view of the author. Lord Mancroft, however, while alive to the importance of safeguarding the rights of students and of the libraries, was inclined to regard the rights and needs of the author of scientific and technical papers or books entirely in commercial terms, and his opposition to some of the amendments suggested by Lord Chorley was in consequence somewhat over-stated.

As Mr. Leslie Wilson pointed out, in commenting on the Copyright Committee's report (see *Nature*, 170, 1108; 1952), for the scientist, and often for the technologist also, publication is seldom a matter of commercial reward. The financial return, if any, is usually nominal, and the real profit is in the increase of his professional reputation. His interest runs very largely with that of science or technology itself in demanding as wide and free a circulation of his results as possible, and the real problem is that of securing for him and for the community the maximum advantage which inventions like microfilming offer in the way of scientific and technical communication, consistent with fair dealing to those who in the first instance took the responsibility and financial onus of publication. The element of cost has to be considered, but rather in relation to that of publication than in terms of the return to the scientist or technologist.

The question of fair copying requires consideration, in fact, in relation to the problem of scientific communication in general, and to those investigations which have recently been initiated by the Nuffield Foundation. As has already been emphasized, the rights and needs of the scientist or technologist who has written the book or article are closely related to those of the scientific or technical community of which he is a member. Indeed, it could be argued that without the facilities which Lord Chorley stressed, it would be difficult for the scientist or technologist to complete his paper or book, and there is more in the point that Lord Chorley made about the scientist and technologist having the maximum access to the materials he needs than Lord Mancroft was disposed to concede. In these days when costs of publications are mounting out of all proportion to the resources of most libraries, it can easily happen that only an industrial library can afford to subscribe to and file some particular periodical, or in a particular area purchase a very expensive monograph. Unless that library is legally entitled to provide a copy of a particular paper or passage, the scientist or the technologist may be put to an expensive and tedious journey to a distant part of the country, or be unable to consult the reference he needs.

Lord Mancroft rightly emphasized that, although industrial organizations often place their libraries freely at the disposal of scholars, access to them remains a matter of grace and favour. That must remain: they can never be on all fours with the libraries of public institutions and universities or public libraries; but the development of an adequate regional library system in which industrial libraries often already co-operate might well provide a way out of the difficulty. Lord Chorley's attempt to extend the clause to cover such libraries was defeated; but, as Lord Douglas of Barloch pointed out, Lord Mancroft did not really dispose of the argument or appreciate the place which the specialized libraries of industry have now come to occupy in the library resources of Britain.

A second point which occasioned some argument and difference of opinion in the House of Lords relates to the copyright of an article in a periodical. Under clause 4 of the Bill, as Lord Lucas pointed out at the second reading, if the article is commissioned, the copyright rests not in the author, as at present, but in the person who commissions the article. This clause was amended in committee to provide that the work should not be used for a different purpose or published otherwise except by express agreement between the author and the person commissioning the work. The amended clause, however, was challenged on the report stage by Lord Douglas as well as by Lord Chorley and Lord Faringdon, and their objections were not entirely removed by the assurances of the Lord Chancellor and Lord Mancroft.

What seems clear is that some far more fundamental thinking is needed about the impact of modern developments in photo-copying, for example, a scientific or technical communication, than is apparent in the drafting of this Bill. More is involved than questions of copyright and author's rights in fair copying, and it is unlikely that all difficulties will be removed by improvements in the law of copyright. It might have been expected, however, that the Government would be more aware of the practical needs and of the importance of such problems for technological and scientific advance. As it is, the Government appears to be as averse to facing the real issues in regard to the needs of the scientist or technologist as it has been in asserting the public interest against the restrictive practices of the Musicians Union, although the Bill as amended in the report stage deals more realistically with television and sound broadcasts.

Some concern was also expressed, both in committee and at the report stage, as to the effect of the Bill on the use of broadcasting and television in education. In the report stage on February 21, the Lord Chancellor moved the insertion of a new clause after clause 36 covering the use of copyright material for education, which he claimed represented a reasonable balance between the needs of schools and the rights of authors and composers. Quoting from Lord Jowitt's speech on December 1, he agreed that authors and composers have given us much that makes life worth living, and that we should be most careful not to erode their rights more than is necessary. As regards the performance of copyright works and copyright material, the Lord Chancellor said that it is necessary to limit the exception to schools; and although the amendment, as Lord Bridgman admitted, goes a long way to meet the points raised by the local education authorities, Lord Chorley and Lord Silkin expressed disappointment that university and adult education were not also included. Lord Chorley, however, had not sufficiently completed his inquiries to be satisfied that the point was of such importance in university teaching to put down a formal amendment, but there may well be some scope for further inquiry along the lines that have already been pursued at Bristol.

The complexity of the whole subject is indicated by the mere fact that in the nine days the Bill was before the House of Lords nearly three hundred and fifty amendments were considered and some thirty of these were down for the third reading. Some of these last went far to remove misgivings expressed throughout the earlier discussions. In particular, an addition to clause 7 places inter-library copying, so far as periodicals are concerned, on all fours with copying for students, and commercial libraries are not debarred from participating in such arrangements. Lord Mancroft, indeed, anticipated that such libraries would join in the general scheme, and that articles in out-of-print scientific periodicals would figure largely in the easier copying thus made possible. The controversial clause regarding television and sound broadcasts was also clarified during the third reading and was accepted by Lord Silkin as meeting the main objection of the critics.

In his concluding speech for the Government, Lord Mancroft was able to claim with justice that the clause affecting libraries, as now amended, gives librarians the powers that the Library Association told the Copyright Committee they needed. Any widening of these provisions, he held, could only be at the expense of the copyright owner. Lord Mancroft also claimed that the clause in no way hampers librarians in exercising any rights they may now have as a result of arrangements with publishers, such as the Royal Society's fair copying declaration, or with copyright owners. The clause simply gives librarians rights which they do not possess under the existing law, and the safeguards it provides for the copyright owner operate only when these new rights are being exercised.

The Bill is not a political party measure, and the debates in the House of Lords have considerably clarified many technical issues. Some, like the syndication of articles, as Lord Silkin noted, merit further discussion and could appropriately be discussed by professional bodies of scientists and technologists before the Bill is further considered in the House of Commons. What is clear, however, is that there is still much room for clear thinking and careful inquiry and experiment as to the place of such media as broadcasting and television in the communication of ideas and in research as well as in education, quite apart from the possibilities which photo-copying itself offers for the improvement of scientific and technological communications. The Copyright Bill is both a reminder that the law of Britain needs adjustment to the new conditions which scientific advance has brought, and a challenge to creative thinking about the possibilities and implications of new powers and processes and the way they can best serve mankind.

PLANT AND ANIMAL TISSUE CULTURE

Cultivation of Animal and Plant Cells

By Philip R. White. Pp. xi+239. (London: Thames and Hudson, Ltd., 1955.) 35*s*. net.

Dr. P. R. WHITE is one of the originators of plant tissue culture. In 1934 he announced the realization of unlimited cultures of isolated roots, and then in 1939 that of tumorous tissues. Since then he has been pursuing his research on the culture of animal tissues without having abandoned the plant domain. The originality of his work is well displayed in the volume under review.

This work is a technical manual which rises above a general level when comparing methods of culturing animal tissues with those for plants. The title does not correspond exactly with the contents, for the book deals not only with the culture of true cells (at least, animal cells) but also with tissues (cambial tissue, parenchyma), with organs (embryonic organs of animals, isolated roots) and even with plant embryos. The manual thus examines all types of cultures *in vitro*, with the exception of those concerned with adult animal organs, by methods derived from that by Carrel-Lindbergh.

White recalls first of all the philosophical origins of the culture method *in vitro*, and then summarizes briefly the subsequent history. This résumé, although schematic, is nevertheless lively. The succeeding chapters deal with techniques: how the same laboratory can be adapted for culturing plant, as well as animal, tissues; and how the rooms for preparing the media, the sterilization apparatus, the rooms for inoculation, etc., are identical. Against this, the culture materials differ significantly. Plant tissues are generally cultivated in vessels that are larger than those used for animal cells. Likewise, the instruments for manipulating them are more robust. However, specialists in the culture of plant tissues adopt in certain cases the 'roller-tube method' and the small humid chambers used for animal cells. As for the nutritive media, these also are different. For plant cells they are very simple, while for animal cells they are still based on plasma and chicken-embryo extracts. White insists on synthetic solutions devised by Fisher and himself for the culture of animal cells; but these solutions are more complex than those used for plant cells.

The principal chapters of the book are concerned with methods and the principal types of culture. The author gives concise instructions which ought to be sufficient for a research worker to obtain good results. The methods for animal tissues are considered apart from those for plant tissues, and the differences between them are made clear. Furthermore, White describes in an appendix several methods suitable for a beginner. A succinct chapter deals with measurements of growth, and the work finally ends with an appraisal of the possibilities of culture methods *in vitro*. This chapter does not pretend to cover the results obtained by this technique, but merely outlines the fields which are pertinent to it: nutrition, cellular metabolism, hormonal correlations, morphogenesis, pathology and even genetics.

Only a particularly competent specialist could write such a concise, and yet complete, book. This excellent work is very timely and will replace older manuals, which are henceforth rendered obsolete.

R. J. Gautheret

WASTAGE AND ITS CONTROL

Deterioration of Materials

Causes and Preventive Techniques. (A Collaboration under the Joint Auspices of the Services Technical Committee of the Department of Defense (Contract No. *N7onr*-29127) and the Prevention of Deterioration Center, Division of Chemistry and Chemical Technology, National Academy of Sciences—National Research Council.) Edited by Glenn A. Greathouse and Carl J. Wessel. Pp. xvii + 835. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1954.) 96*s*. net.

Reviewing a lengthy reference work of this kind might well have been a tiresome business, but for the fact that the authors of the various sections have been successful in presenting a wealth of information in a pleasantly readable manner. As might be expected when so much is packed into such little compass, the data themselves are, in many cases, too brief to be adequate; but, coupled with the copious references and bibliographies which are appended to the various chapters, they provide a valuable introduction to the many aspects of deterioration with which the book is concerned.

In his preface the editor directs attention to the estimate of 12 billion dollars annually as the cost to the United States from all forms of deterioration (excluding that of foodstuffs), a very great proportion of which is attributable to metallic corrosion. It is suggested that "almost any estimate is conservative, for rarely is it possible to put a price tag on man-hours used to combat deterioration". Thus there is ample justification for a book of this kind.

The book commences with a review of world climatic variations, the chemical and physical factors arising from weather conditions and changes and, to complete Part 1, a chapter on biological agents of deterioration; this is a fascinating section in which a reader is tempted to browse. The preservation of various classes of materials such as metals, wood, paper, textiles, leather, plastics, rubber and paint is covered in the next section. It may seem surprising to find paint in this section; but, as the author points out, his is the interest "of the individual who concerns himself with the deterioration of the coating itself", and his philosophy is that the battle against deterioration of a coated article is half won if "we build into the coating the inherent ability to protect itself". Protective measures for electronic, photographic and optical equipment gained much from the experiences of the Second World War, particularly from the problems which arose in connexion with the use of this kind of equipment in the hot, humid climate of the South Pacific.

The drying and maintenance of dry conditions, packaging and the effects of toxins not only on moulds, bacteria, etc., but also as dermatitic agents, form the subjects of the concluding section. Attention is directed to the increasing use of preservatives and toxins for a wide range of materials and the consequently greater exposure of the general population to intimate contact with many complex chemicals. It is suggested that, until a proper evaluation of their toxicological properties has been established, such materials should all be regarded as potential health hazards. Finally, there is a guide to the complexities of United States specifications, including an explanation of the various codes used.

Among the various chapters, by twenty-four different authors, there is some unevenness of presentation both as to style (as would be expected) and also as to intensity of treatment. Nevertheless, the overall result is good, the book is well produced and many of the illustrations are most impressive. Each section concludes with comprehensive references both to the subject-matter in the text and to relevant publications. It is mainly concerned with the American scene; but many of the recommendations and lines of advice have a much wider application, and if followed will undoubtedly lead to the avoidance of very considerable wastage.

NEUROCHEMISTRY

Biochemistry and the Central Nervous System

By Prof. Henry McIlwain. Pp. vii + 272. (London: J. and A. Churchill, Ltd., 1955.) 40*s*. net.

With the exception of a few honourable but isolated instances, the quantitative study of cerebral metabolism was sadly neglected until the end of the Second World War. More recently, biochemical studies on the brain have proceeded apace in a number of centres, and from Prof. Henry McIlwain's laboratory at the Maudsley Hospital, London, have emerged a series of stimulating papers on the subject. It is fitting, therefore, that Prof. McIlwain should have now written a book which is both a survey of past achievements and a welcome analysis of trends in contemporary research.

The individual chapters are compact summaries of the more important aspects of brain biochemistry. After a section on the overall metabolism of the brain *in situ*, the author gives a comprehensive survey of the experimental work carried out on the labile constituents of brain tissue and their relation to cerebral activity *in vivo*. Then follows a detailed account of the information obtained from studies on the metabolism of brain tissue *in vitro*. A careful distinction is made between the results obtained with cell-containing systems (for example, cortical slices) and those obtained with cell-free systems (for example, homogenates and extracts). Other metabolic features of particular significance in the functioning of the nervous system also receive attention. Such diverse topics as the role of the vitamins and the biochemistry of the transmitter substances are treated in a manner which underlines the fundamental relationship between metabolism and function.

The reader becomes rapidly aware, however, that, whereas the chemical transformations of carbohydrates and phosphate esters in nervous tissue are known in considerable detail, information about the metabolism and function of the lipids and proteins (which constitute the greater part of the dry weight of the tissue) is sparse. The link between the metabolism of these large molecules and the activity of the brain is a rich field for future study.

Consistent with the broad view taken of his subject, Prof. McIlwain does not hesitate to discuss biochemical lesions associated with nervous dysfunction; the relevant biochemical characteristics of phenylpyruvic oligophrenia and Wilson's disease are among the topics included in the book.

Apart from the rather frequent use of sub-headings, the lay-out of the book is good and the list of references to original papers at the end of each chapter a considerable asset. The index comprises 10 per cent of the total number of pages and is exhaustive. One of the sentences on p. 238 must be a misprint, and a reference to a non-existent table occurs on p. 239. Students of biochemistry and physiology will find the book a most helpful guide to the intricacies of cerebral metabolism.

G. B. ANSELL

PHYSICS FOR THE ORGANIC CHEMIST

Determination of Organic Structures by Physical Methods

Edited by E. A. Braude and F. C. Nachod. Pp. xiii+810. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 15 dollars.

THE extent to which publishers, particularly in the United States, encourage the production of costly monographs on specialized techniques of physical chemistry is now quite disturbing; the comprehensive collection of such books is getting beyond the scope of many chemical departmental libraries in Britain, since consideration must be given to the high probability that their subject-matter may rapidly get seriously out of date. A summarizing volume on modern techniques of physical chemistry, written so as to give weight to methods of permanent value, is thus welcome, and the editors of this book deserve thanks for the way in which they have organized the collected work so as to describe essentially the principles involved and the scope of the results obtainable by applying various types of physical measurements in the elucidation of the structures of organic molecules, wisely advising that detailed accounts of particular apparatus are given literature citations only.

The book is made up of three parts, totalling sixteen chapters, and Part 1, "The Determination of Molecular Size", consists of two chapters on the phase properties of small molecules (H. F. Herbrandson and F. C. Nachod) and the equilibrium and dynamic properties of large molecules (P. Johnson), respectively. In Part 2, "The Determination of Molecular Pattern", there are five chapters: optical rotation (W. Klyne); ultra-violet and visible light absorption (E. A. Braude); infra-red absorption (R. C. Gore); Raman spectra (F. F. Cleveland); and magnetic susceptibilities (C. A. Hutchison). Part 3, "The Determination of Molecular Fine-structure", contains nine chapters on the following subjects: surface films (E. Stenhagen); dipole moments (L. E. Sutton); electron diffraction (J. and I. L. Karle); X-ray diffraction (J. M. Robertson); microwave spectroscopy (E. Bright Wilson and D. R. Lide); thermodynamic properties (J. G. Aston); dissociation constants (H. C. Brown, D. H. McDaniel and O. Häfliger); reaction kinetics (E. A. Braude and J. M. Jackman); and wave-mechanical theory (C. A. Coulson).

The names of the various contributors suffice to indicate the high quality of each section of the work. Many chapters are model essays on their subjects, delightfully readable and admirable for the breadth of their outlook. One can, however, note great differences in the extents to which individuals have visualized the problems which the organic chemists of to-day regard as matters of elucidation of molecular structure. The extremes are the chapters on applications of optical rotation measurements and on visible and ultra-violet absorption spectra and that on applications of wave-mechanics. The former two, written by experimental organic chemists, both show how physical data are of crucial value in determining the configurations of complex organic molecules of all shapes and types, with examples chosen from studies of natural products of recent interest, while the latter deals only with exact bond-lengths and electron distributions in aromatic systems—a topic which to an organic chemist has interest only in connexion with chemical reactivity.

Chapters that deal adequately with the applicabilities of their techniques are those on surface films, dipole moments, X-ray diffraction, magnetic susceptibility and thermodynamic properties. Of these, the last is noteworthy for the way in which it shows the significance of theoretical calculations in relation to conformation problems. The chapter on infra-red spectroscopy is too brief to give more than the physical background of the subject and fails to show its scope. Those on Raman and microwave spectroscopy and on electron diffraction are again highly physical, specializing on geometrical details for quite simple molecules; but of course the scopes of these techniques are essentially limited to the domain of true physical chemistry.

The long chapter on dissociation constants is over-detailed and yet tends to assume that the reader is already acquainted with both past and present theories of chemical polarity and steric hindrance. Again, the essay on chemical kinetics, in attempting to illustrate too wide a subject, assumes a background knowledge of mechanisms of organic reactions. The need for this whole chapter may be questioned, for at the present time most investigators of the kinetics of organic reactions use knowledge of molecular structure to explain details of their reaction mechanisms and not the reverse (for example, in kinetic studies of isotope replacement). In the examples given, the writers do not give due warning of the serious errors that can so easily be made by assuming that any one reaction mechanism has general validity, but do bring forward the main correlatory schemes of proved value.

Considering the extent to which each contributor has had to curtail his subject-matter to his allocated space, the wealth of information of permanent value, the excellence of its typography and, above all, its readability should ensure the book's success.

W. A. WATERS

A Monograph of the Clingfishes (Order Xenopterygii)

By John C. Briggs. (Stanford Ichthyological Bulletin—Volume 6 complete.) Pp. iv + 224 + 114 figures and 15 maps. (Stanford, Calif.: Natural History Museum of Stanford University, 1955.) 4 dollars.

The clingfishes are an order of small teleosts with an adhesive thoracic disk supported by elements of the secondary shoulder girdle and the pelvic fins. While they have no spinous rays, except perhaps in the pelvic fins, features such as the number and arrangement of the branchiostegal rays suggest that the clingfishes have sprung from a spiny-finned (percomorph) stock. But this relationship is surely not "obvious", as is stated on p. 7 of this monograph.

As a result of Mr. John C. Briggs's comprehensive survey, this order is seen to consist of ninety-three species, which can be readily arranged into eight subfamilies of the family Gobiesocidae. Twenty-one new species are described and thirteen new genera proposed, which is some measure of how little was known of these fishes, but also of the importance of this valuable, well-illustrated monograph. But Mr. Briggs's main purpose was to trace ". . . inter-relationships—hence the course of evolution—within a well-defined group of fishes, in so far as this is possible by systematic revision of a group in which fossil evidence is not available". Evolutionary trends have been followed by studying particularly the respiratory complex, the single or double nature of the adhesive disk, and the arrangement and form of the teeth. The conclusions on phylogeny are presented in the form of dendrograms—three-dimensional family trees. But in the present work, at least, it is difficult to see any particular advantage in this type of figure.

Except for certain species of *Gobiesox*, all clingfishes are marine, occurring in the coastal waters of the tropical and warm-temperature regions. In the section on distribution which concludes this monograph, two particularly interesting features emerge. The New Zealand clingfish fauna of eight species covering seven genera would seem to consist of endemic relicts, and the sub-family Gobiesocinae is not entirely confined to the New World: there is one species in South African waters.

N. B. Marshall

Theory of Ordinary Differential Equations

By Prof. Earl A. Coddington and Prof. Norman Levinson. (International Series in Pure and Applied Mathematics.) Pp. xii + 429. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64*s*.

Ince's standard treatise, "Ordinary Differential Equations", is now nearly thirty years old, so there is room for a book in English which should revise some of Ince's exposition in the light of modern methods, and extend the field of study to include an account of recent work of importance. This has been accomplished by the present authors, in a terse, compact, closely woven volume; the style is clear but stiff, and the book could scarcely be tackled by even a good honours student before his third year. The language of matrices is employed throughout, and the intending reader must be well acquainted with this language.

After two chapters on existence and uniqueness theorems, there are ten on the linear equation, with a discussion of systems with isolated singularities, and a very thorough treatment of eigen-value and boundary-value problems, singular and non-singular, self-adjoint and non-self-adjoint. The remaining five chapters supply a firm base from which to attack the important topic of non-linear mechanics, on which so much original work has been done during recent years. Asymptotic behaviour, perturbation theory and topological methods lead the reader to the focus of much present-day research; he should derive much profit from this very forward-looking volume. But he should not neglect the problems attached to each chapter; some of these are quite straightforward, but others, adding to and generalizing the text, may present a severe test of understanding. Altogether, this is a noteworthy addition to the McGraw-Hill International Series in Pure and Applied Mathematics.

Fuel

Solid, Liquid and Gaseous. By J. S. S. Brame and Dr. J. G. King. Fifth edition, rewritten by Dr. J. G. King. Pp. xii + 551. (London: Edward Arnold (Publishers), Ltd., 1955.) 50*s*. net.

It is good to see a new edition of this very useful book, especially as the previous edition was published twenty years earlier. As might be expected such a gap has made necessary the almost complete rewriting of the text, which has taken account of the changes and developments that have occurred in fuel technology in the period concerned.

It is emphasized in the preface that the book deals strictly with the properties of fuels and their methods of application, and not with details of processes of production or utilization of fuels. Nevertheless, there is a lot of helpful information on the latter aspects.

For those unfamiliar with the book it will be necessary to indicate the general scope in a little more detail. The main chapters treat the essential properties of fuels, classification of solid fuels, and give considerable consideration to the classification and composition of coal, followed by discussion of its storage and preparation, carbonization and use for generating steam, power and heat. Next are given details of the various liquid fuels used for heating and power production. There are then three chapters on gaseous fuels, one on fuel analysis, and another on determination of calorific value. The final chapter is concerned with fuel efficiency. At the end of each chapter there are references to further reading.

The volume is of attractive appearance; the matter is well expressed and well printed on good quality paper, with clear illustrations, and at present prices is very good value. It can be recommended as a very sound text-book.

Fifty Years of Birdwatching

By A. M. C. Nicholl. Pp. xx + 127 + 12 plates. (London: John Murray (Publishers), Ltd., 1955.) 12*s*. 6*d*. net.

Mr. A. M. C. Nicholl is well known as an expert bird-photographer, and he has illustrated this volume of bird reminiscences with some fine examples of his skill with the camera; but this is not a picture book, the illustrations being secondary to the text, which deals with the author's experiences down the years. In a pleasant and chatty manner Mr. Nicholl tells us of much that he has seen and done, often giving us vivid pictures of the English scene and its wild life, coupled with many a shrewd observation on birds and their behaviour.

Frances Pitt

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

PROPOSED EXPANSION SCHEME

Introduction by the College

THE Imperial College of Science and Technology, a school of the University of London, is made up of the Royal College of Science, the Royal School of Mines and the City and Guilds (Engineering) College. It has occupied buildings in South Kensington since 1872. Its present number of students is more than two thousand, of whom some 1,300 are concerned with technology, mainly engineering.

In January 1953 the Government asked the College to raise its student numbers (then 1,650) to 3,000 by 1962. The national need for more highly trained scientists and engineers was urgent then and is more so to-day. Recent statistics have emphasized Britain's deficiency in relation to the Soviet Union, where engineers at graduate level now leave universities and institutes at the rate of 60,000 a year, compared with 22,000 in the United States and 3,000 in Great Britain. For the purpose of the expansion the College was asked to plan on the basis of its taking over the island site, that is, the rectangle south of Prince Consort Road, bounded by Exhibition Road, Queens Gate and Imperial Institute Road.

The decision that the expansion of the College should occur at South Kensington has been generally but not universally approved. Some critics have suggested that a move into the suburbs or the country would have been preferable. This alternative was thoroughly investigated by the College between 1951 and 1953 and, in the end, there was unanimity in favour of expanding in South Kensington. The worst fate which can befall a university institution is to be split for any substantial period between two sites which are far apart. If, therefore, the expansion was to take place outside South Kensington, it would have been essential for the College to give up its existing premises. The difficulty of finding a suitable site of adequate size in the suburbs or near London was very great. Moreover, to build so large an institution in the country would have increased the capital cost enormously through the need to provide so much new residential accommodation. These were important reasons; but the decisive factors were that expansion in South Kensington enabled the College to retain and develop its close ties with the University, with the learned societies and professional institutions, and with the world of science, technology and industry. The decision, taken three years ago, was clearly right and has already led to the investment of nearly £1 million in new buildings on the site.

There is another reason for the College remaining and expanding in South Kensington. The surplus funds of the Great Exhibition of 1851 were invested in the purchase of the land which runs south from Kensington Gardens, on the frontage of which the Royal Albert Hall was built later; the Commissioners for the 1851 Exhibition were charged with the duty of using their resources "to increase the means of Industrial Education and extend the Influence of Science and Art upon productive industry". The use of the island site by the College is clearly in line with this requirement and with the intentions of the prime mover in these matters, the Prince Consort, who was indeed the founder and first president of the College.

The College drew up the academic plan for its expansion in 1953. On the basis of this plan it was calculated that the floor area required would be a little more than 1,800,000 sq. ft. gross (that is, including corridors, lifts, staircases and other similar space). This would give a provision of space per person of about 340 sq. ft. (gross) or about 500 sq. ft. per student. This represents an improvement on the crowded state of affairs during 1952–53, but is some way below the space available before the War (1938–39). Space requirements vary greatly according to technical equipment and these are average figures. The calculations also have to take account of the fact that postgraduates need more space than undergraduates, and that the College has the highest proportion of postgraduates of any college or university in Britain. Of the total requirement, about 340,000 sq. ft. can be provided off the rectangle by adaptations to existing College buildings in the Beit Quadrangle and the Royal College of Science building south of Imperial Institute Road. This leaves about 1,460,000 sq. ft. to be found on the island site itself.

The space is to be used as follows. Very large requirements are needed for the engineering departments, the total floor space of which will rise to about 750,000 sq. ft. Science departments, including their technological sub-departments, will rise to 500,000 sq. ft., and mining departments to 175,000 sq. ft. The College's policy is to provide a central building which will contain the common rooms, refectories, libraries and similar units; also a Great Hall. It is clear that there will be no room for residential buildings on the island site; these are to go nearby.

There are certain limitations which have to be taken into account in the planning. First, there are the normal town-planning requirements: the density of population, the angles of light between buildings, fire precautions, a sufficient area for circulation, and so on.

Next come certain special limitations: (1) It is essential that the College should be kept running during the total operation. (2) One of the largest existing buildings is more than seventy years old, and clearly near the end of its useful life; its demolition will have to be carried out as a carefully planned operation, with a progressive moving of the departments concerned into new buildings or transit accommodation. (3) It has been decided to leave intact the Royal School of Mines building and the Goldsmiths' Extension of the City and Guilds College. (4) The Royal College of Music is to be left undisturbed. (5) The development of the south-western part of the site is obscure as it contains private residences not in the College's possession. Moreover, following a request from the Royal Fine Art Commission, in 1955, the College has undertaken to preserve on æsthetic grounds the Norman Shaw house at the junction of Queens Gate and Imperial Institute Road.

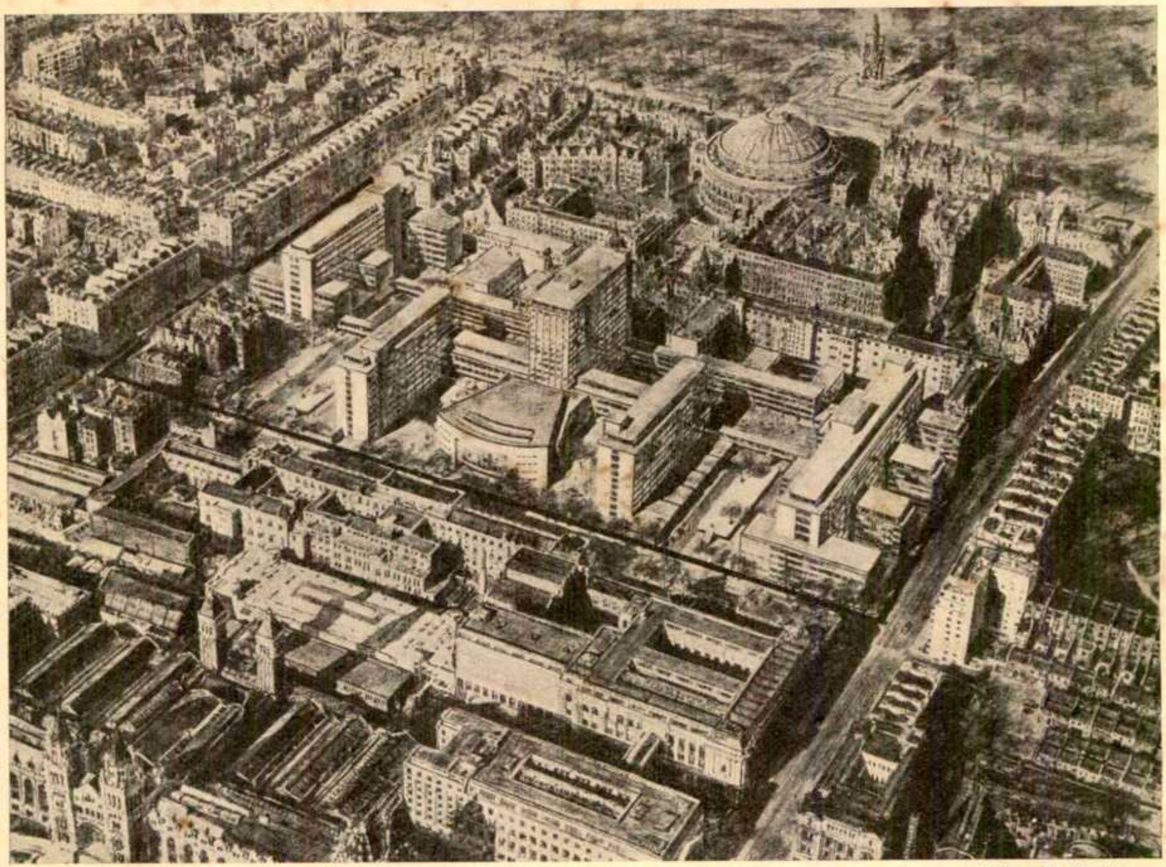

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Fig. 1. Aerial view of the proposed expansion scheme for the Imperial College of Science and Technology, London, from the south-east. Due north is the round dome of the Royal Albert Hall facing the Albert Memorial in Kensington Gardens. Due south is the British Museum (Natural History), showing its four towers. Between this and the proposed new buildings is the Royal College of Science. To the east of the British Museum (Natural History) is the Geological Survey and Museum, and to the north of this is the Science Museum. Exhibition Road passes across the lower, right-hand corner

Messrs. Norman and Dawbarn were appointed architects for the new buildings on the island site in 1953. Mr. Graham Dawbarn presented his plan for the island site at the end of that year and it was afterwards submitted to the University and the University Grants Committee. Detailed drawings have since been made of the buildings to be erected first. The plans have been submitted to the Royal Fine Art Commission, and the 1851 Commissioners. They are now before the Town Planning Committee of the London County Council.

Description of the Scheme by the Architects

The basic scheme to implement the academic requirements of the College on the proposed site was prepared at the end of 1953 and the beginning of 1954. It is this basic scheme indicating the circulation and the general size and massing of the buildings that is illustrated by the model. Since it was made, the model has been altered only in the south-west corner to show the permanent retention of the Norman Shaw house (170 Queens Gate) and the retention for an unknown period of a block of residential property adjoining it (Fig. 2).

Three buildings, all adjoining the northern boundary of the site, are excluded from the new development: the Royal School of Mines and the Goldsmiths' Extension; the Chemical Engineering Building to which a new building—to be known as the Roderic Hill Building—is now being added for that department and for Aeronautics; and, between the two, the Royal College of Music.

The Royal School of Mines and the Goldsmiths' Extension, to which a story has recently been added, is providing essential accommodation and its removal cannot be contemplated in the foreseeable future. The Chemical Engineering Building was erected before the War; the Roderic Hill Building is now nearing completion on foundations that were formed some years ago.

The Royal College of Music, which is between the two, is fulfilling a valuable function and has one of the best concert halls in London. The wings that project on either side of it would strictly limit the height and size of any new building on its site. In the distant future it may perhaps be possible to remove it and form a sunken garden on the axis of the steps from the Albert Hall with colonnades at its southern end opening up vistas beyond; if so, drastic treatment will be required to the wings on either side.

The academic requirements necessitate very large buildings. Owing to their uses they are, in fact, large in comparison with their population. While ground space is invaluable in connexion with heavy workshops and other technical needs, some of the buildings must, to achieve the required accommodation with a measure of expansion, be very high.

The object of the Imperial College is not only to train scientists and technologists but also to form a base for education in its broadest sense. This, in London, can best be fulfilled by the students mixing among themselves and the academic staff in debate, in committee, in common rooms and refectories, and in physical and mental recreation all within the site.

The scheme, to achieve its full purpose, should be gracious and open, with sun and air penetrating the buildings and the spaces between them, with vistas from without and within, with large courts, trees, lawns, sculpture and murals so as to create an environment that will bring pride and pleasure to the occupants and to the passers-by, with 'movement' in the skylines and an avoidance of monotony and overshadowing.

The Royal College of Science building, which is to the south of Imperial Institute Road, is part of Imperial College and should be brought into the scheme. Some four or five thousand people will occupy the buildings and others will visit them. There must be adequate provision for car-parking and for vehicle circulation as independent as possible from pedestrian movement.

The buildings themselves should express their purpose and should serve future as well as present needs. They should be so flexible as to permit, over the years, changes in user and a measure of expansion within the scope of the scheme. These requirements make necessary the application of the most recent advances in structural and mechanical design and in the proper use of contemporary materials.

The site lies between relatively wide flanking roads, and a basically symmetrical layout has been found most suitable. The layout consists essentially of five 'spine' blocks, all running from north to south (Fig. 2).

Four of these blocks are 120 ft. high. The spines of the outer east and west blocks are set back some 80 ft. from Exhibition Road and Queens Gate respectively, with, between spines and roads, a series of lower spurs separated by gardens and paved terraces. The central block is 200 ft. high with low wings on either side, and, at its southern end, a Great Hall.

This orientation, coupled with the wide spacing of the high blocks, permits maximum penetration of sun and air, and provides vistas from south to north.

The rise of the flanking roads assists the segregation of vehicles from pedestrians. All vehicles approaching the College enter Imperial Institute Road, which it is hoped will be absorbed as a precinct as shown on the layout drawing and model. They then circulate through the courts and can make use of four traffic lanes. Parking is at the same level; partly in the open and partly under terraces and decks.

Pedestrians enter from Exhibition Road and from Queens Gate by terraces some 85 ft. wide (Fig. 3). They either enter these blocks or pass under them to emerge on to decks above covered parking, facing the central block. From these decks, bridges seventeen feet above the traffic flow lead to the inner blocks and thence on to covered decks which join a central concourse and also open on to the terraces on either side of the Great Hall.

The site has been opened-up to provide a variety of views and vistas. People travelling north along Exhibition Road, after passing two gardens, look through the pedestrian entrance under the spine of the east block to the central block more than 500 ft. away.

From Prince Consort Road, broad steps just west of the Roderic Hill Building look south past the west bridge to the precinct; one day a corresponding vista may be possible through the Royal School of Mines. If the Royal College of Music is ever pulled down and the site turned into a garden there will be views into the east and west courts on either side of the bastion formed by the north end of the central block—a suitable place for sculptural adornment.

The main blocks (excluding the central one) will all be devoted to teaching and research. The nucleus,

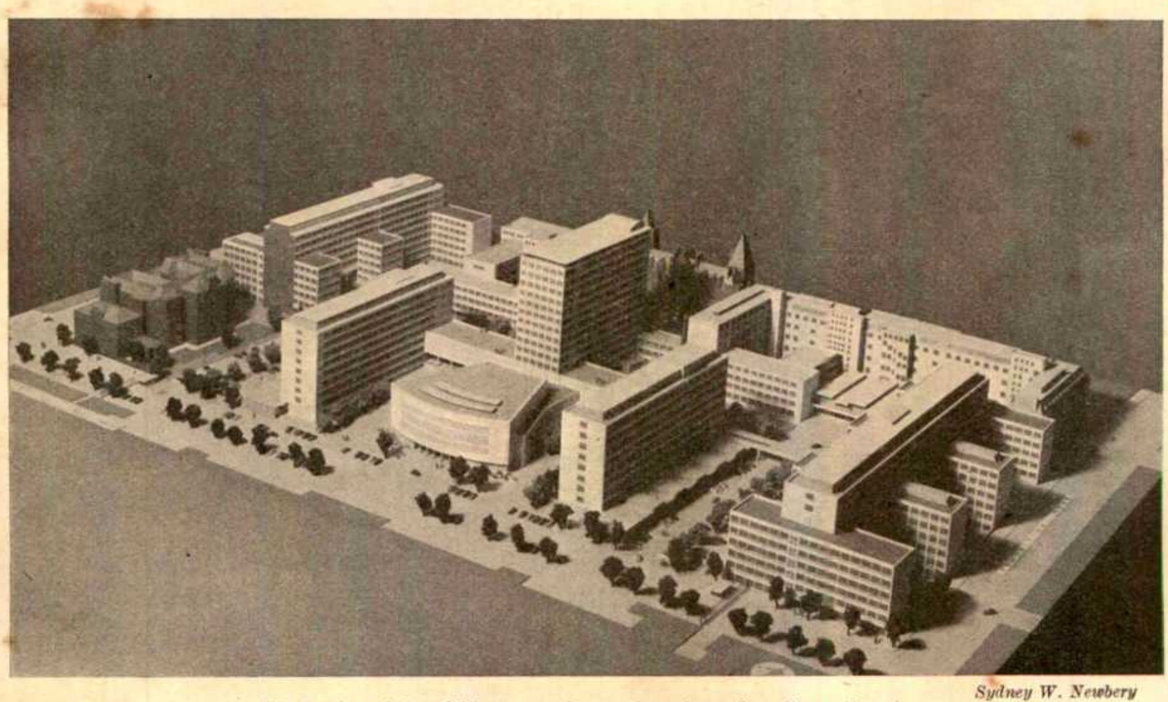

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Fig. 2. Amended model for proposed expansion scheme, from the south-east. The Royal College of Music (with two towers) is on the north side

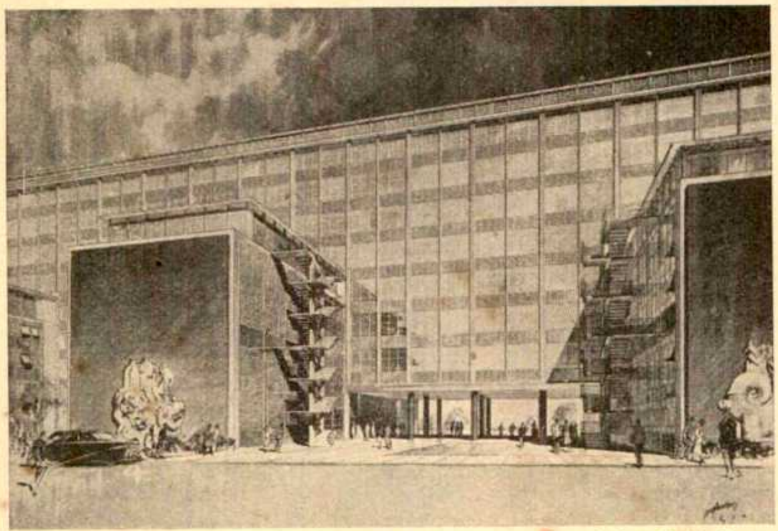

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Fig. 3. Pedestrian entrance for exhibition rooms

composed of the central block with its wings and Great Hall, contains those elements which distinguish university life from technical training. The greatest stress is laid on the fact that these are readily accessible and that libraries, reading rooms, administration, committee rooms, debating halls and facilities for physical recreation adjoin common rooms, cafeterias and refectories. The intimate link between the departments and nucleus might later be extended to the Royal College of Science by means of bridges over the precinct and by covered ways down the edges of the low workshops which are part of the inner east and west blocks.

The nucleus may well serve three or four thousand people at one time. The covered decks under the wings (each some 55 ft. by 120 ft.) contain shops and connect directly with a large common room and with a central concourse within which lifts, escalators and staircases lead to all the components mentioned above. Cloak rooms and sanitary accommodation are necessarily included on a considerable scale ; a number of changing rooms and facilities for physical recreation are placed on the lower levels.

The Great Hall is connected with the central block at each of its several levels, but it also has entrances off the precinct and off the terraces to east and west. These terraces are open to the south and are paved for pedestrian use with groups of flowers and shrubs. They rise, by a slight gradient culminating in broad steps, from the vehicle-level of the precinct to the pedestrian-level of the covered decks. The Hall can be used either independently or as part of the College.

The model represents a basic conception. This conception still holds ; but is subject to constant analysis, development and refinement. The illustrations which accompany this note express different periods of the evolution and some or all will be amended.

The most advanced work has been done on the outer east and west blocks, which have now been designed in some detail. The remaining buildings have been planned diagrammatically to small scale but have not yet been brought to a stage at which various approvals can be obtained and working drawings started.

The Great Hall, originally planned to hold three thousand, is to be altered ; one or more smaller halls will now be provided together with other accommodation. In the southern courts, studies are in progress for providing gardens opening off the pedestrian bridges above parking areas.

MODIFICATION OF RADIATION-INDUCED GENETIC DAMAGE

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THERE have been many discussions of the genetic effects of ionizing radiation ; and it has often been assumed that the amount of genetic damage is determined inevitably by the amount of radiation. However, in certain circumstances, it is now possible to modify experimentally the amount of genetic damage caused by a given dose of ionizing radiation. Practical applications of this work to human hazards cannot be expected for some time, and the difficulties in predicting the eventual extent of the application are great. Nevertheless, the progress has been sufficient to warrant some optimism. For this reason, it seems worth while to review the major progress that has been made and to suggest directions in which future progress might be anticipated.

At the start, it must be emphasized that the damage done to the genetic material of the cell, the chromosomes, is a hazard not only to future generations but also to the irradiated individual himself. In fact, there are workers who think that chromosomal damage is the cellular basis of all, or nearly all, the symptoms characteristic of over-exposure to radiation. The matter is still the subject of controversy[1], but it seems almost certain that procedures that reduce chromosome damage will also reduce certain types of damage to the body as a whole.

Protective Procedures

A number of protective procedures have been developed against radiation death in micro-organisms and mammals[1-3]. This work is more extensive than that on known genetic effects, and at least some of the procedures probably act by protecting against genetic damage to the cells. Therefore, it was thought desirable to review some of the important findings as background for the genetic work.

One of the most widely used experimental means of modifying radiation sensitivity is hypoxia. If oxygen tension is decreased to below normal, the sensitivity of the organism to X- or gamma-radiation often decreases proportionally to the decrease in oxygen concentration. There is little change in sensitivity with increase of oxygen tension above normal. Thus the lethal dose (*LD*50) for mice can be changed from about 600 r. to more than 1,000 r. by putting them in an atmosphere of 5–7 per cent oxygen during irradiation[4]. This technique is not readily applicable to man because of the serious consequences of hypoxia. However, the oxygen effect is of great theoretical importance, because it indicates that there are chemical steps between the absorption of the X- and gamma-radiation and the biological damage, and these steps are subject to modification. There appears to be, at most, only a slight oxygen effect with heavy-particle irradiation.

Certain chemicals can be used to reduce the oxygen concentration. One of the most effective is sodium dithionite ($Na_2S_2O_4$), which has a strong affinity for oxygen. This compound protects micro-organisms but is toxic for mammals. One of the first compounds found to protect against death in mammals was cysteine[5], with which it is possible almost to double the *LD*50 for mice. Its protective action can be prevented by keeping animals under a slight positive pressure in high oxygen concentration[6]. This suggests that the chemical may act by decreasing the oxygen concentration in the tissues, though other suggestions have also been made[1].

A number of other compounds (glycols, glucose, succinate, alcohols) cause cells to use up oxygen by stimulating metabolic consumption. These give some protection to micro-organisms and somewhat less to mammals. Their value for protection of mammals does not seem great since they have to be present in fairly high concentration, which may be toxic. Although dangerous to use, compounds that slow down respiration, reduce blood flow, or produce methæmoglobinæmia also have some protective action for mammals, by reducing oxygen concentration in the tissues.

Of a large number of compounds reported to be more or less protective, three seem to have some promise of practical use: namely, cysteine[5], β-mercaptoethylamine (cysteamine)[7], and S,β-aminoethyl*iso*thiuronium·Br·HBr[8]. All three compounds possess both an —NH_2 group and an —SH group. The presence of both groups, separated by no more than three carbons, has been shown to be very effective[8]. The toxicity of cysteine and cysteamine at the maximally protective concentrations in mammals reduces their usefulness as protective agents. Furthermore, solutions of either are unstable to oxidation. In these respects, S,β-aminoethyl*iso*thiuronium·Br·HBr now appears, at least from studies in this Laboratory, to be the most promising. It is a stable crystalline material, and is effective when given intraperitoneally, intramuscularly, or orally. However, the compound is still sufficiently toxic to warrant considerable caution in its use, especially since most of the results have been obtained with mice. The search for compounds of the same protective power as S,β-aminoethyl*iso*thiuronium·Br·HBr and still lower toxicity is in progress. At least several years work will be required to settle questions pertinent to human application.

Recovery Phenomena

A modest amount of progress has been made during the past few years in finding means of helping the living organism to recover from radiation damage. Such recovery is a normal process, as was learned years ago by noting that mice could tolerate higher amounts of radiation if fractionated instead of single exposures were used. This applies to both lethal and non-lethal physiological effects. It is not certain whether there is actual recovery of damaged cells or simply recovery of the body from the effects of the cell death.

Survival from radiation damage in *Escherichia coli* can be increased if the bacteria are kept, after exposure, at suboptimal temperatures, especially in the presence of certain complete media[9]. These reduced temperatures slow down cell division but still allow some enzyme activity. One interpretation is that cell division utilizes so much of the enzymes and nutritional resources of the cell that the cell cannot synthesize enough of the essential compounds to sustain life. If the cell is permitted to replenish its enzyme supply and redevelop the mechanism of enzyme production before cell division is initiated, then the cell can recover from radiation damage. Evidence for this view is that the cells have a recovery requirement for certain types of extracts, such as yeast or spleen. However, other interpretations are still possible.

Post-irradiation procedures that have proved successful in mice are the transplantation or injection of spleen[10] and injection of bone marrow[11]. The treatment apparently acts by causing the damaged blood-forming tissue to recover; but it is not clear how much of the recovery is brought about by some material given off from the injected tissue and how much by direct replenishment of cells from the transplant. Evidence for functional inter- and intra-species transplantation of bone marrow from unirradiated into massively irradiated animals has been obtained by D. L. Lindsley, T. T. Odell, jun., and F. G. Tausche (*Proc. Soc. Exp. Biol. and Med.*, **90**, 512; 1955); C. E. Ford, J. L. Hamerton, D. W. H. Barnes and J. F. Loutit (*Nature*, 177, 452; 1956); and T. Makinodan (*Proc. Soc. Exp. Biol. and Med.*, in the press). However, this evidence, though suggestive, does not exclude a non-cellular recovery factor from consideration.

Many attempts have been made to isolate specific recovery substances from non-irradiated tissues; but, in mammals, no effect on recovery has been found. However, in bacteria, cell-free extracts of spleen or yeast were as effective as breis made of these tissues. The extract has been simulated by a combination of three compounds, glutamic acid, uracil, and guanine[12]. As a matter of fact, with certain strains of *E. coli*, the protection by cysteamine is dependent to about 90 per cent on the presence of these so-called recovery factors in the medium in which the bacteria are incubated after X-irradiation[13]. This interdependence of chemical protection and recovery might well be much more general than is now suspected.

It has been possible, by combining several treatments (S,β-aminoethyl*iso*thiuronium·Br·HBr before irradiation, bone marrow immediately after, and daily injections of streptomycin for ten days), approximately to triple the *LD*50 for irradiated mice[14]. However, not all effects of the radiation are equally reduced; for example, mice that recover from high doses of X-rays as a result of these treatments show early greying and loss of hair. For this reason, it is very important to find out what parts of the spectrum of radiation damage are reduced by a given treatment, and—in the present connexion—especially important to find out how much protection there is against genetic effects.

Chromosome Aberrations

One of the major effects of radiation is breakage of chromosomes. This type of damage has been discussed extensively[15]. Breakage of chromosomes can lead to death of somatic cells and also to transmissible changes in the germ cells. Two main processes are involved—breakage and reunion. According to the classic view, breakage occurs immediately and so can be modified only by treatment before or during irradiation. Reunion often requires considerable time and so may be modified by post-treatment. Actually, the idea that breakage is immediate may be partially incorrect. In any event, it has proved easier to investigate the modification of reunion than the modification of breakage, and the former will be considered first.

The most extensive analysis of reunion has been made by Wolff and his collaborators[16], using the broad bean, *Vicia faba*. They have shown that radiation not only breaks chromosomes but also inhibits reunion. Furthermore, they have demonstrated that the energy mechanisms of the cell are involved in reunion. Reunion can be delayed by enzyme inhibitors that decrease the amount of adenosine triphosphate formed, and accelerated by adding adenosine triphosphate. The importance of this substance and the long time over which the breaks can remain capable of fusing suggest that covalent bonds are involved. The same investigators have evidence for a class of breaks that reunite very rapidly. These breaks may involve the ionic bonds that Steffensen and Mazia[17] suggest exist in chromosomes. The studies of Wolff and his collaborators show that the number of two-break aberrations can be decreased by accelerating reunion through control of the metabolic processes of the cell provided that the radiation is given at a low enough rate.

The success of these or other methods for modifying reunion by post-treatments depends on the time over which breaks remain open and available for reunion. This period seems to be very different for different cells and organisms. For example, breaks have been estimated to remain open for only a few minutes in *Tradescantia* microspores irradiated late in interphase, but considerably longer in the same spores irradiated earlier in interphase[18]. Breaks induced in *Drosophila* sperm are usually stated to remain open until fertilization, although later evidence has been obtained by Baker and Von Halle[19] for some reunion in the sperm. Thus the time available for post-treatment may vary from a few minutes to several hours, or longer, and is probably different even for different tissues of the same individual.

Despite the frequently held view that breakage is immediate, several investigators[21] have suggested that a part of the breakage is not realized until after irradiation. This must be true of any breaks caused by the chromosome 'stickiness' induced by irradiation during mitosis. It would also be true if, as a few investigators have postulated, there are breaks resulting from disturbances in metabolism induced by radiation. However, the most extensive experimental support for delayed breakage is the work of Swanson and his collaborators[21], with infra-red radiation. They have interpreted their results to mean that both X-rays and infra-red radiation induce damage in the chromosomes, which can either be brought to expression by subsequent treatment with the other agent or caused to revert to normal by a heat shock. The occurrence of delayed breaks is still a matter of controversy[22]; but it is of great importance, since numerous possibilities for modifying chromosomal damage by post-treatment may be available if the breakage process really requires considerable time for completion.

In studies of delayed breakage, and other aspects of radiation cytogenetics also, it is often difficult to distinguish effects on breakage from those on reunion; this is very well illustrated by the controversies that have developed over the oxygen effect. Thoday and Read[23] first reported that the number of chromosome aberrations is markedly decreased by irradiating in the absence of molecular oxygen. As pointed out earlier, the effect of oxygen has now been found for many kinds of radiation damage, although it is not universal[24]. The early work by Thoday and Read and by Giles and his collaborators[25] led to the interpretation that part of the chromosome breaks are produced by those products of the radiolysis of water which require molecular oxygen for their formation. This interpretation still has much to recommend it as at least a partial explanation, although evidence has been obtained[26] that seems to rule out one product, hydrogen peroxide, of the radiolysis of water from consideration. Other interpretations of the chemical mechanism of the oxygen effect must also be considered in the light of the demonstration of an oxygen effect in dried materials[27].

Later work has raised a number of difficulties for the hypothesis that oxygen influences the frequency of primary breaks. These difficulties arise from observations that not all classes of aberrations are reduced to the extent expected if only the breakage process were affected. These observations have led Schwartz and Baker[19] to the view that oxygen affects reunion instead of breakage. Swanson[21] has attempted to explain the discrepancies in terms of potential breaks. Wolff and Atwood[16] have shown that the oxygen concentration during irradiation affects both the initial breakage and the subsequent reunion in *Vicia faba*. The matter is still the subject of considerable controversy, as discussions in a recent symposium[28] show.

From a practical point of view, the most important conclusion that can be drawn with certainty is that different classes of chromosomal aberrations in different cells are not affected to the same extent by oxygen. This is emphasized by the observation[29] that hypoxia does not influence the frequency of dominant lethals induced in mouse sperm. It is possible that the sperm of the mouse is normally anoxic and so is uninfluenced by hypoxia of the whole animal. However, it is not certain that this is the explanation, because there is only a small effect of hypoxia on the induction of dominant lethals in *Drosophila* sperm[19], although there is a considerable effect on the induction of other classes of aberrations in sperm and of dominant lethals in oocytes[30]. E. F. Oakberg (personal communication) has found that hypoxia and S,β-aminoethyl*iso*thiuronium·Br·HBr reduce the amount of cell death in mouse spermatogonia.

It has been reported[31] that a number of chemicals (ammonia, S,β-aminoethyl*iso*thiuronium·Br·HBr, British anti-lewisite (*BAL*), cysteine, sodium cyanide, sodium dithionite and thiourea) are able to reduce the frequency of detectable chromosome aberrations. Several of these chemicals probably act by removing molecular oxygen, but some may act in other ways. The presence of carbon monoxide or carbon dioxide during irradiation increases the frequency of aberrations[20]. The method of action is not thoroughly understood, although the respiratory enzymes of the cell appear to be implicated.

If indirect absorption of energy in the water of the cell is important, then it could be predicted that decreasing the water content of the cell would reduce the effect of the radiation. This seems to be the case in some materials[32]. In seeds of higher plants, water content has a distinct effect[33]; but the frequency of aberrations is greater at very low than at a water content somewhat higher than normal. Within the range of normal water content, the frequency of aberrations increases with increased hydration.

There is a distinct effect of temperature on the production of aberrations[22,25], but the results are complicated by the greater solubility of oxygen at low temperatures. In any event, it seems unlikely that changing the temperature will prove to be a useful procedure for reducing human hazards, although temperature studies may well add to the basic understanding of the production of aberrations.

Mutations

The major genetic changes of concern to later generations, except in relatively limited circumstances, are not gross chromosomal aberrations, but so-called point mutations. Actually, many of the changes in this category are probably small chromosomal losses or rearrangements. Thus the previous discussion of chromosome aberrations applies in large part to mutations as well.

The oxygen effect has been found for a variety of mutational changes, including recessive lethals in *Drosophila*[34] and a nutritional reversion in bacteria[35]. Protection by chemical agents has also been obtained for mutations in bacteria[18] and in *Paramecium* (unpublished work); but several workers have failed to obtain protection with cysteamine and cysteine in mice and *Drosophila*[36]. The facts that the oxygen effect is found for recessive lethals in *Drosophila* and chemical protection has been obtained for chromosome aberrations in plants suggest that there may be difficulties in getting these agents into the germ cells of animals, in unchanged form and in adequate concentration. In any event, it is obvious that there are discrepancies here which must be resolved before general conclusions on chemical protection against the mutational effects of X-rays can be drawn.

The most important question, from the present point of view, is whether mutations occur irrevocably during irradiation or are produced through intermediate steps that require considerable time for completion. There is good evidence that mutation by agents other than ionizing radiation can involve processes which require some time after the original mutagenic treatment has ceased. Thus Auerbach[37], working with the effect of mustards on *Drosophila*, has shown that some mutations do not come to stable expression for a generation or more after treatment. Also, it is known that the mutations induced by ultra-violet radiation are subject to photoreactivation[38] and heat reactivation[39] after irradiation. None of these phenomena has been found to take an important role for mutations induced by ionizing radiation.

However, there is some evidence, admittedly of a controversial or preliminary kind, which suggests that mutation by ionizing radiation, in micro-organisms at least, requires time for completion. Several workers[40] have reported delayed mutations which are expressed only after several generations of vegetative multiplication. At least a part of the phenomena may be the results of phenotypic lag, artefacts of the method of detection, and the peculiar circumstance that newly produced mutants are considerably delayed in division compared to non-mutants and old mutants. However, it is impossible to account for all the observations in this way. Recent work in this Laboratory[3,13] with certain strains of *E. coli* has suggested that the mutation process requires time for its completion. It is observed that various treatments, including post-treatments, which increase survival also decrease mutation to about the same extent. Even when allowance is made for the effects of population density, an influence of oxygen tension on mutation can be demonstrated and, though the analysis is incomplete, it seems probable that there is also a real influence of the post-treatments. Thus these observations suggest that the mutation process requires, for its completion, considerable time after irradiation. During this time it can be modified. The frequency of detectable mutations in *Paramecium* can be decreased by treatment with hydrogen peroxide after irradiation[24] and similar, though not very striking, results have now been obtained for several other post-treatments. Therefore, several pieces of evidence suggest that, at least in some cells, the induction of mutations by X-rays can be modified by treatment after irradiation.

Conclusions

Modification of the physiological damage of ionizing radiation is possible in mammals, and work is under way to apply this finding to man. However, the increased exposures which this protection might allow would have harmful genetic consequences if protection against genetic damage were not also afforded. It therefore becomes desirable to develop methods that protect against both, either by combining methods that, individually, do one and not the other, or by developing methods that will do both. The latter seems particularly feasible if, as seems probable, the cell death responsible for the physiological effects is primarily the result of nuclear damage.

The work on modification of genetic damage is, in some respects, less advanced than the work on physiological damage, and so it would be premature to make definite predictions. However, the prospects are better than many investigators would have dared hope a decade ago. The outlook is best for reducing the effects of foreseeable exposures to X- and gamma-rays since, in this case, pre-treatments could be used. Several successful pre-treatment procedures that give some promise of general applicability are already known. It is less certain that genetic damage can be modified by post-treatment following unforeseen exposures, although promising leads are available and are being investigated. Damage produced by neutrons and other densely ionizing radiations has proved less amenable to many of the procedures that are successful with less densely ionizing radiations, though the possibilities of post-treatment have not yet been adequately explored. From a practical point of view, keeping the exposure low by physical protection or avoiding the radiation are the only useful procedures at present. However, if the progress of the past decade were to continue, practical methods for reducing genetic damage in other ways might well become available. Meanwhile, this work is developing a better picture of the events involved in the induction of mutations and chromosomal aberrations by ionizing radiations, and so is providing the basic foundation upon which further developments in this field must rest.

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OBITUARIES

Sir Edmund Whittaker, F.R.S.

SIR EDMUND WHITTAKER, emeritus professor of mathematics in the University of Edinburgh, died in Edinburgh on March 24. He had been for some time in failing health; but he retained to the end his mental faculties clear and unimpaired.

Edmund Taylor Whittaker, of a family which he was able to trace back through several generations (the Whittakers of Grindleton, near Clitheroe on the Ribble), was born at Southport on October 24, 1873. He was educated at Manchester Grammar School, and in 1891 went up with an entrance scholarship to Trinity College, Cambridge. In 1895, in a Tripos of great distinction, he was Second Wrangler, bracketed with J. H. Grace and followed by Alfred Young; the Senior Wrangler was T. J. I'A. Bromwich. All four of these men were destined to make a variety of contributions to mathematics. In 1896 Whittaker was elected a Fellow of Trinity College, and in 1897 he was First Smith's Prizeman. His first long paper embodied the results of his thesis, which was on automorphic functions; here, as elsewhere, his inspiration was derived in the first place from Poincaré, whom he placed very high in his pantheon of modern mathematicians.

In 1902 he published his first book, "Modern Analysis", destined in its later editions, from the second in 1915, when he had the collaboration of G. N. Watson, to have a wide influence on the teaching of functions of a complex variable and their various expansions, and almost more on the study of special functions and the differential equations associated with them. To the end of his life he preserved the keenest interest in the functions and partial differential equations of mathematical physics. In 1902 he also discovered his well-known general solution of Laplace's equation, and in 1903 he introduced the now very familiar confluent hypergeometric function, about which quite a literature has gathered. During all this time, with characteristic versatility, he had also been writing on problems of dynamics involving periodic orbits. His second book, "Analytical Dynamics", may be called epoch-making in a very precise sense, in that on the very eve of the era of relativity he summed up in rounded chapters the classical dynamics from Lagrange through Hamilton to Poincaré and Levi-Civitá. He had the gratification, and once at least the surprise, of seeing this work translated into other languages.

In 1906 Whittaker was appointed professor of astronomy in the University of Dublin, under the title of Royal Astronomer of Ireland. Though his duties pertained in a general way to astronomy, it was understood that his chief function was the strengthening of the school of mathematical physics. He therefore gave courses of advanced lectures, one of his pupils, whose future career was not to be in mathematics, being Mr. de Valéra. His principal work of these years, a work of piety and one that entailed an immense amount of reading and historical research, was his "History of the Theories of Aether and Electricity, from the Age of Descartes to the Close of the Nineteenth Century", published in 1910. This, together with its revision and amplification of 1951, and a second volume appearing in 1953 (his eightieth year) and bringing the history up to 1926 (thus just entering the Born–Heisenberg–Jordan–Schrödinger–Dirac period), must be regarded as his *magnum opus*. The last sentence of this second volume reserved for a third volume an account of later developments up to 1950; but this, though the mental power remained, the physical strength was not sufficient to carry through.

On the death in 1911 of George Chrystal, professor of mathematics in the University of Edinburgh, Whittaker was elected his successor, entering on his duties in January 1912. He held this post for thirty-five years, retiring in 1946. In Edinburgh he founded a school of research and, guided in part by the example of Runge in Germany on numerical analysis, a mathematical laboratory, at a time when this was an innovation in universities in Britain. With G. Robinson he published in 1924 a book, "The Calculus of Observations", based on the experience of the laboratory and his own knowledge of this field. Some of the incentive, and a certain part of the material, came from his contact with actuaries in Edinburgh, in particular from his close friendship with the very distinguished actuary, the late Dr. G. J. Lidstone. He will, however, be chiefly remembered in Edinburgh for his teaching, full of inspiration and flawless in delivery; he regarded it as incumbent on him to give lectures to classes at every level. At the same time, he took more than a full share in university administration and in membership of outside bodies.

On the Continent of Europe and in the United States Whittaker was very well known, and indeed kept up an extensive correspondence with mathematicians all over the globe. The mere enumeration of his honorary doctorates, fellowships, visiting lectureships or professorships, presidentships, foreign memberships and other distinctions would exceed the limits of space, and is available in any event in works of reference; much as he valued his well-deserved medals, the Sylvester, the De Morgan, the Copley and others, he appeared to be specially touched and warmed by the honorary fellowship of Trinity College, bestowed on him in his later years and reminding him of his earlier. He was knighted in 1945.

After 1930, when he was received into the Roman Catholic Church, Whittaker's interests turned to natural theology; several of his essays and books of this period, such as "Space and Spirit", have as their explicit aim the reconciliation of modern natural and cosmological science with religion. These preoccupations are a mark of the underlying seriousness of his character. In mind he was clear and rapid to a quite exceptional degree; his capacity for industry was equally beyond the normal; not least he possessed a Roman *pietas*, exercised not only in seeing justice done to the most obscure of his remote precursors in natural philosophy, but also to those close at hand, as when—to choose but one instance—he took up and edited the posthumous manuscripts of Eddington, thus producing the book, "Fundamental Theory". In manner he was unfailingly courteous, yet not formal; entirely accessible and sympathetic.

He is survived by Lady Whittaker, daughter of the Rev. Thomas Boyd and granddaughter of Sir Thomas Jamieson Boyd, of Edinburgh, and by three sons and two daughters. His second son, Dr. J. M. Whittaker, formerly professor of mathematics in the University of Liverpool, is now vice-chancellor of the University of Sheffield. A. C. Aitken

Prof. A. M. Blackman, F.B.A.

Prof. A. M. Blackman, who died at Abergele on March 9 at the age of seventy-three, was almost the last surviving member of the older generation of British Egyptologists whose researches and publications during the past sixty years have so widely extended our knowledge of Ancient Egypt and early man.

Aylward Manley Blackman was born on January 30, 1883, the eldest son of the Rev. J. H. Blackman, and until he was sixteen was educated privately. He then entered St. Paul's School, whence he obtained a scholarship to Queen's College, Oxford. Under the influence of his father, a keen amateur archæologist, Blackman had at a very early age acquired an abiding interest in Egypt and in archæology, and hence on going to Oxford it was not surprising that he should have read Egyptian, Coptic and Arabic. In 1906, he obtained a first class in Oriental studies.

Blackman's first few years after graduation were busily spent in Nubia and Egypt. During 1907–8 he was one of the assistants of the late Prof. G. A. Reisner on the first of the great expeditions of the Archæological Survey of Nubia and thus obtained practical field-experience in a very hard school. During 1909–10 he helped in the excavations by the University of Pennsylvania at Buhen, slightly to the south of Wadi Halfa, and was solely responsible for the inscriptional work of the expedition. 1910, in fact, was an intensely busy year for him. In that year he was elected Oxford University Nubian Research Scholar and participated in the Oxford Excavations at Faras, a few miles north of Wadi Halfa on the Egypto-Sudan frontier. Almost simultaneously he became one of the international team of scholars engaged in recording those of the Nubian temples that the building of the Assuan Dam threatened to submerge. Between January and May, 1910, by dint of prodigious physical effort and at the cost of sickness the effects of which never left him for the rest of his life, he recorded all the scenes and inscriptions in the temples of Bigeh, Dendur and Derr (all published between 1911 and 1915), and began but never completed the record of the temple of Gerf Hussein.

In 1912, he was elected Laycock Student of Egyptology at Worcester College, Oxford, and in the same year he began, on behalf of the Egypt Exploration Society, the copying of the inscriptions of the important group of rock tombs at Meir in Middle Egypt. His work at Meir occupied the seasons 1912–14, 1921 and 1949–50, and the results were published in a series of six volumes between 1914 and 1953.

In 1934, he was elected Brunner professor of Egyptology in the University of Liverpool, and held this post until his retirement in 1948. Academic and other responsibilities limited his opportunities of visiting Egypt; but 1936–37 saw him once again in the Sudan as director of the Egypt Exploration Society's excavations at Sesebi.

Blackman's main scientific interest was in the religion of Ancient Egypt, particularly its liturgy and ritual. Unfortunately, he never wrote a book on the subject that was nearest to his heart; but his most important contributions to Egyptology certainly lie in the numerous papers which he contributed to the leading Egyptological journals. Typical of these are his massive contributions on such subjects as "Priesthood", "Purification" and "Worship" to Hastings's "Encyclopædia of Religion and Ethics" which still retain all their freshness and value.

He was a magnificent teacher. He liked young people, and his deep knowledge of his subject, coupled with a lively and warm sympathy with and understanding of his students, made him an inspiring teacher. Above all, he was interested in showing that Ancient Egypt was alive: to him there were no dead bones in archæology, and this was reflected not only in his scientific papers, but also in his popular writings, such as his delightful "Luxor and its Temples" (1923), which was also translated into German, his "Literature of the Ancient Egyptians" (1927), a translation of Erman's original work and still the only book of its kind in English, and in his inaugural lecture, "The Value of Egyptology in the Modern World" (1936). Of all British Egyptologists, he was possessed of a real sense of style and language: his translations, even if they had perhaps rather too strong a Biblical flavour, were vivid, accurate and attractive, and his commentaries displayed that same gift of expression allied to deep learning.

Blackman's last years were clouded with tragedy and misfortune. When returning from Meir in 1950 he broke his hip on board ship, and returned home on a stretcher, only to discover that his home had been broken up by the tragic fate of his sisters. Throughout his life he had been peculiarly devoted to his family: this double blow was one from which he never really recovered, and his years of retirement were marked by increasing physical weakness and pain. His election in 1952 as a Fellow of the British Academy was a recognition of his contributions to Egyptology that brought him great cheer in his last difficult years. A great scholar, an inspiring teacher, a very human and kindly man, deeply religious, and in private life the most unselfish and sincere of friends, his death removes one of very great gifts whose place, in his own special field, it will be hard to fill.

H. W. FAIRMAN

Prof. Samson Wright

THE sudden death on March 11 of Prof. Samson Wright came as a great shock to his many friends; he was fifty-six years of age.

Samson Wright ('Sammy' to his colleagues) entered the Middlesex Hospital Medical School as a student in 1916 and, apart from one year when he was lecturer in physiology at King's College in 1929, he remained at the Middlesex until his death. After gaining the Gold Medal in the M.B., B.S. examination in 1922, he became senior demonstrator in the Department of Physiology under the late Prof. Swale Vincent, and, after his brief sojourn at King's College, he was appointed as the first John Astor professor of physiology at the Middlesex Hospital Medical School when Prof. Swale Vincent retired in 1930. In 1931 he gave the Oliver-Sharpey Lecture at the Royal College of Physicians on "Certain Aspects of the Reflex Control of the Circulation" and in 1933 he was elected a Fellow of the College.

Wright's services to physiology were many; but there is no doubt that his greatest contribution was as a teacher. Both as a lecturer and as the author of the well-known "Applied Physiology" (first published in 1926 and now in its ninth edition) he was supreme. His vast knowledge, his critical insight and his fluent exposition could make the most difficult topic seem simple, and he had a wonderful gift for stimulating others to think for themselves. He believed that physiology was the corner-stone of medicine, and his classic text-book is a vivid commentary on this theme.

During 1938–49 Wright served the Physiological Society as editor of *Physiological Abstracts*, and during this difficult time he developed it into an indispensable scientific publication.

Samson Wright made notable original contributions to the physiology of the circulation, respiration and the central nervous system. In his early work on the circulation, he was the first to show that ergotamine abolishes the response of the vasomotor centre to sino-aortic afferent impulses. His most important work on respiration was the demonstration with Selladurai that anoxic hyperpnœa is entirely dependent on chemoreceptors, whereas carbon dioxide hyperpnœa is unaffected by sino-aortic nerve section. He also studied the action of acetylcholine and related compounds on chemoreceptors and put forward the hypothesis that acetylcholine might be the transmitter substance in the glomus.

Wright worked with various colleagues for many years on the complex problem of chemical transmission within the central nervous system, and studied the actions of anticholinesterases such as eserine, neostigmine and di*iso*propylfluorophosphonate. They suggested that the differences between the central actions of the first two drugs were due to the fact that eserine is a tertiary compound which penetrates cell membranes easily, whereas neostigmine is a quaternary compound which does not.

Recently he had been investigating the effects of injection of *d*-tubocurarine into various parts of the brain as revealed by electrical wave patterns recorded from different areas.

Apart from his own work, Wright was a most inspiring and enthusiastic director of research, though he was very critical of anything which fell below his own high standards.

Wright had many interests outside physiology. He was an enthusiastic Zionist and he did all that was humanly possible to help those Jewish refugees who came to Britain from Hitler's Germany. After the establishment of the State of Israel, he took a great interest in the Hebrew University of Jerusalem, of which he was a governor. He was also vice-chairman in Britain of the Friends of the Hebrew University. He helped to build up the University's Faculty of Medicine along traditional British lines, and it is most fitting that a laboratory in its Department of Physiology was recently named after him.

In Samson Wright great intellectual brilliance was linked with a most lovable character. He was a formidable but always constructive critic, and he took a constant, unselfish interest in the welfare of his colleagues and staff. His great gift of exposition, combined with humility and sincerity of purpose, made him a most stimulating and delightful companion. His challenging personality will be greatly missed. His wife died in 1950 and he leaves three daughters.

C. A. Keele

NEWS and VIEWS

Mellon Institute of Industrial Research, Pittsburgh : Dr. E. R. Weidlein

Dr. Edward R. Weidlein retired on March 31 from the presidency of the Mellon Institute of Industrial Research, Pittsburgh, after more than forty years of active work at the Institute. Happily, his retirement will not sever his connexion with the Institute as he will remain on the Board of Trustees and will be available in an advisory capacity in the administration of the various research programmes. His successor as head of the research executive staff of the Institute has not yet been announced. Dr. Weidlein joined the Mellon Institute in 1912, becoming acting director during the First World War and then director in 1921. In 1951 he was appointed president of the Institute and, in addition, he was for four years chairman of the Board of Trustees, a post which he relinquished last year. The Mellon Institute, which is associated with the University of Pittsburgh, is an endowed, non-profit organization, conducting long-term investigations in chemical and physical technology, mainly by a system of industrial fellowships, and it is with this industrial fellowship scheme that Dr. Weidlein has been particularly concerned. However, he has also had many activities outside the Institute, and mention must be made of his work during the Second World War, as head technical consultant in the War Production Board, when he was largely instrumental in establishing the synthetic rubber industry in the United States. In Pittsburgh he is deeply interested in the health, well-being and community development of his home city and its surroundings and, in particular, in the control of industrial pollution. In 1938 the American Section of the Society of Chemical Industry awarded Dr. Weidlein the Chemical Industry Medal, and in 1948 he received the Priestley Medal of the American Chemical Society. He was president of the American Institute of Chemical Engineers during 1927–29.

Imperial College of Science and Technology : Honorary Fellowships

Honorary fellowship of the Imperial College of Science and Technology has been conferred on the following, all of whom have been connected with the College in various ways : Prof. William Brown, formerly professor of plant pathology ; Prof. Sydney Chapman, formerly professor of mathematics ; Mr. David Garnett, author, and a former student ; Dr. Willis Jackson, formerly professor of electrical engineering ; Prof. J. W. Munro, formerly professor of zoology and applied entomology ; Sir William Penney, director of the Atomic Weapons Research Establishment, a member of the Governing Body and a former student ; and Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, U.S.A., and a former student.

Industrial Fund for the Advancement of Scientific Education in Schools

It was announced last November that seventeen firms had agreed to form an Industrial Fund to assist in the teaching of science in independent and direct-grant schools in Great Britain by the provision of capital grants towards the building, expansion, modernizing and equipping of science laboratories (see *Nature*, November 5, p. 860). It was originally intended to raise £1,500,000 ; but seventy-three more companies have since agreed to support the Fund, and the total now subscribed from all sources is £2,900,000. The committee for administering the Fund has appointed the following four assessors to act as technical advisers both to the committee and to the schools concerned : Sir Graham Savage, formerly senior chief inspector of the Ministry of Education and thereafter chief education officer of the London County Council ; Mr. D. B. Briggs, formerly one of H.M. inspectors of schools ; Mr. W. F. Bushell, formerly headmaster of Birkenhead School ; and Mr. A. G. McKimmie, formerly headmaster of Allan Glen's School, Glasgow, whose special province is schools in Scotland and Northern Ireland.

An architectural brochure of current good practice for the building and equipping of school science laboratories has been prepared, which includes a table of standards of space and cost judged appropriate for the various types of buildings and equipment. It has been decided that, in the main, grants will be restricted to the teaching of the fundamental sciences of physics, chemistry and mathematics, that grants will not exceed two-thirds of the cost of that part of the project which is admissible for consideration, and that priority will be given to schools having 250 or more pupils over the age of thirteen and having at least 10 per cent of them in the mathematics and science sixth forms (the forms after the Ordinary Level of the General Certificate of Education). 439 schools have applied for grants from the Fund, and some interesting statistics have been compiled from their applications. In boys' schools the proportion in the mathematics and science sixth forms is now 50 per cent of the total in sixth forms, and while the total number of pupils over the age of thirteen has increased by more than a third since before the Second World War, there are now two and a quarter times as many boys specializing in mathematics and science. As a result, the facilities for teaching science are overcrowded and inadequate. Unlike maintained schools in Britain, the chief problem for independent and direct-grant schools is not a lack of science teaching staff but one of money for capital projects, and it is for this that the Fund has been created. On the basis of the applications, it has been decided to try to raise a further £600,000 to bring the Fund to a total of £3,500,000, and an appeal will be made shortly for this extra money.

United States National Committee for the Development of Scientists and Engineers

WHEN he announced, on April 3, the establishment in the United States of a National Committee for the Development of Scientists and Engineers, President Eisenhower said: "The National Science Foundation will provide staff services for the Committee and provide leadership to other departments and agencies in carrying forward activities which will contribute to a solution of the problem". The director of the Foundation, Dr. Alan T. Waterman, has recently welcomed this statement and reiterated the important part played by science and technology in the economy of the United States. Dr. Waterman emphasized that the problem of increasing the number of scientists and engineers in the United States is essentially one of educating American youth—a limited amount of education in the sciences for all young people and first-rate advanced training for the small proportion who show the necessary aptitude. Efforts must be made on a local scale all over the country, and the National Committee must stimulate non-Federal groups to encourage State and local approaches to the problem. On the national scale the various agencies of the Federal Government—notably the Department of Defense, Atomic Energy Commission, and the Department of Health, Education and Welfare—are keenly interested in the furthering of science and technology, and the National Science Foundation will co-operate with these agencies in supporting the programme of the Committee.

Scientists for Colonial Research

A QUESTION was asked in the House of Commons regarding the steps being taken to implement the proposals of the Advisory Council on Scientific Policy for home-based pools of scientists for use on Colonial problems. The Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, in a written reply, said that such pools have been established at the instance of the Secretary of State for the Colonies at a number of agricultural research institutions and also at certain stations of the Department of Scientific and Industrial Research. Some research on Colonial medical problems is also based on the United Kingdom. A new post is being set up for research on stored products, and two pools of scientists have recently been enlarged.

Re-development of the British Museum Library

THE Advisory Council on Scientific Policy in its seventh report supported proposals for a central reference library in London or for a national science lending library, and for a science centre, of which they would form part. These proposals were not mentioned in the debate on the new British Museum Library, usually referred to as the National Library, which Mrs. L. Seger raised on the adjournment in the House of Commons on April 10, though they are related to that scheme in so far as the discarding of literature more than fifty years old is concerned. Mr. J. R. Bevins, replying for the Government, stated that under the present plans the first relatively small stage of re-development of the British Museum Library would not take place before about ten years, and that the second stage was not expected to start before 1975, and would probably be later. It would seem from these comments that the Government has no present intention of implementing the proposals for a science centre and its related library facilities.

Advisory Council of the Commonwealth Scientific and Industrial Research Organization

THE following have been appointed new members of the Advisory Council of the Commonwealth Scientific and Industrial Research Organization, Australia: Prof. N. S. Bayliss, Chemistry Department, University of Western Australia; Dr. A. R. Callaghan, director of agriculture, South Australia; Prof. H. R. Carne, professor of veterinary pathology and bacteriology, University of Sydney; Mr. T. A. Frankcomb, Tasmanian fruit- and hop-grower; Mr. A. McCulloch, chief engineer, Southern Electric Authority of Queensland; Prof. W. W. Macfarlane, Department of Physiology, University of Queensland; Mr. M. A. Mawby, vice-chairman of Consolidated Zinc Pty., Ltd., and commissioner of the Australian Aluminium Production Commission; Mr. W. W. Pettingell, general manager, Australian Gas Light Co.; Mr. W. J. Russell, Western Australian grazier; Mr. E. M. Schroder, managing director, Adelaide Cement Co., Ltd.; Mr. H. B. Somerset, managing director, Associated Pulp and Paper Mills, Ltd.; Prof. A. D. Trendall, master of University House, Australian National University; Prof. J. S. Turner, Botany Department, University of Melbourne; and Dr. J. Vernon, senior executive officer, Colonial Sugar Refining Co., Ltd.

The Scientist and Society

AN address, "The Dilemma of the Scientist", given on August 25 by Dr. J. Bronowski at the annual conference of the International Liaison Committee of Organizations for Peace, held in The Netherlands at Oosterbeck, has been published by the National Peace Council as No. 59 in the series of Peace Aims Pamphlets (pp. 10. London, 1955; 9*d*.). Dr. Bronowski points out that the main responsibility for the dangers which confront the world to-day rests on the peoples and governments and not on the scientist as such, who is not the keeper of the nation's policy. He is, however, the keeper of his own personal conscience, and Dr. Bronowski urges that governments have a duty to make it possible for the scientist to exercise his conscience and decline to participate in particular projects which are distasteful to him. Dr. Bronowski points out that, once a scientist touches the fringe of a secret subject, it is practically impossible for him to withdraw. The scientist's great responsibility, he argues, is to see that the public is sufficiently well informed on the scientific issues to vote wisely and thus secure sound decisions of policy; and a government has a further responsibility to see that scientists have the opportunity to speak freely on such issues. Dr. Bronowski concluded his address by indicating briefly the way in which the continuance of science itself as well as of a free society depends on the preservation of this right of discussion and dissent.

World List of Biological Periodicals during 1950–54

UNDER the title "Biological Sciences Serial Publications: A World List, 1950–1954", *Biological Abstracts* has published for the United States Library of Congress a list of biological periodicals that appeared during 1950–54 (pp. 270. Philadelphia: University of Pennsylvania, 1955; 2 dollars). Publications devoted entirely to medical and applied aspects of biology have been largely omitted, as "it has been estimated that if all the serials containing material on biological topics, both pure and applied, were to be included, the total number might exceed by five times the three thousand five hundred titles in the present list. The serials are grouped under five broad headings and, where possible, are subdivided according to country of origin. These headings include: general biology, botany, zoology, science of man, and general science publications containing contributions on biology or a significant number of biological papers in each issue or volume. Bibliographical details include title, issuing agency and publisher, date of first issue, frequency of publication and contents. The material comprising the regular features of a publication is classified and described as original research, analyses (including review literature and summaries of original research), proceedings of societies, conferences and congresses, abstracts, bibliographies, popular notes and book reviews. The value of this useful list would doubtless have been greatly enhanced had it included the World List abbreviations of each of the periodicals cited.

Old Akkadian Tablets from the Middle East

A CONSIDERABLE number of clay tablets have come into the possession of the Chicago Natural History Museum, and they have been deciphered by Prof. Ignace J. Gelb in *Fieldiana* (Anthropology, 44, No. 2; 1955). The writing is Old Akkadian, and internal evidence would suggest that they date to some period during 2261–2199 B.C. The tablets resemble closely some published and unpublished examples which bear the dates of Narâm-Sin and Šar-Kali-Šarrī. Unfortunately, the new tablets were obtained from an Arab, and their exact provenance will never be known. But once again internal evidence would point to the Diyala river region, and this agrees with the meagre information obtained from the Arab. The tablets (except the last two, which are letters) are texts of legal and business interest. Usually at the top are a number of proper names, and these are presumably the witnesses of the transaction given below. While they cannot be said to be exciting reading, as naturally we know nothing of the people or of the transactions, the general picture of the ordinary life and business of those times is very interesting. One of the letters at the end of the book is concerned with the slackness of a person named Ginunū who, it seems, has stopped sending bread for the soldiers. No reasons are given; but one can perhaps suppose he was a contractor of the type which has existed at all ages, and doubtless he duly sent in his bills to the head commissariat for the total amount of the bread. The volume as a whole is beautifully published, all the tablets being reproduced in half-tones.

Curtis's Botanical Magazine: Index

THE Royal Horticultural Society, London, has rendered a service that plant lovers will appreciate by the publication, under the authorship of F. J. Chittenden, of an index to Vols. 1–164 of *Curtis's Botanical Magazine*. There is also an appendix of the titles and numbers of plants from Vols. 165–170. To quote a comment in the preface: "There is little doubt that a complete set of the Botanical Magazine provides the most comprehensive and probably the most accurate collection of plant-portraits in existence though for convenience and speed of reference there has long been a need for a consolidated index to the illustrations". This very considerable task has now been completed. A major aim of providing accepted contemporary nomenclature throughout has added much to the value of the volumes that have appeared since the inception of the *Magazine* in 1787. The index and history, amounting to 282 pages, can be obtained from the Royal Horticultural Society, Vincent Square, London, S.W.1; price £2 2*s*.

Chromosome Numbers in *Oxalis*

THE genus *Oxalis*, comprising some eight hundred species, occurs principally in South America and South Africa, though some, such as *O. acetosella*, are cosmopolitan. Chromosome numbers in species of the genus have already been reported on by various investigators. The basic numbers cover a fairly wide range, namely, 5, 6, 7, 9, 11—7 being apparently the commonest. In a contemporary paper on this subject by G. E. Marks (*New Phytol.*, 55, 1, 120; 1956), the chromosome numbers of an additional twenty-six species have been ascertained, sixteen of these being of South African origin. The new data admit of cytological comparisons being made between species from the two major regions. From the total information now available the author concludes that it is possible to separate cytologically the South African from the South American group of species, the former having no variation in chromosome size, little variation in basic chromosome number but a high degree of polyploidy, while the latter group has variability in chromosome size and basic chromosome numbers with relatively little polyploidy. Using this evidence, together with morphological and ecological data, it is postulated that the South African group of *Oxalis* species is a specialized group within the genus.

The Manchester Museum

THE report of the Manchester Museum for 1954–55 is a record of quiet but steady progress made in the face of financial stringency. The rising costs of salaries and wages necessitated a restriction of all other expenditure to the lowest possible figures. Notwithstanding such an atmosphere, all departments report progress and much valuable research was carried out and published by the staff. As usual, an impressive series of twenty museum lectures was arranged for Saturday afternoons, with an average attendance throughout the year of sixty-five. At the annual reception the Museum welcomed about three hundred guests, and the idea of showing them special displays of recent acquisitions and illustrating the scientific and technical work done in the Museum is to be commended.

Commonwealth Fund Fellowships

THE Committee of Award of the Commonwealth Fund Fellowships has made the following elections, among others, for 1956–57: *General Fellowships*: H. G. Alexander, Aberdeen, Christ Church, Oxford, and Manchester (philosophy); J. A. Beardmore, Sheffield (genetics); J. S. Cumpsty, Durham (mining); Miss Marion Fairman, Durham and Glasgow (bacteriology); W. Galbraith, Birkbeck College, London (physics); Miss Janet Graham, St. Andrews (botany); N. Macleod, Imperial College, London, and Leicester (chemistry); J. McDaniel, Imperial College, London (engineering); J. N. Murrell, King's College, London, and Corpus Christi College, Cambridge (physics); H. M. A. Onitiri, London School of Economics (economics); D. F. Shaw, Manchester (chemistry); J. G. Taylor, Christ's College, Cambridge (mathematics). *Home Civil Service Fellowships:* E. Y. Bannard, Ministry of Transport and Civil Aviation; A. A. Bellamy, Ministry of Housing and Local Government; R. W. Howe, Department of Scientific and Industrial Research; E. H. Simpson, Ministry of Education. *Oversea Civil Service Fellowship:* W. J. A. Payne, Fiji (animal climatology).

University of London: Appointments

The following appointments have been made in the University of London: M. W. Humphrey Davies, reader in electrical engineering in the Imperial College of Science and Technology, London, to the University chair of electrical engineering tenable at Queen Mary College; Dr. E. Shotton, senior lecturer in pharmaceutics in the School of Pharmacy, London, to the University chair of pharmaceutics tenable at that School; Dr. O. S. Heavens, lecturer in the University of Reading, to the University readership in experimental physics tenable at the Royal Holloway College; Dr. H. B. Henbest, lecturer in organic chemistry in the University of Manchester, to the University readership in organic chemistry tenable at King's College; Dr. J. C. Pugh, senior lecturer in the Department of Geography, University College, Ibadan, to the University readership in geography tenable at King's College; and Dr. A. J. B. Robertson, lecturer in physical chemistry, King's College, to the University readership in physical chemistry tenable at that College.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: J. D. Broatch (deputy director of agriculture, Gold Coast), director of agriculture, Gold Coast; E. J. Butler (senior agricultural officer, Northern Region, Nigeria), principal research officer, Northern Region, Nigeria; I. W. Hughes (plant pathologist, Bermuda), assistant director of agriculture, Bermuda; R. A. Kitching (agricultural officer, Gambia), senior agricultural officer, Sierra Leone; L. N. H. Larter (senior botanist, Federation of Malaya), chief research officer, Federation of Malaya; H. K. Ashby, E. J. H. Berwick, J. Cook, W. N. Scott and H. J. Simpson (senior agricultural officers, Federation of Malaya), senior agricultural officers, grade A, Federation of Malaya; J. B. G. S. Staub (sugar technologist, Mauritius), registrar, Central Board, Mauritius; D. G. Cumming (senior assistant conservator of forests, Northern Rhodesia), conservator of forests, Northern Rhodesia; D. H. L. Rollinson (veterinary research officer, Uganda), chief veterinary research officer, Uganda; O. S. Barr, agricultural officer, Uganda; J. V. Huhta, mining geologist, Sierra Leone; W. J. Bell, special grade medical research officer, West African Council for Medical Research; A. J. MacLeod, veterinary research officer, Federation of Nigeria; A. C. Brooks, biologist, Game Department, Uganda.

Announcements

The Earl of Iveagh, chancellor of the University of Dublin and Trinity College, will open the reconstructed Iveagh Geological Laboratory in the College on May 10.

The Right Hon. Sir David Eccles, Minister of Education, will open the extensions to the Northampton Polytechnic, London, on May 7.

Mr. G. H. C. Amos, a principal in the Ministry of Agriculture, Fisheries and Food, has been appointed agricultural and food adviser to the High Commissioner for the United Kingdom in Ottawa.

The Development Commission is offering two or three training grants to British honours graduates for training in research problems in marine or freshwater science, which is designed to fit them for employment either in the Fishery Research Service of the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £250–£350 a year, with allowances for university fees, etc., and are tenable for one year initially, renewable up to a maximum of three years. Application forms, to be returned by May 20, and further information can be obtained from the Secretary, Development Commission, 3 Dean's Yard, London, S.W.1.

The annual conference of the Electron Microscopy Group of the Institute of Physics will be held in the University of Reading during July 24–26. Papers on all aspects of electron microscopy, both theoretical and practical, together with applications of the instrument are invited. Further information can be obtained from the Assistant Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

A conference on the science and technique of photography, organized by the Scientific and Technical Group of the Royal Photographic Society, will be held on May 12 in the Institute of Physiology of the University College of South Wales and Monmouthshire, Cardiff. The conference will be open to all, without admission ticket. Further information can be obtained from the honorary secretary of the Group, R. J. Cox, Ilford, Ltd., 134 St. Albans Road, Watford, Herts.

The Electronics Section of the Scientific Instrument Manufacturers' Association is holding an exhibition on "Atoms, Electrons and Industry" in the Royal West of England Academy, Bristol, during June 6–8. Twenty-nine firms will be participating and also the Atomic Energy Authority, Harwell, and the University of Bristol. The aim of the exhibition is to acquaint industrialists with the progress being made by British instrument firms and, by showing applications already in use by some industries, to stimulate other industries to find further uses for these new tools. Admission will be free, by ticket only, applications for which should be made to the Association, 20 Queen Anne Street, London, W.1.

An international light metals convention will be held at the Montanistische Hochschule, Leoben, Austria, during June 7–9, when, as in the case of the previous two conventions there in 1934 and 1948, a survey will be given of the present state of the development of light metals. Lectures will be given by leading experts from Europe, Canada and the United States, and will cover the following fields: light metals in the national and world economy; metallurgy of light metals (aluminium and magnesium); the development of titanium; technology of light metals; metallography and physics of light metals; and the application of light metals. A programme has been published, and this and further information can be obtained from the Geschaftsstelle der 3 Internationalen Leichtmetalltagung, Leoben/Stmk., Austria, Montanistische Hochschule, Institut für Metallkunde.

ATOMIC SPECTROSCOPY

SYMPOSIUM AT THE ARGONNE NATIONAL LABORATORY

DURING February 15–17 a symposium on spectroscopy was arranged by the Argonne National Laboratory, Lemont, Illinois, which is one of the research centres (administered by the University of Chicago) of the United States Atomic Energy Commission. Many contributors to the meeting were either members of the Commission or were doing work under contract for it; but the symposium was concerned with non-classified subjects of optical research and gave an opportunity for seeing current developments in the United States.

Emphasis at the meeting was put on general research rather than on spectrochemical techniques. However, a few papers dealt with such problems. D. W. Steinhaus (Los Alamos) discussed the problems of a high-resolution spectroscopy laboratory when radioactive materials are involved. The view that the poor reproducibility of the porous-cup source is caused by inhomogeneous porosity of the graphite was expressed by M. Slavin (Brookhaven); quicker and more reliable results have been obtained by use of water cooling and a lacquer coating. A paper on the spectrographic determination of oxygen in metals (in particular, iron) was presented by R. W. Tabeling and V. A. Fassel (Iowa State College), who showed that with d.c. carbon-arc excitation and argon as an internal standard, reliable results (to about 20 p.p.m.) can be obtained.

L. Wilets (Los Alamos) discussed isotope shifts and nuclear structure, and pointed out there are three main observations which theory should explain. The observed shifts are on the average too small, show regular variations with neutron number and exhibit even–odd staggering. A possible explanation for these experimental facts may be connected with compressibility and deformation of the nucleus. W. M. Cloud, J. E. Mack and J. A. Vreeland (Wisconsin) discussed experimental isotope shift data for palladium-46, cadmium-48, tin-50 and tellurium-52. L. E. Owen and D. C. Manning (Goodyear Atomic Corporation) described the narrow wave-length interval direct-reading spectrometer being built on the principle of conversion of photoelectric currents into pulse counts. Techniques used by F. S. Tomkins and M. Fred (Argonne) for spectroscopic examination of small radioactive samples were outlined; such methods include high-frequency discharge sources and porous electrodes, and the spectra are obtained on a 30-ft. Paschen–Runge grating mounting.

The nuclear dipole moment (μ) and the electric quadrupole moment (Q) have been determined by T. E. Manning, M. Fred and F. S. Tomkins (Argonne) from consideration of the hyperfine structure of certain lines and a partial term analysis of americium-I and -II. The values are given as $\mu = +1{\cdot}4$ nm. and $Q = +4{\cdot}9 \times 10^{-24}$ cm.^{2} for the isotope 241. The corresponding quantities from isotope 243 agree within 1 per cent. J. G. Hirschberg (Wisconsin) described a photoelectric method for examining, with the use of a Fabry–Perot interferometer, the Lamb shift in ionized helium (excited from a liquid-helium cooled source). A similar investigation on lead isotopes has been carried out by J. Brody (Argonne), who also discussed the relative effectiveness of metal and dielectric coatings in interferometers. Isotopic analysis of polonium-208 and -209 mixtures by measurements of intensities of band heads from the molecules $(^{208}\mathrm{Po})_2$ and $(^{208}\mathrm{Po}\ ^{209}\mathrm{Po})$ was discussed by D. J. Hunt and G. Pish (Monsanto). V. W. Cohen (Brookhaven) pointed out that optical methods for studying nuclear properties should still be considered together with the more modern techniques such as those involving microwaves and atomic beams; he gave a list of radioactive elements which could profitably be studied. G. W. Stroke (Massachusetts Institute of Technology) and F. H. Sullivan and D. K. Rice (Jarrell-Ash) gave theoretical and experimental criteria for measurement of the performance of a diffraction grating and maintained that wave-front interferograms give most information on this matter.

Studies of hyperfine structure are sometimes rendered difficult because the lines are broadened by the Doppler effect. F. Bitter (Massachusetts Institute of Technology) discussed general methods of overcoming this problem by such means as atomic beams in electrodeless discharges at low pressures. A method involving coincidence counter techniques was proposed by P. L. Sagalyn (Massachusetts Institute) for considerably reducing the effect; the photons of two lines are simultaneously detected by coincidence techniques, and the difference in wave-lengths is independent of the Doppler effect. If a mercury arc is placed in a magnetic field, the wave-lengths of the hyperfine structure components of the lines emitted are a function of the field. One of the components can be used as a variable wave-length source for the study of hyperfine structure in absorption. H. H. Plotkin and J. E. R. Young (Massachusetts Institute) gave papers in which this technique was used for the study of the mercury $^3S_1$ state and the resonance lines of mercury radioisotopes, respectively; a similar principle was used by P. L. Sagalyn for some radio-frequency experiments in the mercury $^3P_1$ level.

A session on term analysis was opened by G. H. Dieke (Johns Hopkins University), who discussed a semi-automatic method for spectroscopic wave-length and intensity measurement; the spectral lines are displayed on an oscilloscope screen and the comparator readings recorded electronically, much of the tediousness and strain of measurement being thus eliminated. L. F. H. Bovey (Harwell) described a furnace which can be used for obtaining the absorption and emission spectra of neutral atoms of radioactive elements such as plutonium. The analysis of praseodymium-I was discussed by S. P. Davis (Massachusetts Institute), who emphasized the use made of Zeeman patterns (taken at fields of 79,000 oersteds) of neutral atoms excited by an electrodeless microwave discharge source. The lines were recorded on an echelle spectrograph. Similar experiments on erbium have been carried out by J. W. Lindner and S. P. Davis (Massachusetts Institute). C. C. Kiess and R. Zalubas (National Bureau of Standards) gave details of a comprehensive programme being carried out on thorium-I. The term analysis of this atom may show when the $5f$ electron enters the configuration of valence electrons in the heavy elements. Some twelve thousand lines have been measured in this work, and while not all are thorium-I, it is estimated that it will take at least three years to finish the analysis. In describing the application of new techniques to Zeeman spectroscopy, P. M. Griffin and K. L. Vander Sluis (Oak Ridge) showed how a combination of electrodeless discharge sources, very uniform magnetic fields of about 33,000 oersteds and an echelle spectrograph can produce very well-resolved Zeeman patterns; results off the plates were obtained with the aid of a high-speed electronic computer (Oracle).

H. H. Nielsen and K. N. Rao (Ohio State University) discussed measurements connected with the theory of centrifugal stretching constants in linear polyatomic molecules. The results from an analysis of the absorption spectrum of thallous chloride taken with a Fabry–Perot interferometer crossed with a 21-ft. grating instrument were given by R. R. Kadesch, J. C. Moldenhauer and J. G. Winans (Wisconsin); and G. W. Charles (Oak Ridge) discussed the vibrational analysis of the spectrum of Po_2. The use of absorption and fluorescence spectra to derive the symmetry of the micro fields about europium ions in methanol (C_{2v}) and in water (D_{3h}) was described by S. Freed, E. V. Sayre and D. G. Miller (Brookhaven). Further results from the polarization, absorption and fluorescent spectra of single crystals at temperatures between 4° and 300° K. of some praseodymium and europium salts obtained by Freed and Sayre give much information on the micro-crystalline fields surrounding the ions.

After a discussion of the derivation of selection rules for rare-earth ion spectra in crystals, R. A. Satten (University of California) showed how these are violated in the spectra of neodymium bromate and ethyl sulphate. The breakdown in the selection rules is partially attributed to interaction of electronic and vibrational motion. The possible electronic configuration of the Am^{+3} ion was briefly discussed by J. G. Conway, R. D. McLaughlin, B. B. Cunningham (Berkeley) and D. M. Gruen (Argonne) following a description of the experimental absorption (over the range 3000–12,000 A.) and fluorescent (range 3000–8800 A.) spectra of single crystals of lanthanum chloride containing 0·04 and 0·2 mole per cent americium chloride. The Raman spectrum of uranium hexafluoride and the infra-red spectra of neptunium hexafluoride and plutonium hexafluoride have been observed by J. K. Brody, H. H. Claassen and B. Weinstock (Argonne), and all six fundamental frequencies arising from the O_h symmetry determined. The absorption spectra of the last two fluorides have also been studied between 5000 and 25,000 A., and an interpretation of the fine structure seen in some of the bands was discussed.

K. W. Meissner and E. C. Finckh (Purdue University) discussed the possible use of a calcium atomic-beam lamp for high-precision measurements of wave-length. A half-width of 9×10^{-3} cm.$^{-1}$ was observed in preliminary experiments. A complete and consistent set of oscillator strengths for dipole transitions from the ground-level of the helium atom were given by W. F. Miller and R. L. Platzman (Purdue). From a study of the unusual Doppler effects in calutron ion sources, J. R. McNally, jun., and M. R. Skidmore (Oak Ridge) showed that these should be attributed to an ordered ionic drift about the arc column with ion velocities often exceeding 10^6 cm./sec.

The use of nuclear magnetic resonance to determine isotope ratios ($^1H/^2H$ and $^6Li/^7Li$) was summarized by B. E. Holder and M. P. Klein (California). The techniques described included both a relative and an absolute method. The natural $^7Li/^6Li$ ratio was found to be 11·8. The same authors also discussed measurement of nuclear magnetogyric ratios by nuclear magnetic resonance. Where direct observation is not possible because of such causes as residual atomic paramagnetism, nuclear quadrupole interaction, low abundances or small magnetogyric ratios, a double resonance technique can be tried. In this method the atom under investigation is bonded to an atom with more favourable properties. Under suitable conditions, by an indirect spin–spin interaction, the constants of the unknown atom can often be determined. L. S. Goodman (Argonne), in a paper on atomic beam measurements of radioactive isotopes, discussed problems connected with the source, magnetic field, calibration and detection.

Much of the work discussed was in the course of publication or had been published, and therefore no arrangements were made for issuing any detailed account of the symposium.

L. F. H. Bovey

PHYSIOLOGY OF FUNGAL PARASITISM

STUDIES of the physiology of fungal parasitism, begun by Prof. W. Brown many years ago at the Imperial College of Science and Technology, are being maintained and extended, special attention being given to the part played by the enzymes which bring about the dissolution of the cellular structure and the death of tissues. In the *Annals of Botany* (20, 77; 1956) three investigations are reported. J. S. Cole gives an account of the pathogenicity of *Botrytis cinerea*, *Sclerotinia fructigena* and *S. laxa*, with special reference to the action of their pectolytic enzymes. He has found that although these three fungi cause rotting of apple tissue and the death of the protoplasts, very little pectolytic activity can be detected in the rotting tissue.

Pectolytic activity was measured by methods involving (*a*) maceration of plant tissues, (*b*) viscosity and reducing group determinations in pectic substrates, (*c*) increase in acidity of pectin. By these methods it was shown that pectolytic enzymes were produced by all three fungi in synthetic media. With *S. fructigena*, which was the only fungus studied in detail, replacement of glucose by pectin increased the formation of pectolytic enzymes. When various apple extracts were used as culture media, little or no pectolytic activity was detectable. With all three fungi the presence of apple juice in a culture medium, which by itself was suitable for enzyme formation, resulted in the suppression of pectolytic activity. Oxidized apple juice had a pronounced effect in deactivating certain pectolytic enzymes, an effect which was especially marked with *B. cinerea*. This points to an interaction between the pectolytic and oxidizing systems and introduces a new line of approach to the study of the biochemical interaction between host and parasite.

R. K. Singh and R. K. S. Wood, in an investigation of the production and properties of the pectic enzymes secreted by *Fusarium moniliforme*, have observed that this fungus secreted macerating enzymes in liquid media only when these contained certain natural extracts, pectic substances, or galacturonic acid. Apple extract was unsuitable for enzyme secretion and also inhibited enzyme secretion in synthetic media otherwise suitable. Protopectinase activity of solutions was highest in the *p*H range 8·0–9·0, was rapidly lost at temperatures above 50–60° C., and was reduced by concentrations of phosphate higher than 0·02 *M*. The enzyme was partially purified by precipitation in 60 per cent acetone at *p*H 6·0. Protopectinase solutions also contained an enzyme which reduced the viscosity of solutions of various pectic substances. The properties of this enzyme were, in general, similar to those of protopectinase. When activity of enzyme solutions was measured by the liberation of reducing groups, pectate solutions were more rapidly degraded than were solutions of a high methoxyl pectin, particularly in the early stages of the reaction. Partition chromatography of the products formed showed that pectate and pectin were degraded in different ways. Although the pathogen readily secreted protopectinase in potato extract, potato tubers were not readily parasitized. In contrast, *Fusarium avenaceum*, which readily attacked tubers, secreted little protopectinase in potato extract.

S. C. Gupta has examined the production of pectolytic enzymes by *Pythium de baryanum*. Among other things, he observed that the incorporation of sodium chloride in a synthetic medium stimulated the pectolytic activity of cultures of *Pythium de baryanum*. The chloride ion appeared to be mainly responsible for this effect; on the other hand, presence of the calcium ion depressed enzymic activity. Glucose, fructose and mannose were about equally suitable for growth and enzyme production. Sucrose, if used as sole carbohydrate source, gave good mycelial growth but poor enzyme production; but if a small proportion was replaced by glucose, enzyme production was as good as on glucose itself. Galactose gave very poor growth and negligible enzyme production. For optimum production of pectolytic enzyme, glucose (or fructose or mannose) requires to be autoclaved in a somewhat alkaline medium—very conveniently with the dipotassium hydrogen phosphate or potassium phosphate of the nutrient medium. A yellow to brown coloration (due to caramelization) is produced in the process; but the stimulating factor is not bound up with the colouring substance. The same stimulating effect on enzyme production was obtained by adding to the nutrient medium a small quantity of glucose which had been dry-heated at 150° C. for 20 min. Partition chromatographic analysis suggested that the stimulating substance was probably glyceraldehyde, though it is not excluded that other breakdown products of sugars may also play a part.

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

REPORT FOR 1954–55

THE fifty-fourth annual report of the Executive Committee of the Carnegie Trust for the Universities of Scotland, covering the academic year 1954–55*, records an increase in the numbers of students from 1,408 to 1,502, chiefly in science and medicine, to whom assistance was given with their class fees, the amount expended increasing from £22,007 to £24,232. Problems created for the Trust by the bursary awards made by local education authorities in terms of the Education (Scotland) Act are by no means solved, and the Executive Committee directs attention to the, apparently, growing assumption of many students that the Carnegie Trust grant is to be applied for as an addition to the education authority bursary, whatever be the value of that bursary. Strongly emphasizing its declared intention to limit its assistance in this direction to holders of local education authority bursaries whose circumstances, taken as a whole, appear genuinely to warrant additional help, the Executive Committee expresses its desire for a proper appreciation of this policy and the reasons for it on the part of directors of education, university advisers of studies and similar officials.

Expenditure on the Trust's research scheme totalled £33,155, and its various features were maintained. Three senior scholarships and fifty-three scholarships were awarded or renewed, some being supplements to scholarships and bursaries gained from other sources, and twenty-three of these were used for postgraduate study outside the parent university. The high value of this part of the programme is stressed in the report, as is that of the scheme, inaugurated in 1950, which affords annually ten members of university staffs, more than thirty years of age, the opportunity of study abroad. Eleven such awards were made in 1954–55, three being in scientific subjects, two in medicine and one in African studies. Besides the annual grant made to the Royal Society of Edinburgh and to the *Scottish Historical Review*, eleven learned societies in Scotland were assisted in the publication of their transactions and journals; in addition to an immediate grant of £2,000 to the Scottish National Dictionary, the Scottish Dictionaries Joint Council was invited to submit plans by which £20,000 could be used for ensuring substantial developments within a reasonably short period, and this sum has been placed at the Council's disposal. Repayments by former beneficiaries declined slightly from £1,921 from thirty-six former beneficiaries to £1,868 from thirty-three beneficiaries.

Besides particulars of grants made under the ninth quinquennial distribution, October 1, 1952–September 30, 1957, there are appended the terms of the scheme for the endowment of postgraduate study and research and a summary of reports received from the advisers to the Trust on the work of investigators under the research scheme during 1954–55. In the mathematical, physical and engineering section, the fellowships of R. Giles on quantum field theory at the Institute of Theoretical Physics, Copenhagen, and of D. Chisholm on the flow of two-phase mixtures at the University of California are stressed as outstanding. K. M. Swanson's work on nuclear magnetic resonance was again successful, and in connexion with J. V. Thomson's work in fluid dynamics it is suggested that the Scottish universities should co-operate to provide an electronic computer with the strong support of the Carnegie Trust.

In the chemistry section, J. S. S. Reay, working on organic ammonium derivatives of montmorillonite, has noted interesting relations between the molecular volume of the ammonium ions and the adsorptive capacity for hydrocarbons. J. M. Beaton's work at the Royal Technical College, Glasgow, has been instrumental in establishing the constitution of taraxerol; also, by establishing the orientation of the carboxyl group in glycyrrhetic acid, he has completed the determination of its stereochemical configuration and has effected the first direct conversion of a member of the ursane triterpenoid group into an isomer of the oleanane group. Miss H. Kerr's successful work on the algae of the highest life zone of the shore at the Marine Station, Millport, and G. K. Wallace's work, in the Anti-Locust Research Centre Laboratory of the Entomology Department, Oxford, on the influence of light and of observable objects on the movements of locusts, are also noted, as well as that of Dr. S. M. Marshall and A. P. Orr on the distribution, anatomy, reproduction, development and life-cycle of the small crustacean *Calanus finmarchicus* (Gunnerus). Continuing his gravity survey in Scotland, Dr. J. Phemister covered the whole of Fife and Scotland south of the Forth–Clyde, and W. G. Jardine continued his researches at Cambridge on the relation between shore-lines and river-valley development, with particular reference to the Southern Uplands. D. H. Mackenzie commenced a structural and petrological study of the granite and associated rocks of Mid-Strathspey, and D. I. Smith a similar study of the third ring dyke complex of Ardnamurchan.

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* Carnegie Trust for the Universities of Scotland. Fifty-Fourth Annual Report (for the Year 1954–55) submitted by the Executive Committee to the Trustees on 20th February, 1956. Pp. iv+72. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1956.)

The usual lists of publications by fellows, scholars and recipients of grants and of awards under the research scheme during the year are also appended, together with the financial accounts.

FLOW OF VISCOUS LIQUIDS IN BRANCHED TUBES

WITH REFERENCE TO THE HEPATIC PORTAL VEIN

By Dr. C. H. BARNETT and Dr. W. COCHRANE

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THE existence of independent stream-lines within the hepatic portal vein[1] may account for the localization of disease processes within certain parts of the liver[2]. Before conclusions drawn from animal experiments can be applied to man, however, anatomical and physiological differences need to be considered. In different species, the tributaries and branches of the vein vary with respect to diameter and angle of junction; moreover, the relative rates of flow and viscosity of the circulating blood probably show species variations. To investigate the significance of these differences, experiments have been carried out on non-turbulent flow for the following typical junctions: a minor branch leaving a straight main tube; a minor tributary joining a straight main tube; and major and minor tributaries uniting to form a main tube. The aim has been to determine the region of the main stream which feeds the branch in the first case, and the region of main stream receiving from the tributary in the second and third cases. Some answer can then be given to the question: What are the chances that particles (bacteria, malignant cells, etc.) suspended in the blood leaving an organ and entering the portal vein will be eventually directed into a particular region of the liver ?

The liquids used were (1) water and (2) 40 per cent glycerine in water (specific gravity 1·100), referred to below as 'glycerine'. The viscosities of these liquids at room temperature (19°–21° C.) were (1) 1·0 and (2) 3·5 centipoises, approximately that of human blood[3]. The tubes were of 'Perspex', cut and drilled as necessary, and cemented together so as to give sharp internal edges at the junctions. Unless otherwise stated, the internal diameters of the main tube and the wide and the narrow branches or tributaries were 10, 8 and 6 mm., respectively. The lengths of all the tubes from the junction were sufficient to ensure that the steady parabolic velocity profile was usually at least 99 per cent developed. By means of a large opal lamp and a lens, the system under investigation was projected on to a white screen and measured at a magnification of × 8. Corrections for optical distortion were applied. No elaborate investigation of the scaling of tube dimensions has been attempted, but it appears that the results are valid for other dimensions of tubes if the ratio of diameters remains unchanged. When flowing in tubes of diameter exceeding 0·4 mm., blood can be regarded as a continuous medium[4].

For flow into a branch from a straight main tube, the apparatus is shown in Fig. 1*a*. Flow-rates were adjusted by constricting the two exits. The position of a stream-line in the main tube was shown by a fine line of coloured liquid (Evans blue) from a quill tube, the position of which was controlled by a micrometer screw. When the rates of volume flow, Q_s in the branch and Q_m in the lower part of the main tube, were steady, the position of the coloured stream-line was adjusted until it just failed to enter the branch. The distance x of this critical stream-line from the wall of the main tube was measured (Fig. 1*a*). Graphs of Q_s/Q_m against x were drawn, x being expressed as a percentage of the diameter of the main tube. Some results are shown in Fig. 2. Each curve is the result of thirty or more observations and is probably accurate to ± 5 per cent. The results were independent of the total flow-rate. It was concluded that, for a given value of Q_s/Q_m, the chances that particles in the main tube remote

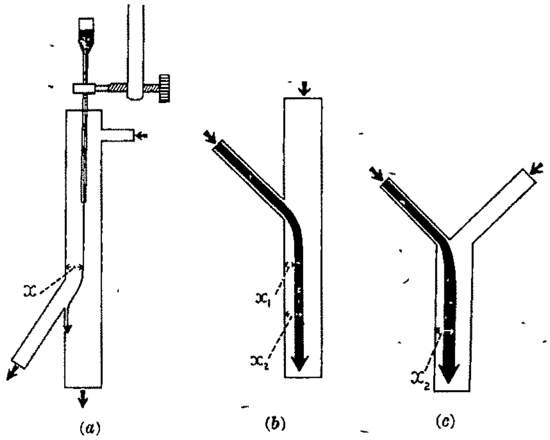

Fig 1

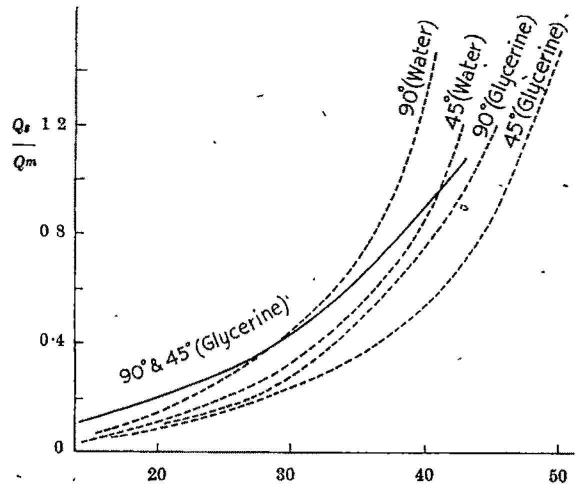

Fig. 2. Critical distance x for wide (——) and narrow (- - - -) branches, different angles and viscosities

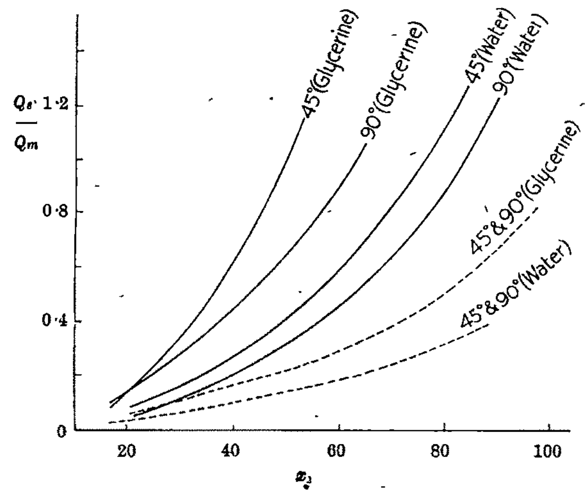

Fig. 3. Limiting distance x_2 for wide (——) and narrow (- - - -) tributaries at angles of 45° and 90° and different viscosities

from the branch will pass into it are greater with increasing viscosity and decreasing width of the branch. The angle of outflow is of little significance when the values of Q_s/Q_m are those likely to occur in the portal venous circulation.

For inflow from a tributary to a straight main tube, the apparatus is shown in Fig. 1*b*. The flow-rates, Q_s of the coloured liquid in the tributary and Q_m in the upper part of the main tube, as well as the distances x_1 and x_2, were measured. With glycerine, x_1 was usually zero unless the ratio Q_s/Q_m was very high: this measure is therefore not discussed here. The value of x_2 was measured about 6 cm. below the junction; here the coloured tributary stream was nearly always flowing parallel to the axis of the main tube. Graphs of Q_s/Q_m against x_2 were drawn, x_2 being expressed as a percentage of the main tube diameter (Fig. 3). In contrast to the findings for outflow, the values of x_2 depended on the total flow-rate Q_t (= $Q_s + Q_m$). However, when Q_t exceeded 100 ml./min., the results were effectively independent of Q_t. This flow corresponds to an average velocity of 2·1 cm./sec. and, since lower velocities would not be physiologically important[3], only the experimental results for the higher values of Q_t are given in the graphs. It was concluded that, for a given value of Q_s/Q_m, the chances of particles from the tributary passing far across the main tube are greatest when the tributary is narrow, the liquid is of low viscosity and (in the case of wide tributaries) when the angle of junction is large.

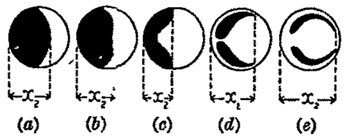

Fig. 4

Finally, we considered major and minor tributaries uniting to form a symmetrically-placed main tube. The apparatus is shown in Fig. 1*c*. The major tributary and the main tube were 10 mm. in diameter; the minor tributary was 8 mm. ('wide') or 4 mm. ('narrow'). The rates of flow in the major and minor tributaries ($Q_{\text{maj.}}$ and $Q_{\text{min.}}$) and the distance x_2 was measured (Fig. 1*c*). The significance of x_2 requires further explanation, since—except at high values of $Q_{\text{min.}}/Q_{\text{maj}}$—the liquid from the minor tributary spread out on entering the main tube. This is shown in the cross-sectional diagrams of Fig. 4 *a* . . . *e*, which correspond in that order to a decreasing series of values of $Q_{\text{min.}}/Q_{\text{maj.}}$. The distance x_2 is thus the limit of penetration across the main tube *as seen in profile*. The lower portions of the curves in Fig. 5, where the slope is negative, correspond to this circumferential spreading, which occurs for most physiologically important values of $Q_{\text{min.}}/Q_{\text{maj.}}$. The total flow-rate Q_t (= $Q_{\text{min.}} + Q_{\text{maj.}}$) is of considerable importance; the effect of altering the total flow, using wide tributaries at 90°, is shown in Fig. 5. A similar effect was observed using narrow tubes or 45° junctions. With water, the circumferential spreading was found to occur at lower values of $Q_{\text{min.}}/Q_{\text{maj}}$ than with glycerine. For a given value of $Q_{\text{min.}}/Q_{\text{maj.}}$, the chances of particles

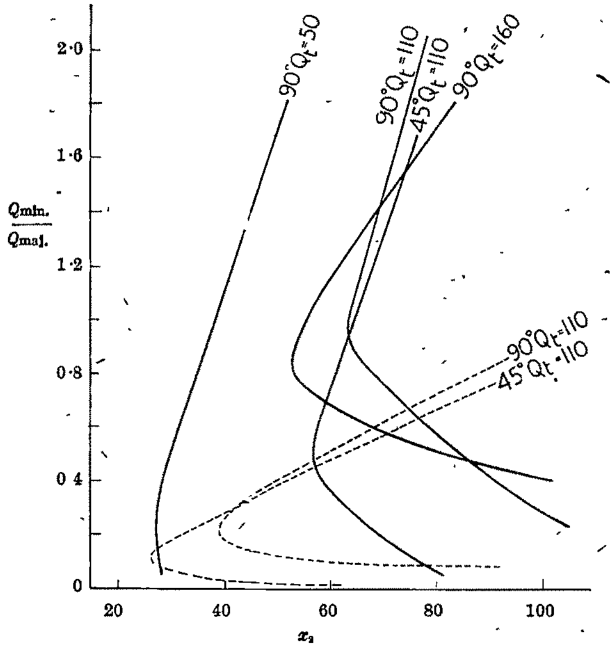

Fig. 5. Penetrating distance x_2 for symmetrically joined major and minor tributaries, using wide (——) and narrow (·······) minor tributaries, differing angles and three rates of total flow (Q_t); glycerine throughout. The curve - - - - is qualitative only

from the minor tributary passing far across the main tube are greater when the angle of junction is large (Fig. 5). In flow conditions simulating those within the portal venous system, the circumferential spreading is especially marked when the diameter of the minor tributary is large, the ratio $Q_{\min}/Q_{\text{maj.}}$ low and the viscosity of the liquid high.

Physical explanations of the experimental curves will be discussed later.

To summarize, it may be said that when the blood-flow within the hepatic portal vein is compared in different species, the following principles should be borne in mind: (1) At the liver hilum the angle of branching of the portal vein is immaterial. For a given ratio of the rates of flow in the main vessel and a branch, a narrow diameter branch is more likely to withdraw particles from far across the main vessel than is a wide one. (2) The manner of formation of the portal vein is important. Where it is formed by a tributary joining a straight main vein, as in Fig. 1b, particles are more likely to pass across the portal vein when the rate of flow in the tributary is large and its diameter small. The converse is true where the portal vein is formed by the symmetrical union of a major and minor tributary, as in Fig. 1c, unless the rate of flow in the minor tributary is very high. In both types of junction more crossing-over of the streams occurs when the angle of union is large than when it is acute.

[Aug. 12

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FINE STRUCTURE OF THE INSECT RETINULA AS REVEALED BY ELECTRON MICROSCOPY

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IN the course of electron microscope studies of the compound eye of insects, interesting structural details of the visual cells forming the retinula have been observed, which bear relation to the complex functional properties of these light receptors.

The percipient portion known as the retinula at the base of each ommatidium consists of a group of generally seven or eight elongated visual cells, arranged so that their differentiated medial borders (rhabdomeres) form together the central rhabdom or optic rod occupying the longitudinal axis of the ommatidium[1] (Fig. 1,*a*). An analysis of the submicroscopic organization of these receptor elements was carried out by electron microscope examination of ultrathin (200 A.) serial sections of whole insect eyes fixed with osmium tetraoxide and embedded in methacrylate. In view of the tough chitin components of the insect eye, a diamond knife[2] had to be used for routine serial sectioning.

In transverse sections through an ommatidium of the eye of the house-fly (*Musca domestica*), the seven rhabdomeres of the corresponding retinula cells appear as dense round or oval bodies, 1–2 microns in diameter, which are grouped in a regular pattern around the light granular central region (Fig. 1,*b*).

Each rhabdomere is surrounded by a double membrane (approximately 200 A. thick), and most of these elements show a characteristic internal laminated structure represented by twenty to thirty transverse dark lines alternating with light spaces, with a regular period of approximately 500 A.

Serial sections indicate that this transverse lamination corresponds to corrugated and perforated membranes running generally parallel to the long axis of the rod-shaped rhabdomere (Fig. 1,*c*). In addition to this predominant type of longitudinally oriented lamination, the other rhabdomeres in each ommatidium exhibit a distinct fenestrated structure (Fig. 1,*d*) formed by a network of intersecting oblique transverse dark lines. This characteristic appearance in cross-sections may correspond to fenestrated disks arranged with their planes perpendicular to the rhabdomere axis (Fig. 2,*c*).

In longitudinal sections through a rhabdom, the two main types of internal structure can be readily recognized in adjacent rhabdomeres (Fig. 2,*a*) separated by the clear central space containing fine filaments and a granular material. The most common texture encountered is represented by a fenestrated membrane with a roughly hexagonal framework of dark lines in which an axial periodicity of approximately 600 A. can be detected (Fig. 2,*b*). This characteristic structure probably corresponds to the longitudinally oriented membranes described in the transverse sections (Fig. 1,*b*).

The second type of structure appears as a system of regular transverse light bands alternating with dark bands (approximately 600–700 A. in thickness), each of which is delimited by two dark, segmented lines (Fig. 2,*c*). These dark bands can be interpreted as representing perforated disks arranged perpendicularly or obliquely to the long axis of the rhabdomere.

Each of the rhabdomeres constituting a rhabdom exhibits a slightly different, characteristic fine structure; but as a group they are nevertheless organized in certain basic patterns. Thus, in transverse sections (Fig. 1,*b*) the six external rhabdomeres symmetrically distributed around the central rhabdomere (*D*) can be grouped into three pairs of elements which are similar in shape, size and internal structure. These paired rhabdomeres are usually located diagonally opposite to each other (Fig. 1,*b*: *A*1, *A*2; *B*1, *B*2; *C*1, *C*2).

The differentiated submicroscopic organization of the rhabdom depicted on the basis of these preliminary findings suggests a correlation with the functional differentiation of the retinula cells which has been postulated in order to account for the remarkable capacity of insects to discern the plane of polarized light and to orientate themselves by it[3]. According to the investigations of Autrum[4], the visual cells of each ommatidium may perform the functions of radially placed analysers for polarized light. The highly regular submicroscopic laminated structure of the single rhabdomeres described here might well furnish the structural basis for the optical properties (such as textural birefringence of the composite laminated and fenestrated bodies, combined with the intrinsic birefringence of its components) which are required of such an analyser for polarized light.

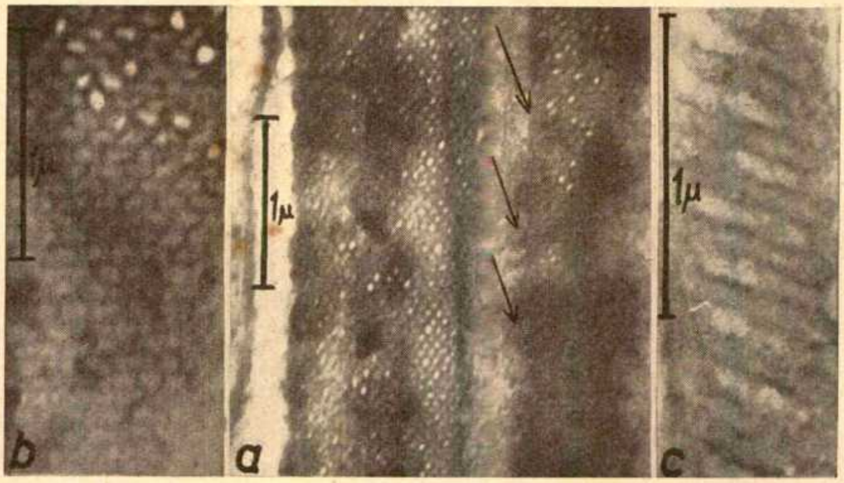

Fig. 2. Electron micrographs of longitudinal sections of rhabdomeres. (*a*) Longitudinal ultrathin section of two rhabdomeres of the house-fly eye with fenestrated structure and transverse lamination (arrows). × 22,000. (*b*) Longitudinal section of a rhabdomere showing the regular fenestrated framework of the membrane. × 29,000. (*c*) Longitudinal section of a rhabdomere with transverse laminated structure. × 39,000

Moreover, the characteristic distribution pattern of the rhabdomere pairs would provide a spatial arrangement adequate for the proposed functions of a compound analyser ascribed to an ommatidium.

The same general type of fine structure has been observed in the rhabdomeres of all other insects examined so far (the honey bee, *Apis mellifiora*, *Erebus* and other tropical Lepidoptera and Odonata). The transverse laminated structure of the receptors in the visual cells of insects described here is similar in some respects to the submicroscopic disks found in the external segments of the rods and cones of the vertebrate retina[5]. Further details of the rhabdomere texture and of their association with specialized submicroscopic tubules, as well as their characteristic structural relationship with the components of the optic ganglion, will be published elsewhere. [Feb. 18

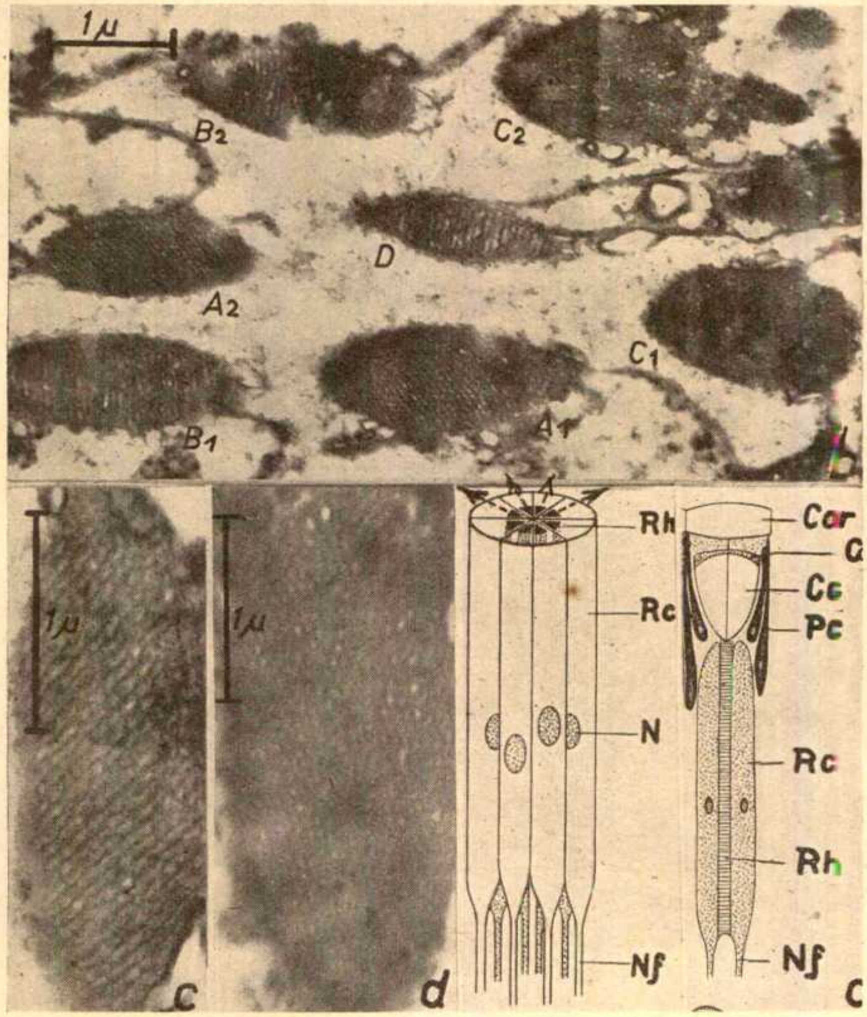

Fig. 1. (*a*, lower right) Schematic diagram of a longitudinal section through an ommatidium showing the visual cells (*Rc*) with the rhabdomeres. (According to Grenacher and Hesse) Electron micrographs of: (*b*) transverse ultrathin section through the rhabdomeres of an ommatidium from the house-fly eye. × 16,000; (*c*) transverse section of a rhabdomere with oblique transversal lamination. × 28,000; (*d*) transverse section of a rhabdomere with fenestrated internal structure. × 24,000

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Atomic and Astronomical Time

A cæsium atomic resonator[1] has been in operation as the standard of frequency at the National Physical Laboratory for eight months and its performance under a variety of conditions has been investigated. It has been found that the electrical and mechanical conditions required for an accuracy of repetition of ± 5 parts in 10^{10} are easily attained, and it is expected that the model now being designed for routine operation will give an accuracy approaching ± 1 part in 10^{10}.

During this investigation many changes were made to the cæsium beam chamber; but it was nevertheless found possible to calibrate the quartz standard under specified conditions at regular intervals of about one week. The results of the calibration, given in Fig. 1*a*, are based on the value of the cæsium frequency determined in June 1955[1]. The actual values are not therefore of particular interest, and it is only the variations with which we are here concerned. The National Physical Laboratory quartz clock *Q*13 was chosen for these measurements, because it had been in operation for three years with a uniform rate of change of frequency of 3·5 parts in 10^9 per month and appeared, therefore, to be one of the most stable of existing timekeepers. It is seen that for a further period of six months the rate of change was almost constant at the same value, but that it then changed to 1·5 parts in 10^9 per month. No reason for this change could be found.

The determination of the rate of the clock in terms of astronomical time is somewhat complicated[2]. For its time determinations, the Royal Greenwich Observatory is able to use all the most reliable clocks in Britain by means of a continuous interchange of information between the different laboratories, and *Q*13 is one of the clocks used in this way. Details of its calibration in astronomical time could therefore be supplied by the Observatory, and it was not necessary to wait for the publication of time signal corrections, as would normally be necessary for precise measurements. The results obtained with the different clocks are combined to give a mean clock, the rate of which is determined by observing the times of star transits. This mean clock can then be used to give the performance of the individual clocks. The values for *Q*13 supplied by the Observatory one month in arrears are given in Fig. 1*b*. The curve of Fig. 1*c* is obtained by subtracting the ordinates of Fig. 1*b* from those of Fig. 1*a*, and it thus represents the variations of the unit of astronomical time in terms of the cæsium standard. The maximum variations of ± 4 parts in 10^9 agree well with the estimate of the accuracy of the Observatory time service made by Smith[3].

It is customary for the Observatory to make a new assessment of the unit of time after a period of six months, when the clock performances and the stellar observations can be viewed in retrospect. This has not yet been done for the period in question; but a special reassessment was made at the end of January, using the results obtained over a long period with a group of nine quartz clocks. The results given in Fig. 1*d* show a considerable improvement in uniformity. This uniformity is mainly a function of the clock performance, only the general slope of the line being determined by the astronomical measurements. Finally, in Fig. 1*e* are plotted the monthly means of the star observations in terms of the cæsium standard (Smith, H. M., and Tucker, R. H., private communication). The results give an indication of the variation in the rate of rotation of the earth, although the scatter of the points about a mean curve is probably due to the instrumental errors associated with the astronomical observations.

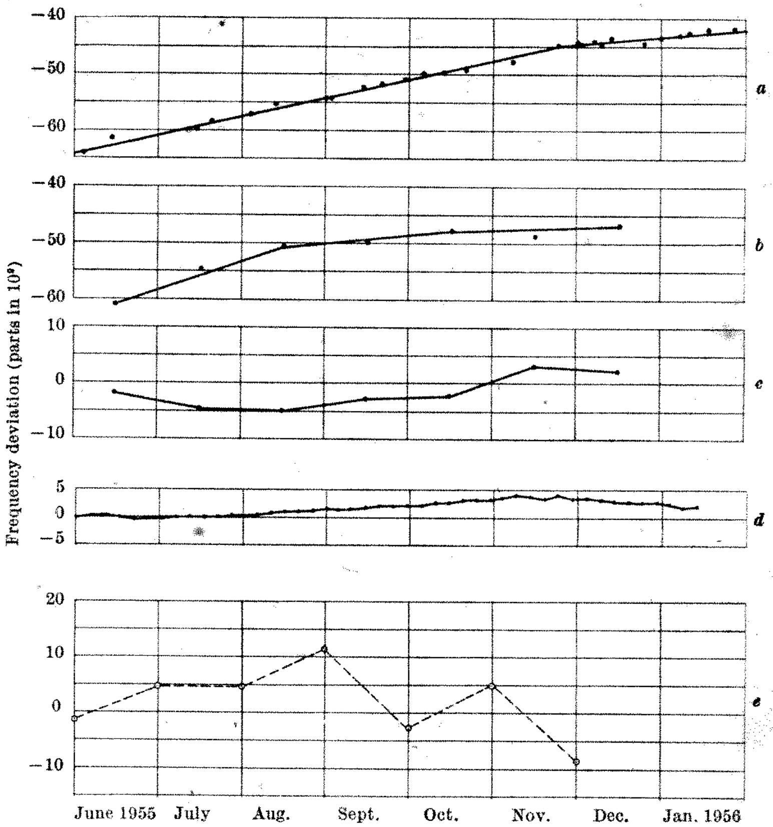

Fig. 1*a*. Frequency deviation of *Q*13 in terms of the cæsium 3·0–4·0 resonance, based on the frequency of the cæsium resonance measured in terms of the Royal Greenwich Observatory monthly current value of *Q*13 in June 1955.

Fig. 1*b*. Frequency deviation of *Q*13 in terms of the Royal Greenwich Observatory monthly revised values.

Fig. 1*c*. Royal Greenwich Observatory monthly revised values in terms of cæsium.

Fig. 1*d*. Royal Greenwich Observatory reassessed values, based on astronomical observations and the mean of nine quartz clocks, in terms of cæsium.

Fig. 1*e*. Astronomical observations in terms of cæsium.

A mean curve would agree fairly well with the periodic variation predicted from the observations of previous years.

Another important result of the investigation was the gradual realization that when the most suitable conditions of operation had been found, and the novel techniques mastered, the cæsium resonator became a remarkably simple instrument to use. There can be no doubt that this or some other atomic standard will revolutionize the technique of determining the unit of time, and will in practice be used to make the unit available, however it may be defined.

We are glad to acknowledge the co-operation of Mr. H. M. Smith and Mr. R. H. Tucker of the Royal Greenwich Observatory in supplying the astronomical data.

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Teddington, Middlesex. Feb. 14.

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Gelatin Light-scattering, by a New Enzymic Digestion Technique

In applying light-scattering techniques to molecular-weight and dissymmetry measurements for gelatin fractions in solution, serious doubts arose concerning the efficiency of the usual clarification methods (ultrafiltration, high-speed centrifugation). A convincing check of clarifying processes existed only for fractions of low molecular weight, where the experimental value of the dissymmetry, Z, should approximate to the theoretical value, unity, if all suspended impurities have been removed. For higher molecular weights, a solution free from impurities would be expected to give Z greater than 1, and the procedure adopted by other workers has been to repeat the clarification until Z became constant. It was suspected that this limit did not correspond with complete clarification, and that the use of this criterion caused significant errors in the 90° scatter (and M_w) and large errors in the values of Z.

The alternative, and novel, procedure was therefore adopted of measuring the light scattered from a solution which had been given only a moderately effective clarification, and then destroying the gelatin macromolecules by adding a solution of Armour crystalline trypsin. The residual scatter was mainly that of the solvent and the impurities, since the digestion products of the gelatin, and the added trypsin, have negligible scatter. Subtraction of the residual scatter from the original figures then gives the scatter due to gelatin alone, so that the molecular weight and true dissymmetry of the dissolved gelatin may be obtained. The effects of the addition of trypsin may be seen in Table 1.

In this experiment the gelatin solution was forced by air pressure (2 lb./sq. in.) through a '5 on 3' sintered glass disk into the metal semi-octagonal cell (capacity 50 ml.), held at 40·0° C. At the time '0·50 hr.', 2 ml. of the trypsin solution (concentration 10 mgm. per 100 ml. water) was pipetted into the cell. The trypsin solution had also been filtered through a '5 on 3' sintered glass disk. After 24 hr. a further 2 ml. of the trypsin solution was added, and the scatter increased by 2 per cent at each angle.

Table 1

Time (hr.)	Scatter (arbitrary units) at 135°	90°	45°	Apparent dissymmetry ($\lambda = 546$ mμ)
0	26·0	12·0	32·0	1·23
0·50	26·0	12·0	32·0	1·23
0·75	9·5	4·65	14·7	1·55
1·0	8·55	4·4	13·6	1·59
2·0	8·0	4·1	13·8	1·73
4·0	8·0	4·1	13·9	1·74
24·0	8·0	4·1	13·9	1·74

Gelatin concentration: 3·35 gm. per litre, in 0·5 molar saline, pH 6·8

These results show that the gelatin fraction contributed only two-thirds of the original 90° scatter, and gave unit dissymmetry of scatter, within experimental error. From the 90°-scatter due to gelatin a value of 22,000 was deduced for M_w.

In low-angle studies the extra accuracy available through the trypsin digestion technique is incompletely realized unless the solutions are clarified as effectively as possible. On the other hand, in the determination of molecular weight by the 90°-scatter method, where the suspended impurities contribute a smaller proportion of the total scatter, poor clarification may be adequate. For example, a 0·5 M saline neutral solution of another gelatin fraction was divided into two parts, and one part was filtered as in the above experiment whereas the other was filtered, under gravity, through a coarser sintered glass disk only. The following results were obtained:

	Type of filter 2	'5 on 3'
Molecular weight gelatin	119,000	115,000
Percentage original 90°-scatter due to gelatin	64	98

In principle, the method is applicable to many macromolecular systems, and may be found to be particularly useful for aqueous solutions, many of which are more difficult to clarify than non-aqueous solutions. The successful application of the technique rests principally upon selective breakdown of the macromolecules under investigation, and it is in this connexion that enzymic attack can be so valuable. It is also necessary that the mode of degradation should interfere as little as possible with the scattering from the solution, and that the impurities should not settle out of solution during the experiment. As the above experiments confirm, the gelatin/trypsin system meets these requirements.

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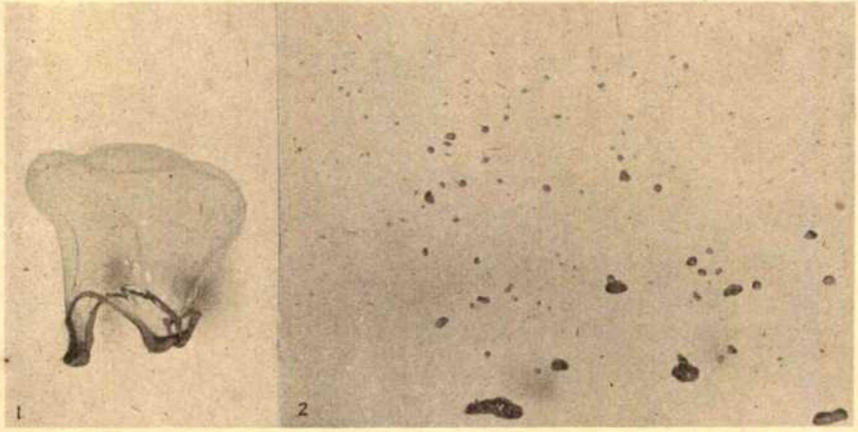
Nov. 11.

Shattering of Large Drops

The purpose of this communication is to present some experimental results obtained during a laboratory investigation of the mechanism of the break-up of drops. Results of previous workers indicate that drop deformation and turbulent air flow are major factors in the break-up of drops suspended in the air stream of vertical wind tunnels. Shattering break-ups have been observed for drops 5–9 mm. in diameter as a result of sudden changes in the velocity of the wind stream, or as a result of collisions between drops[1]. The fragments from the disintegrations of one hundred parent drops between 9 and 12 mm. in diameter have been collected and a size distribution determined[2]. No account of the actual mechanism of break has come to our notice, although factors responsible for the deformation of drops between 5 and 7 mm. in diameter have been evaluated[3].

We now report a phenomenon associated with the shattering of large drops that apparently has escaped the attention of previous workers in the field. Reasonably well-formed drops, 10–25 mm. in diameter, were allowed to fall through stagnant air and the resulting break-ups observed. Most drops larger than 10 mm. in diameter and all drops larger than 12 mm. in diameter were shattered with considerable violence after a limiting velocity had been reached. High-speed photographic techniques were employed in the study of the actual break-ups, and hundreds of photographs were obtained showing their different phases.



(1) Inflated drop in which the canopy has been torn by aerodynamic forces. (2) Fragments from the break-up of a drop 15 mm. in diameter

Photographic evidence indicates that deviation from sphericity increases with increasing velocity of the drop as it falls through the air. Smaller drops assume a reasonably stable shape at terminal velocity; but larger drops are deformed to such a degree before the terminal velocity is reached that a critical value for the ratio of the minor to the major axis is attained. When this ratio is reached, the centre of the flattened drop suddenly bulges upward and the drop opens in somewhat the same manner of a parachute. Aerodynamic forces immediately rupture the canopy of the inflated drop, which disintegrates into a shower of smaller droplets. From the time the first bulge appears on the upper surface of the parent drop until the break-up is complete, less than one-fifteenth of a second elapses. Fig. 1 shows a typical drop in the stage of disintegration in which the canopy has just been torn by aerodynamic forces. The size distribution of fragments to be expected from the break-up of a 15-mm. drop is indicated in Fig. 2.

We wish to thank the Nova Scotia Research Foundation for the support given this project. Further details of the work and techniques of large-drop formation will be published elsewhere.

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Solvent Extraction of Polonium from Nitric Acid Solutions

THE usual valency of polonium is 4, as was established by tracer-scale investigations[1] and by recent studies[2] with milligram amounts of the element. It has also been suggested[3], from electrochemical deposition experiments and co-precipitation studies, that hydrazine, hydroxylamine, sulphur dioxide, oxalic acid and hydrogen peroxide can, in certain conditions, reduce tracer-amounts of polonium to a lower valency state, the reduction occurring readily.

Recent investigations[2] with weighable quantities of material have shown that quadrivalent polonium is reduced, in halogen acid solution, by sulphur dioxide and hydrazine to a bivalent state, with some evidence for an intermediate trivalent state in the case of the chlorides. It was found that hydroxylamine and oxalic acid have no effect on solutions of polonium chlorides, and that hydrogen peroxide oxidizes macro-amounts of bivalent polonium to the quadrivalent state.

Investigating the extraction of trace amounts of polonium from nitric acid solutions by diethyl ether and other organic solvents we found an interesting property, probably related to a lower-valency state of this element.

Some microcuries of pure polonium, prepared by anodic electrodeposition[1], were dissolved in nitric acid with a molarity ranging from 1·75 to 8. Negligible extraction was found by shaking these solutions with the same volume of peroxide-free diethyl ether, in the absence of daylight. However, when ether containing peroxide was used, a part of the polonium passes into the organic phase. The polonium was found to be extracted by peroxide-free diethyl ether when some drops of hydrogen peroxide or some milligrams of hydrazine or hydroxylamine were previously added to the nitric acid solution; with oxalic acid no extraction was observed.

When sulphur dioxide was bubbled through concentrated nitric acid solutions of polonium visible decomposition was observed, and the polonium was not extracted from these solutions by peroxide-free ether. Extraction occurs when the nitric acid molarity is adjusted after previous reduction of polonium by sulphur dioxide in dilute nitric or hydrochloric acid. Fig. 1 illustrates the effect of increasing nitric acid molarity on the percentage of polonium extracted, for the various reducing agents used.

It can be seen from the graph that approximately the same percentage of polonium is extracted, at a given nitric acid molarity, by peroxide-containing ether and also by peroxide-free ether when to the aqueous phase hydrogen peroxide or sulphur dioxide is added. However, the results with sulphur dioxide are less reproducible at high nitric acid molarities, which is probably due to the oxidation of this reagent by nitric acid. The percentages of polonium extracted are approximately the same as those obtained in the extraction of uranyl nitrate from nitric acid solutions

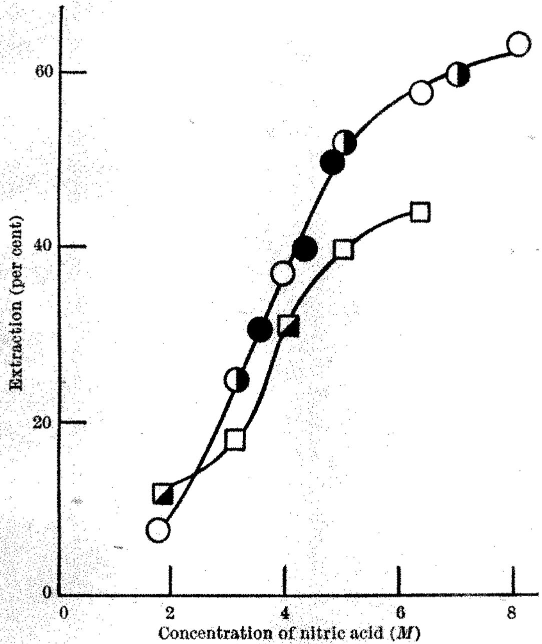

Fig. 1. ●, Sulphur dioxide ; ◐, hydrogen peroxide ; □, hydrazine ; ◪, hydroxylamine ; ○, organic peroxide

by diethyl ether ; nearly 65 per cent of polonium is extracted from a solution in 8 M nitric acid by ether containing peroxide.

The same amount of polonium is extracted by peroxide-free ether when the nitric acid solution contains hydrazine or hydroxylamine ; the percentages of extraction are lower than those obtained with ether containing peroxide or with the other reagents. Visible decomposition of the solution was observed at nitric acid concentrations greater than 7 M, and no extraction was possible from these solutions.

No extraction occurs if instead of these reducing agents a strong oxidant such as chromic acid is added to the nitric acid solution containing the radioelement. Complexing agents of polonium such as hydrochloric acid lower the distribution coefficient, and no salting-out effect was found by adding ammonium nitrate to the nitric acid solutions. Back-extraction was readily verified when the organic phase with the extracted polonium is shaken with water.

In the presence of the same reducing agents other organic solvents such as di*iso*propyl ether and *iso*amyl alcohol also extract polonium from concentrated nitric acid solutions, although to a smaller extent than diethyl ether. However, it was found that with n-amyl alcohol and methyl*iso*butyl ketone the extraction occurs even when no reagent is added to the nitric acid solution ; but the presence of reducing agents in these solvents was verified. On the contrary, oxygen-free solvents such as carbon tetrachloride or chloroform fail to extract the radioelement in any conditions.

In agreement with the previous work on the tracer-scale, the solvent extraction behaviour of tracer-amounts of polonium suggests that hydrogen peroxide and hydroxylamine act as reducing agents in the conditions described. The reduction of trace-amounts of polonium by hydroxylamine has been reported before[3b] in acetic and sulphuric acid media, on warming the solutions. It is interesting to observe that for plutonium also the oxidation-reduction behaviour of trace amounts with hydrogen peroxide, in nitric acid solution and other media, differs from that with macro-concentrations of the element[4]. In the trace-experiments quadrivalent plutonium appears to be oxidized to quinquivalent plutonium or to sexavalent plutonium, whereas in the macro-experiments reduction to trivalent plutonium was observed.

It has been shown[5] that only a limited number of elements that have a marked tendency to form nitrate complexes are extracted in relatively high proportion from nitric acid solutions by diethyl ether. Investigating the anion-exchange behaviour of polonium in the presence of reducing agents, we have found evidence for negatively charged complexes in nitric acid media (unpublished results).

We are indebted to Prof. Fritz Feigl and to Dr. K. W. Bagnall for helpful discussions.

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Chromatographic and Spectroscopic Properties of Ellagic Acid, and its Occurrence in Dicotyledonous Plants

CHROMATOGRAPHIC and spectrophotometric properties of ellagic acid have now been investigated in order to facilitate the identification of this acid in plant extracts and hydrolysates. In early studies, ellagic acid has not always been adequately characterized; but the present work has confirmed the occurrence of this substance in a wide range of dicotyledonous plants[1]. Ellagic acid has also been identified in *Terminalia arjuna, bellirica, citrina, pallida* and *travencorensis* for the first time.

Table 1. R_F VALUES

Compounds	Ellagic acid	Flavellagic acid
Aqueous 40 per cent (v/v) formamide, pH 3·5	0·33	0·12
60 per cent formamide, pH 3·5	0·61	0·27

In order that paper chromatography may be used for the unequivocal identification of ellagic acid, solvent systems must be selected in which this substance has a reasonably high mobility. It has now been found that formamide – water mixture, buffered at pH 3·5 with formic acid, separates ellagic and flavellagic acids (Table 1). Ellagic acid has a high R_F value (0·70)[2] in benzyl alcohol–*tert.*-butanol–*iso*-propanol–water (3 : 1 : 1 : 1) mixture containing 1·8 per cent formic acid, and this solvent system has also been found useful for chromatographic identification purposes.

A study of the absorption spectra of ellagic and flavellagic acids (Table 2) has now shown them to

Table 2. ABSORPTION SPECTRA (MAXIMA, IN mμ, FOLLOWED BY LOG ε) IN β-METHOXYETHANOL

Ellagic acid	256 (4·53) ;	279 (4·63) ;	357 (4·15)
Flavellagic acid	266 (4·58) ;	279 (4·51) ;	358 (4·14)

Table 3. INFRA-RED MEASUREMENTS (BANDS. IN CM.$^{-1}$, FOLLOWED BY THE GROUP CONCERNED) IN 'NUJOL' MULLS AND POTASSIUM BROMIDE DISKS

Ellagic acid	Flavellagic acid	
1,712	1,712	; carboxyl stretching vibration
1,600, 1,580, 1,518	1,600, 1,580, 1,518	; aromatic bands
3,200	3,200	; H-bonded hydroxyl
3,570, 3,485	3,445	; free hydroxyl

belong to the type characteristic for compounds in which the phenolic hydroxyls are conjugated through the aromatic nucleus with carbonyl functions. Infra-red measurements (Table 3) have now shown a fundamental carbon–oxygen stretching vibration at 1,712 cm.$^{-1}$, which is assigned to the lactonic carboxyls. The comparatively low frequency of the lactonic carboxyl band is due to the lack of strain in six-membered lactone rings[3], and also to the fact that the lactonic carboxyls are attached to aromatic rings. It is well known[4] that the frequency of carboxyl functions is less when measured in the solid state than in solution. Both substances have bands assignable to H-bonded and to free hydroxyl, the band at 3,445 and 3,485 cm.$^{-1}$ respectively in the two substances being too strong to be assigned to the overtone of a ketonic carbon–oxygen stretching vibration. All attempts to prepare ketonic derivatives of ellagic acid have failed. In the solid state and in neutral and acidic solution, ellagic acid behaves in agreement with the conventional configuration, and it lacks unusual ketonic properties.

Our electrometric titration of ellagic acid shows that dissolution in cold alkali is not accompanied by ring-fission, and this is of interest in connexion with the recent isolation[5] from alkaline medium of a quinonoid benzylation product, $C_{42}H_{30}O_8$, by a reaction clearly involving enolic-benzylation of the lactone carbonyls. In alkaline solution, ellagic acid reacts in this case in the tautomeric quinonoid form, previously suggested in an entirely different context by Perkin[6].

Resonance energy is associated with the condensed ring-structure for ellagic acid, and it is accordingly suggested that the correspondingly low redox potential explains the poor response which the substance gives with the ferric chloride – ferricyanide reagent for polyphenols.

Some aspects of ellagic acid chemistry are now being studied in these laboratories, and detailed results will in due course be communicated elsewhere.

I thank Dr. H. Phillips, director of the British Leather Manufacturers' Research Association, for his interest and encouragement, and the Council of the Association for permission to publish this communication. I am indebted to Mr. D. E. Bethell, British Rubber Producers' Research Association, for recording the infra-red spectra.

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Discoloration of Muscle Preparations from Codling (*Gadus callarius*) by Degradation Products of I-Methylhistidine

BROWN discolorations of foodstuffs, resulting from Maillard-type reactions between amino-compounds and sugars, have been known for many years. Recently, it has been established that in the whole muscle of fish and the separated muscle extractives, reactions between amino-compounds and ribose may take place very readily: the free glucose in the muscle is less reactive[1,2]. However, evidence has been accumulating in this laboratory that such reactions may not contribute all the discoloration found in the muscle of codling under certain processing conditions.

Freeze-dried preparations of muscle extractives showed relative humidity/'browning' relations atypical of Maillard reactions[3], and considerable quantities of free sugars have been detected in badly 'browned' samples of stored vacuum contact-plate-dried muscle kindly given by Mr. E. J. Rolfe. High sugar values have also been found in 'browned' samples of freeze-dried muscle prepared by Dr. A. C. Jason, Dr. R. M. Love and me at this Station and afterwards stored over phosphorus pentoxide at room temperatures (~ 15° C.) in daylight (conditions which would largely eliminate Maillard reactions). In darkness, little or no 'browning' was observed under these zero-humidity conditions. Maillard-reactive free amino-nitrogen was in very large excess over sugar in all these preparations[2,4].

In investigations into the enzymic hydrolysis of anserine (β-alanyl-1-methylhistidine) in the muscle of codling, it was reported that synthetic *dl*-1-methylhistidine was unstable and developed discoloration in light[5]. As the natural amino-acid is liberated rapidly in the muscle after death (to some 60–80 mgm. after 8–10 days storage in ice at an ambient temperature of 2° C.[4]), it was thought that 1-methylhistidine degradation could contribute appreciably to any discoloration taking place during processing and storage of dehydrated fillets. For the present study, *dl*-1-methylhistidine has been prepared by the hydrolysis of anserine-containing fractions from pike (*Esox lucius*)[5] and fractionating the hydrolysate by displacement from 'Dowex 2 (OH)' resin columns with $N/50$ hydrochloric acid. The anhydrous amino-acid was repeatedly crystallized from 80 per cent ethanol.

The extractable free amino-acids and sugars of the muscle of 18–24 in. codling were removed from structural material by exhaustively dialysing homogenates against distilled water. Aliquots of extractive-free suspension, together with *dl*-1-methylhistidine at a concentration equivalent to 50 mgm. per 100 gm. wet weight original muscle, were freeze-dried over phosphorus pentoxide. They contained 0·3–0·4 per cent 'water' as estimated by 4-hr. heating to constant weight in a forced-draught oven at 105° C. Stored in desiccators over phosphorus pentoxide in daylight at 15° C., the preparations changed rapidly from white to yellow-brown at the surface. Controls with no 1-methylhistidine remained white, as did preparations containing the amino-acid if they were stored in darkness.

When freeze-dried suspensions containing 1-methylhistidine were equilibrated and stored at different relative humidities, it was found that, in preparations at high humidities (60–100 per cent relative humidity), a yellow-brown coloration appeared throughout:

this coloration did not occur in the absence of the amino-acid and was noticeable at relative humidities as low as 30 per cent. 'Browning' increased rapidly with temperature. During these experiments, controls with no added amino-acid have been checked chromatographically for the appearance of sugar from non-dialysable bound forms, and this has not been found. Under these conditions, it is possible that metallic ions bound to protein in a non-dialysable manner could be available to catalyse the degradation.

In relation to this work, it is of interest that 4 (5)-methylimidazole has been isolated from mixtures from Maillard-type browning reactions between glucose and ammonia[6] and glucose and glycine[7], so that there is evidence that simple imidazole compounds may lie on one of the pathways of such reactions. In physico-chemical studies on histidine, Lewin[8] has demonstrated degradations leading to the formation of yellow coloration in solution, and that glucose may inhibit this action under certain conditions.

The present communication indicates that simple compounds of imidazole type may initiate a non-enzymic discoloration of foodstuffs in the effective absence of sugar. It is not suggested that, in the presence of sugar and free amino-compounds under Maillard-reactive conditions, it is likely to be a major factor in 'browning'. Admixture of *dl*-1-methylhistidine and *d*-ribose under such conditions gave a dark-brown coloration considerably in excess of the yellow-brown obtainable with the amino-acid alone.

The chromatographic separations of anserine and *dl*-1-methylhistidine were carried out in part by Mr. J. Murray. The work described in this communication is part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Experimental Allergic Encephalomyelitis produced by Tubercle Bacillus Residues

It has been known for some time[1] that mixtures of acid-fast bacilli and homologous brain in water-in-oil emulsions produce allergic encephalomyelitis when injected parenterally into animals. A knowledge of the chemical composition of the substances responsible for producing this reaction is important, because of the light it might throw on processes occurring in some human and animal demyelinating diseases. Much attention has been devoted to the chemistry of the brain factor[2]; but relatively little is known concerning the bacillary factor. The latter was considered by Allegranza and Rovescalli[3] to be a high molecular-weight complex consisting largely of protein with the lipopolysaccharide acting synergistically. Working independently and along similar lines, we reported[4] that residues left after fat extraction of human tubercle bacilli retained encephalitogenic activity, whereas the material extracted was inactive; the activity was relatively resistant to acid, alkali or proteolytic enzymes, and was present only in the insoluble residues. It has now been found that, when tubercle bacilli are treated serially with these reagents, the insoluble residue is still active.

The starting material, obtained from Glaxo Laboratories, Ltd., was heat-killed human tubercle bacilli, which had been extracted with acetone and *iso*propyl ether[4]. A sample (10 gm.) was treated successively with $N/2$ potassium hydroxide for 48 hr. at 0–4°, N hydrochloric acid for 24 hr. at room temperature, pepsin (B.D.H., 200 mgm.) in $N/10$ hydrochloric acid for 24 hr. at 37° (two digestions), trypsin (B.D.H., 200 mgm.) in $M/10$ sodium bicarbonate for 24 hr. at 37° (two digestions). The dried residue, which after these treatments weighed 2·8 gm., was then extracted (Soxhlet) for four days with each of the following solvents to remove any free lipid: *n*-butanol, benzene and finally chloroform–methanol (2 : 1, v/v). Most of the lipid was extracted by the first solvent, and by the end of each four-day period no further material was being extracted. The resulting residue, on drying, weighed 1·9 gm. and was a pale yellow powder, no longer acid-fast by the Ziehl–Neelsen staining technique.

The residue was tested, as described by Colover[4]; it was incorporated (0·5 mgm./ml.) in an emulsion containing 'Bayol F' (Esso Standard Oil Co., N.J.), 'Falba' (Pfaltz and Bauer, Inc., N.Y.) and homologous brain suspension and the mixture injected intramuscularly into a group of six guinea pigs. Four injections of 1 ml. each were given at weekly intervals to each animal. On the thirty-first day the three survivors were killed. One animal was killed on the twenty-eighth day because it had become moribund; two others died a few days before the thirty-first day and had become paraplegic. On histological examination, the three animals which had shown clinical signs and one which had not were found to have the typical lesions of experimental allergic encephalomyelitis, as illustrated in Fig. 1. Histologically, two showed some evidence of perivascular demyelination in addition to the characteristic cellular reactions, but the amount of demyelination was somewhat less than that produced by the original starting material.

The analysis of the residue is given in Table 1. The percentage figures are based on dry weight. Carbohydrate was determined in the supernatant

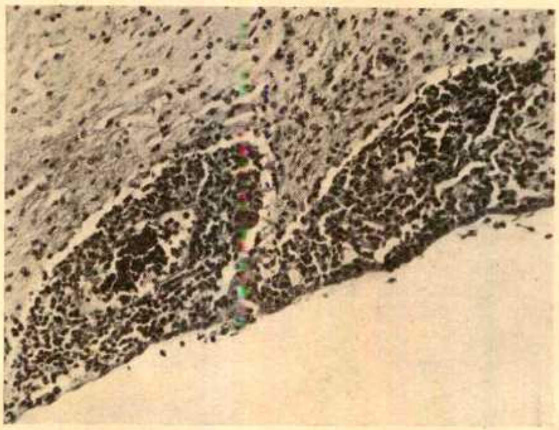

Fig. 1. Cross-section of guinea pig brain showing intense inflammatory-cell infiltration in the neighbourhood of two sub-ependymal venules (hæmatoxylin and eosin. × 210)

Table 1. ANALYSIS OF ACTIVE RESIDUE

Nitrogen	11·9 per cent
Hexosamine (ref. 5)	1·0 ,, ,,
Carbohydrate (as galactose-mannose) (ref. 6)	12·7 ,, ,,
Mycolic acid	9·8 ,, ,,
Amino-acids (liberated by 6 *N* hydrochloric acid)	Alanine (strong), glutamic acid (strong), diaminopimelic acid (moderate). Others, relatively weak or moderate
Sugars (liberated by *N* sulphuric acid) (ref. 7)	Glucose, galactose (both weak)

after hydrolysis with *N* sulphuric acid. Mycolic acid was determined by isolation following hydrolysis of a weighed sample with 6 *N* hydrochloric acid at 105–110°. The black residue was extracted with hot *n*-butanol. On cooling, the precipitate was collected and weighed. (A further small quantity was obtained from the mother liquor.) The crude substance was acid-fast; its melting point was 53–57°, undepressed by admixture with an authentic sample of mycolic acid supplied by Dr. N. Polgar. The equivalent was about 1,100 (alkali titration) and it contained C, 79·6; H, 12·5 per cent (α-mycolic acid, $C_{88}H_{176}O_4$ requires C, 81·4; H, 13·7 per cent and equivalent, 1,296). The total lipid, which was extracted by chloroform from another hydrolysed sample, was close in amount to the mycolic acid content, and did not appear to contain any other fatty acids in appreciable quantity.

Hydrolysed samples of the residue were examined for amino-acids and sugars by paper chromatography and paper electrophoresis[6]. The amounts of sugars observed were much smaller than expected from the apparent carbohydrate figure in Table 1. Because of this and also because much of the original carbohydrate of the starting material would have been removed by the various treatments, this figure is probably too high.

Since the tubercle lipopolysaccharide, 'wax D'[8], contains similar components to those in the active residue, it was decided to test this substance and also a sample of methyl mycolate, strain Marmorek (melting point 39°) (both supplied by Dr. E. Lederer), for activity as described above and at a dosage of 0·5 mgm./ml. Both substances were found to be inactive. On the other hand, Waksman and Adams[9] found that lipopolysaccharide and wax from tubercle bacilli were active in the production of experimental allergic encephalomyelitis in rabbits. However, these substances were much less active than the intact bacilli, and may not have been entirely free from tuberculoprotein. Several attempts by ourselves and others[3] with wax preparations have failed to produce positive results in guinea pigs. So far as our observations are concerned, the active principle in the tubercle bacillus is a relatively stable and insoluble substance. Although no attempt has yet been made to assess quantitatively the amount of activity of the residue as compared with that of the starting material[4], it is significant that even after a loss of more than 80 per cent as a result of the various treatments, the residue was still active at the same level (0·5 mgm./ml.). This residue is largely protein in character, with glutamic acid and alanine as predominant amino-acids. It would also appear that the mycolic acid present is chemically bound to protein, which would accord with its insolubility and resistance to chemical attack. It is conceivable that this type of substance, which may also contain some polysaccharide, is responsible for the encephalitogenic activity.

We thank Sir Robert Robinson and Drs. N. Polgar, E. Lederer and J. Ungar for helpful advice and material. One of us (J. C.) is in receipt of a grant from the Medical Research Council.

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Effect of Vitamin B_{12} Deficiency on Liver Dehydrogenase Activity in Rats

WEANLING rats born of mothers maintained on a diet deficient in vitamin B_{12} during pregnancy were fed on a vitamin B_{12}-free ration for twelve weeks and their liver dehydrogenase levels were compared with those of similar animals receiving 2-μgm. supplements of vitamin B_{12} daily. The basal diet had the composition: whole soya bean flour, 25; groundnut cake flour, 14; sesame cake flour, 14; wheat flour, 14; rice flour, 14; Bengal gram flour, 14; vitaminized starch, 2 (containing adequate quantities of all B-complex vitamins except vitamin B_{12}); shark liver oil, 2; Osborne and Mendel salt mixture, 1. At the end of the experiment, the animals were killed and the excised livers freed of blood clots and immediately chilled and used for measurement of dehydrogenase activities. Liver homogenates prepared in ice-cold *M*/15 phosphate buffer of *p*H 7·2 were used for the measurement of lactic, glutamic, succinic, butyric and choline dehydrogenase activities, according to the method described by Sreenivasa Murthy and Swaminathan[1], using tetrazolium bromide as the hydrogen acceptor. Portions of the liver tissue were used for nitrogen estimation by the Kjeldahl method. The vitamin B_{12} content of the liver was measured microbiologically using *L. leichmannii*-4797 as the test organism.

In a second series of experiments, the effect of vitamin B_{12} injection to deficient rats on the regeneration of liver dehydrogenases was studied. The levels of dehydrogenases in these animals were compared with those found in positive control groups that had been receiving the vitamin supplements since the beginning of the experiment.

The results for dehydrogenase-levels of animals on the diet deficient in vitamin B_{12} and control animals are presented in Table 1. They show a significant difference in weight between the vitamin B_{12}-deficient and control animals, although there was no difference between the two groups with respect to the weight of the liver or the nitrogen content of the liver. The general level of various dehydrogenases in the liver is, however, reduced. The differences in enzyme activity between deficient and control groups are statistically significant. The fact that the pattern

Table 1

Diet	Average gain in weight (gm.)	Average liver weight (gm.)	mgm. Nitrogen/gm. of liver	Average B_{12} (mμgm./gm. liver)	Enzyme activities (μgm. of indicator reduced/gm. of liver tissue)				
					Lactic	Glutamic	Succinic	Butyric	Choline
1 (deficient)	108·0 (9)	7·4 (9)	31·6 (8)	62·4 (7)	757·1 (7)	680·6 (9)	1,621·2 (9)	354·4 (9)	524·4 (9)
2 (control)	131·1 (9)	7·5 (9)	32·3 (8)	160·0 (7)	1,014·3 (7)	1,001·1 (9)	1,978·7 (9)	616·7 (9)	815·7 (8)
	± 4·24* 8 deg. of freedom	± 0·19 8 deg. of freedom	± 0·43 7 deg. of freedom	± 7·6 6 deg. of freedom	± 75·5 6 deg. of freedom	± 61·6 8 deg of freedom	± 24·2 8 deg. of freedom	± 45·8 8 deg. of freedom	± 162·2 7 deg. of freedom

* Standard error of the mean. Figures in parenthesis represent the number of animals.

of change in the deficient animals is always a lowering in all the enzymes studied would indicate that the action of vitamin B_{12} is probably a general one of promoting the synthesis of enzymic protein rather than as a coenzyme factor for the enzymes studied. This is substantiated by *in vitro* studies, where the addition of vitamin B_{12} to the liver homogenates failed to raise the enzyme activities to the same level as those of the vitamin B_{12}-fed controls.

The results of studies on the rate of enzyme regeneration when vitamin B_{12} was injected into deficient animals as obtained in the second series of experiments have been somewhat inconclusive and have not been reported here. A statistical interpretation of the data was not possible owing to the large individual variations and the small number of animals used (four for each group). These experiments are therefore being repeated on a larger number of vitamin B_{12}-deficient animals.

We are indebted to Dr. V. Subrahmanyan, director of this Institute, for his interest in this investigation.

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Fæcal Micro-organisms of Parabiotic Rats

SURGICAL techniques for the production of artificial Siamese twins ('parabiotics') are well established for small laboratory animals, and, in skilled hands, provide an elegant method for study of hormone circulation and other problems involving humoral transmission. There is some doubt as to whether capillary anastomosis or the lymphatic system is the primary mode of transfer from one twin to the other; but, in either case, it would seem that parabiotic animals are excellent material for nutritional research. In this connexion, it may be of interest to record that a pair of rats joined in this way since shortly after weaning were among a number of animals studied during a preliminary investigation of the influence of age and diet on intestinal micro-organisms.

The animals, both females, were just under eighteen months old (510 days). Shortly after weaning, they had been joined by the method of Bunster and Meyer[1] and formed part of an extensive programme of work with parabiotics of different ages being carried out at Cornell University by Prof. C. M. McCay and Dr. F. Pope[2]. The rats were receiving the same diet ('stock' + 10 per cent cooked egg) and their management was, of course, identical. It might be expected, therefore, that the various micro-organisms of their alimentary tract would be present in approximately equivalent numbers—assuming diet and intestinal environment to have some influence.

Errors in this type of work are known to be enormous; but the results of 'presumptive' counts from fæcal suspensions made on several days with each of the two rats were fairly consistent, and there was a relatively constant ratio between the numbers of the various organisms from one twin and those from the other, that is, the fæcal flora of the two halves was different. The individuality of each rat was therefore evident.

A pair of rats of comparable age (13 and 14 months), and on a comparable diet, were examined by the same method some time later (in Britain) and roughly the same degree of individuality as reflected in fæcal flora was found. These figures and those from the Cornell parabiotics are shown in Table 1.

Table 1. NUMBER OF ORGANISMS PER GM. OF FRESH FÆCES

	General numbers	Lactobacilli	Enterococci	Coliform organisms
I. *Parabiotics at Cornell*				
1 *L*	160,000 m.	875·0 m.	500	< 1 m.
R	90,000 m.	346·5 m.	2,500	< 1 m.
2 *L*	14,000 m.	1,170·0 m.	1,700	35,000
R	3,000 m.	1,515·0 m.	60,000	3,500
3 *L*	8,000 m.	1,610·0 m.	11,000	80,000
R	3,500 m.	285·0 m.	> 180,000	2,500
4 *L*	3,000 m.	220·0 m.	> 160,000	35,000
R	5,000 m.	840·0 m.	> 180,000	2,500
5 *L*	5,000 m.	1,120·0 m.	130,000	50,000
R	1,300 m.	410·0 m.	900,000	250
II. *Separate individuals at Queen Elizabeth College*				
1 *A*	1,700 m.	1,950 m.	450,000	8·0 m
B	2,500 m.	5,450 m.	80,000	1·7 m.
2 *A*	350 m.	805 m.	30,000	8·0 m.
B	800 m.	2,325 m.	50,000	0·25 m.
3 *A*	1,700 m.	420 m.	35,000	20,000
B	250 m.	600 m.	50,000	110,000
4 *A*	500 m.	1,110 m.	11,000	1·3 m.
B	1,300 m.	2,525 m.	25,000	0·5 m.
5 *A*	350 m.	303 m.	8,000	170,000
B	2,500 m.	2,335 m.	30,000	<20,000

m, million; *L*, left; *R*, right.

General numbers. Determined by the most probable number method in the reinforced *Clostridium* medium of Hirsch and Grinsted (ref. 3) incubated at 37° C. for 1 week. *Lactobacilli.* Plate count (double plates) on the medium of Rogosa *et al.* (ref. 4) incubated at 37° C. for one week. *Enterococci.* Determined by M.P.N. method in Hajna and Perry's (ref. 5) S.F. medium incubated at 45° C. for 48 hr. *Coliform organisms.* Determined by M.P.N. method in ordinary MacConkey broth incubated at 37° C. for 48 hr.

This work was largely exploratory. Extension of the types counted and refinement of method might have yielded more information, yet it is probably fair to conclude that parabiotic rats may be closely linked but show as much 'between animal' variation in their fæcal organisms as comparable separate animals.

This work was done in the Department of Animal Nutrition at Cornell University, Ithaca, New York,

while in receipt of United States Public Health Services Grant H.1658.

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Growth of Bovine Amniotic Ectoderm as a Cell Monolayer on Glass and its use as a System for Virus Multiplication

It has been found in this laboratory that monolayer cultures of cells on glass can be prepared successfully from bovine amniotic membranes. Such cultures have proved to be suitable for differential growth-curve experiments with the virus of foot-and-mouth disease in which frequent changing of the medium is necessary. The yields of virus obtained were essentially similar to those obtained with cell suspensions or monolayer cultures derived from adult bovine tongue tissue. This success, and that of Zitser *et al.*[1] with similar monolayer cell cultures from human amnion in growing the virus of poliomyelitis, suggest the more extended use of fœtal membranes for the study of mammalian viruses, and particularly those with a very restricted host or tissue susceptibility.

Pregnant bovine uteri are obtained from the abattoir, if possible on the day of slaughter. The uterus is first washed with a 1 : 100 dilution of a quaternary ammonium compound, 'Deciquat' (The British Hydrological Corporation), and then with sterile physiological saline; the uterus and fœtal membranes are then incised with aseptic precautions. When the amniotic fluid has been collected for use as a culture medium[2], the fœtus is removed and the amnion stripped from the chorio-allantois. On removal of the amnion, it is placed intact in a flask containing either a solution of trypsin, if to be used at once, or amniotic fluid if to be stored for future use. Storage at 4° C. in amniotic fluid, with subsequent satisfactory growth of cells, has been carried out for periods up to nine days.

For the preparation of cell suspensions, a 0·25 per cent solution of trypsin ('Difco' 1 : 250) in a calcium- and magnesium-free modified Tyrode's solution[3] is employed, with incubation for 1–3 hr. at 37° C. During incubation the flask is agitated to assist the separation of cells and, on completion, an excess of the modified Tyrode's solution is added to the flask. The amnion is removed to another flask containing sterile modified Tyrode's solution for washing to ensure removal of all separated cells. The cell suspension from the first flask plus the washing fluid from the second flask are pooled and allowed partially to sediment, or it is filtered through stainless steel mesh to remove the amniotic pustules and other large fragments of tissue. The decanted or filtered cell suspension is then centrifuged at 1,000 rev./min. for 2 min. and the cell deposit resuspended in amniotic fluid plus 10 per cent ox serum to give a concentration of approximately 10^6 cells per ml. It is unnecessary to wash the cells to remove trypsin if ox serum is incorporated in the growth medium.

An amnion from a fœtus of 10–30 cm. head-rump length yields approximately 100 ml. of a suspension containing 10^6 cells per ml., that is, sufficient to inoculate ten 80-mm. Carrel flasks. These cell suspensions, even after prolonged exposure to trypsin, contain a large number of cell clusters which do not readily break down further. For purposes of cell counting, clumps of ten or more cells are counted as ten, and a suspension containing nominally 10^6 cells per ml. usually includes approximately 3×10^4 such clumps per ml. On inoculation into a flask, these cell clumps become attached to the glass and within 48 hr. an intact sheet of cells develops between them. After a further two or three days incubation at 37° C., the cell clusters become detached from the glass, leaving behind a very regular, intact monolayer sheet of cells. The paucity of mitotic cells in stained preparations, coupled with the rapidity with which the monolayer is formed, suggest that the bulk of the cell sheet is produced by migration of cells from the cell clusters rather than by cell division. If a more dilute seed inoculum is used, an extensive cell sheet develops within 48 hr. around the cell clusters, but it usually takes many more days for these discrete growth areas to become confluent and the resulting cell sheet is invariably very irregular and fenestrated, with a wide variation in cell morphology and size.

A monolayer produced from a heavy seed inoculum consists of an intact sheet of polygonal ectodermal cells, with an optically clear, very transparent cytoplasm. In living cultures nuclei can be seen, but the cell borders can be distinguished only faintly. In methanol-fixed preparations stained by May–Grünwald–Giemsa, only the nuclei could be identified against a homogeneous, palely stained background of cytoplasm.

By a direct count of nuclei per microscopic field of known area, total values of about $2 \cdot 5 \times 10^6$ cells are obtained for mature cell sheets in 80-mm. Carrel flasks.

Satisfactory growth of cells occurs when amniotic fluid is used alone, but the cell sheets have remained intact for a longer period if bovine serum is added to a concentration of 10 per cent. No advantage was apparent following the addition of bovine embryo extract. Antibiotics are added to the amniotic fluid at the time of collection (200 units of penicillin and 200 μgm. of streptomycin per ml.).

Amniotic membranes from fœtuses of 10-cm. head-rump length to nearly full term have been used with no apparent difference in rate of growth or susceptibility to infection by foot-and-mouth disease virus. In general, because the amniotic fluid from older fœtuses is not suitable as a culture medium, only fœtuses of 10–30-cm. head-rump length are used. On several occasions, fœtuses have been successfully employed following storage *in utero* overnight at 4° C.

Following inoculation of excess virus to cells, amnion cultures have usually shown cytopathogenic changes by 24 hr., progressing to complete degeneration by 48 hr. Occasionally, however, similar cultures have continued to release virus at a fairly constant rate for at least 60 hr. before showing evidence of cytopathogenic change. The irregularity of the time of appearance of cytopathogenic changes, together with the fact that mature cultures, even when stained with neutral red, are almost invisible to the naked eye, suggest that bovine amnion monolayers would not be particularly suitable for the titration of the virus of foot-and-mouth disease using Dulbecco's plaque counting method[4], recently shown in this Institute by Sellers[5] to be possible with the virus of foot-and-mouth disease using monolayers of pig kidney cells.

Although infections with recognized pathogenic agents such as *Rickettsia burneti*, *Brucella abortus*, *Vibrio foetus*, etc., could occur following the use of amniotic membrane or amniotic fluid from a naturally infected fœtus, no evidence of such infection has been observed in this series of cultures prepared from more than twenty-five bovine fœtuses.

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Isolation of β-Dihydroequilin and α-Dihydroequilenin from the Urine of Pregnant Mares

In 1937, Hirschmann and Wintersteiner[1] reported the isolation of 17-dihydroequilenin from the urine of pregnant mares and expressed surprise that no evidence of the presence of dihydroequilin was obtained. (The nomenclature used here is that employed by Carol and his co-workers[3,4,6].) Afterwards, the presence of β-dihydroequilin was detected in material derived from pregnant mares' urine by the dioxane hydrolysis procedure of Grant and Beall[2], but isolation was not effected[3].

We now wish to report the isolation of large quantities of pure β-dihydroequilin from two different concentrates of conjugated œstrogens prepared from pregnant mares' urine collected respectively at mid-pregnancy (approximately the sixth month of pregnancy) and at late pregnancy (approximately the ninth month of pregnancy). It was found that in both instances the proportion of β-dihydroequilin present exceeded the proportion of β-œstradiol. No α-dihydroequilin was found in either concentrate.

The findings of Hirschmann and Wintersteiner[1] were confirmed by the isolation of large amounts of β-dihydroequilenin from both concentrates, but in addition to this α-dihydroequilenin was also obtained. The latter appears to be present in such small proportion that it cannot be considered a major constituent of the naturally occurring œstrogens in pregnant mares' urine.

The concentrates of conjugated œstrogens were prepared by solvent extraction of pregnant mares' urine. Predominantly non-ketonic material was isolated by counter-current distribution methods. This non-ketonic, conjugated material was hydrolysed by heating for 1 hr. at *p*H 1 on the water-bath, freed from ketonic material by a Girard separation, and a phenolic, non-ketonic fraction isolated by extraction into sodium hydroxide. This phenolic, non-ketonic fraction, which was a mixture of œstrogenic diols, was finally separated into its components by the chromatographic methods described by Carol, Haenni and Banes[4] employing sodium hydroxide on 'Celite' (manufactured by the Johns Manville Co.) as the immobile phase and benzene as the mobile phase. A concentrate of mixed conjugated œstrogens, giving a response by the Kober procedure equivalent to 100 gm. of sodium œstrone sulphate, fractionated by the methods described above, gave a phenolic, non-ketonic fraction which yielded 3 gm. of crystalline β-dihydroequilin (melting point 205–206°), identical with the β-dihydroequilin prepared by Carol, Haenni and Banes[4] by reduction of equilin with aluminium *iso*propoxide, and 1 gm. of β-dihydroequilenin (melting point 216–217°), identical with the material originally isolated by Hirschmann and Wintersteiner[1]; further quantities of β-dihydroequilin could also be isolated from various other side-fractions. Products were characterized by infra-red examination, preparation of derivatives and by analysis.

Throughout laboratory operations care was taken to avoid prolonged exposure of material to strongly acidic conditions. When this precaution was not taken, compound 3 of Hirschmann and Wintersteiner[1] was isolated in addition to β-dihydroequilenin and β-dihydroequilin and was presumably formed by isomerization of the latter in accordance with the findings of Banes, Carol and Haenni[5].

We shall publish this work in greater detail elsewhere.

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Mating Reaction in Yeast

A preliminary study has been made of the mating mechanism of haploid cells of *Saccharomyces cerevisiae*. Three haploid pairs were used: one pair from Dr. C. C. Lindegren and the others derived from two strains of baker's yeast (Lindegren's α = plus; *a* = minus mating type in Fowell's nomenclature).

Lindegren's discovery[1] that stable haploid clones of two mating types could be derived from the spores of certain strains of baker's yeast made it possible to investigate Winge's suggestion[2] that conjugation is hormone-controlled. When haploid cultures of opposite (plus and minus) mating types are mixed, or cells are paired on an agar film, the cells may put out hyphal ('copulatory') processes; and when these meet, fusion may occur and a dumb-bell-shaped zygote be formed, from which diploid cells may be budded. This sequence of events constitutes the mating reaction, and a cell which puts out a copulatory process may be said to show a mating response.

Experiments in which a plus cell was placed close to a minus cell and allowed to grow on a malt agar film in a moist chamber[3] showed that the mating reaction is probably hormone-controlled, since a

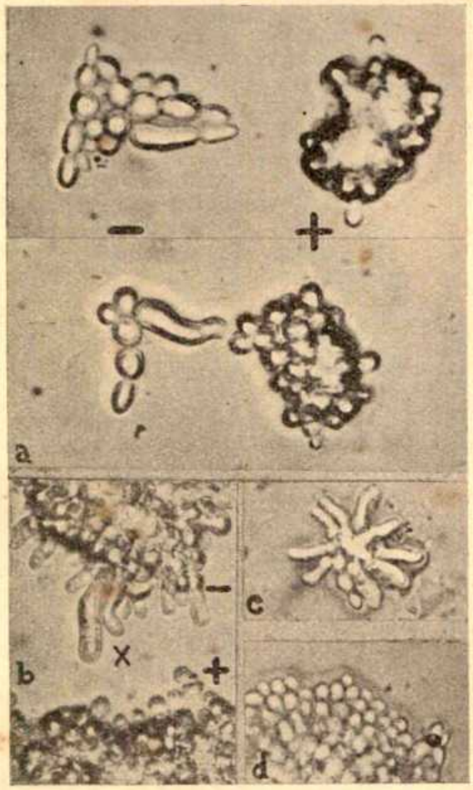

Fig. 1. (*a*) Two pairs of haploid cells, after incubation on a malt agar film; the cells of minus mating type show a mating response. × 480. (*b*) Parts of larger colonies, as (*a*). Both colonies were afterwards removed, and fresh minus cells were placed at point *X*. × 400. (*c*) Minus cells, after incubation on the agar at point *X*, show a mating response. × 400. (*d*) Fresh minus cells, showing normal morphology. × 400

mating response developed without contact between cells of opposite mating type; but it was found that only the minus cells put out copulatory processes (Fig. 1,*a*). In several experiments involving more than a hundred pairings of three pairs of haploids from different strains of yeast, plus cells never responded on a solid medium. The mating reaction occurred only after mutual interaction between a plus and a minus cell; but an agar surface from which sexually reacting cells had been removed could induce copulatory processes in minus cells added later (Fig. 1, *b*, *c*), but not in plus cells. However, on only one occasion was a mating reaction observed in a minus culture separated from a plus culture by a collodion membrane. In liquid medium, it should be noted, both plus and minus cells may develop copulatory processes.

The investigation is continuing, with particular attention to the isolation of chemical substances involved in the mating reaction. So far, an active culture filtrate has not been obtained from a mating mixture.

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Viability and Developmental Capacity of Eggs from Immature Mice treated with Gonadotrophins

SEXUALLY immature mammals induced to superovulate and mate following gonadotrophin treatment provide a convenient supply of fertilized mammalian eggs for experimental purposes. The time of their ovulation is known and is independent of diurnal regulation. The large number of eggs recoverable from a single superovulated female can be expected to contain less genetical and physiological variability than an equal number from several mature donors. Also, when egg recovery necessitates killing females, the economy of using immature animals is realized in greater egg productivity and in a shortened generation interval. It is important, therefore, to establish whether eggs from ovulations induced in immature females are of normal viability and developmental capacity. Previous evidence[1-3] on this problem is not decisive in that it lacks direct comparisons with spontaneously ovulated eggs, from adult females, developing in similar uterine environments. The present work was intended to meet these requirements.

Genetically tagged eggs from superovulated and mated immature mice[3] were transferred as 3½-day morulæ or blastocysts to the uteri of seventy-four adult recipients (each having borne one litter) in which ovulations and matings with fertile males were synchronous with those of the donors. A control series, run concurrently with the first, consisted of eighty-three similar transfers of eggs spontaneously ovulated by mature donors. Fifty-eight hosts from the first series and sixty-three from the control group became pregnant and were autopsied at 18½ days gestation. Fœtuses from transferred and native eggs were counted in each uterine horn, and body-weights to the nearest 0·01 gm. were taken after severing the umbilicus and removing embryonic membranes and surface fluid.

Donor and recipient matings were so arranged that fœtuses from transferred and native eggs, though distinguishable by presence or absence of eye pigmentation, were otherwise similar in genetic background. Donor and recipient females were from the same highly fertile albino stock. Males were from the inbred albino strain *A* and from a homozygous non-albino stock derived by repeated back-crosses to strain *A* with forced segregation at the albino locus. The genetic tags for transferred and native eggs were reversed for half the experimental and control transplants.

Viability of eggs from immature mice. A comparison of viability of eggs from immature and mature donors is made in Table 1 as percentage survival of transplanted blastocysts to living fœtuses at 18½ days gestation. Most transfer operations were bilateral, and percentage survival has therefore been computed within uterine horns rather than within hosts. (Transuterine migration of eggs[4,5] appears to be rare in the stocks used; only one case was observed among those 124 genetically tagged eggs which survived in forty-one uterine horns from unilateral transfers of 194 eggs.) Among hosts becoming pregnant, the incidence of horns with no transferred eggs surviving was greater than could be accounted for by chance occurrence; an estimation that whole inoculum loss of eggs occurs in 20–25 per cent of transplants is consistent with the data. Consequently, in Table 1 a separate column is given for percentage survival

Table 1. Comparative Viability of Eggs from Immature and Mature Mice
Percentage survival to $18\frac{1}{2}$-days gestation of blastocysts transplanted to mated adult recipients

		Survival in recipients becoming pregnant			Survival in horns with one or more fœtuses from transplanted eggs		
Source of transplanted eggs	No. of eggs transplanted per horn	No. horns receiving eggs	Total eggs transplanted	% survival to $18\frac{1}{2}$ days	No. horns receiving eggs	Total eggs transplanted	% survival to $18\frac{1}{2}$ days
Immature donors	4	53	212	35·85	35	140	54·29
Mature donors	4	40	160	38·75	30	120	51·67
Immature donors	2–6	88	377	40·58	63	272	56·25
Mature donors	2–6	86	322	48·76	63	255	61·57

in horns with one or more transferred eggs surviving. In all transplants (two to six blastocysts per horn), the comparative survival-rates of eggs from immature and mature donors show a divergence which may be a consequence of the difference in mean numbers of eggs per inoculum. Transplants of four eggs per horn were the most common, and the corresponding percentage survivals of eggs from immature and adult donors, of 35·85 and 38·75 per cent, respectively, are strong evidence for the normal viability of eggs from ovulations induced in immature mice.

Developmental capacity of eggs from immature mice. The developmental capacity of eggs transplanted from immature donors has been compared with that of spontaneously ovulated, untransplanted eggs developing in the same uterine environment, that is, eggs native to the adult recipients. Hosts to $3\frac{1}{2}$-day eggs transplanted from adult donors provide a control for effect of transplantation on subsequent development. Comparisons were made within litters, and for each sex, of differences between mean weights of $18\frac{1}{2}$-day fœtuses from transferred and native eggs. From these within-litter differences, weighted according to relative numbers of fœtuses, calculations were made of the best estimates of mean differences in weight and their standard errors (Table 2). Neither the mean difference in weight between fœtuses derived from eggs of immature and mature females, nor that between fœtuses from transplanted and untransplanted eggs of mature females, varied significantly from zero. On the basis of the overall estimate of mean weight difference, $-0{\cdot}017 \pm 0{\cdot}011$ gm., if a retarding effect of transplantation on embryonic growth exists, it is most unlikely to exceed 0·04 gm. ($P = 0{\cdot}05$) or 3 per cent of the mean weight of native embryos, 1·23 gm. It was concluded, first, that transplantation of $3\frac{1}{2}$-day mouse eggs does not appreciably affect their subsequent embryonic growth in a host uterus of corresponding gestational stage and, secondly, that the developmental (growth) capacity of eggs from immature mice treated with gonadotrophins closely approximates that of eggs from spontaneous ovulations in adult mice.

Table 2. Developmental Capacity of $3\frac{1}{2}$-day Eggs transplanted from Immature and Mature Mice
Comparisons within litters of weights of $18\frac{1}{2}$-day fœtuses from transplanted eggs (immature and mature donors) and eggs native to the adult recipients

Source of transplanted eggs	Sex of fœtuses	No. litters for weight comparisons	No. fœtuses from trans. eggs (T)	No. native fœtuses (N)	Best estimate of mean difference in wt. (T–N) and stand. error (gm.)
Immature donors	♀ ♂	37 39	79 74	107 139	$-0{\cdot}005 \pm 0{\cdot}020$ $-0{\cdot}037 \pm 0{\cdot}020$
Mature donors	♀ ♂	35 36	69 70	119 128	$-0{\cdot}013 \pm 0{\cdot}029$ $-0{\cdot}011 \pm 0{\cdot}016$

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Reduction in Growth of Clover due to Applied Molybdenum

In the course of co-operative investigations into problems of pasture establishment on coarse Taupo pumice, an observational minor-element trial was superimposed upon clover inoculation trials laid down by the Grasslands and Plant Disease Divisions, Department of Scientific and Industrial Research, N.Z. The soil was Kaingaroa sandy and gravelly sand of pH 5·7 and low in available nutrients, derived from rhyolitic pumice deposited less than two thousand years ago.

Seed and serpentine superphosphate (3 cwt./acre) or, in one treatment in replicate A, a serpentine superphosphate/lime mixture containing 12 per cent lime, were 'roller drilled' in on March 19, 1954. 'Roller drilling' followed by brush harrowing covered the seed and fertilizer to a depth of about 1–$1\frac{1}{2}$ in. Minor elements (boron, sulphur, zinc, copper, vanadium, manganese, cobalt, singly and all combined and all crossed with sodium molybdate at $2\frac{1}{2}$ oz./acre) were then watered, or in the case of sulphur, dusted on. Afterwards, 1 cwt. muriate of potash and 3 cwt. (spring 1954) and $1\frac{1}{2}$ cwt. (autumn 1955) per acre of double superphosphate were applied.

Table 1. Herbage Wet Weight (lb. per 100 ft. × 20 in.; Cut March 3, 1955

Treatments	Replicate A No Mo	Replicate A + Mo	Replicate B No Mo	Replicate B + Mo
Uninoculated + serp. super	18·1	7·0	16·2	8·0
Inoculated + „ „	20·3	13·7	27·5	9·7
„ + lime/serp. super	18·7	20·3	—	—
Available soil Mo (Grigg) p.p.m.	0·07	0·18	0·07	0·34
Total soil Mo (p.p.m.)	—	— 0·51 —		—

Table 2. Plant Analyses

	P (%)	N (%)	S (%)	K (%)	Na (%)	Mg (%)	Ca (%)	Mn (p.p.m.)	Cu (p.p.m.)	Mo (p.p.m.)
White clover, no molybdenum	0·22	3·4	0·21	2·5	0·08	0·30	1·4	146	6·0	0·3
White clover, + molybdenum	0·23	3·5	0·22	2·7	0·07	0·30	1·3	148	6·9	1·0
Red clover, no molybdenum	0·13	2·2	0·14	1·5	0·03	0·35	1·5	155	6·2	0·36
Red clover, + molybdenum	0·14	2·6	0·15	1·9	0·03	0·34	1·4	189	8·7	0·5

No effects due to minor elements were seen on November 17, 1954. But on December 17, 1954, it was obvious that molybdenum was severely depressing growth on replicate *B* and by February 11, 1955, the same was true of replicate *A*, excepting where the lime/serpentine superphosphate mixture had been used. The clovers showed no abnormal visual symptoms. The effect continues at the time of writing. There have been no consistent effects due to other minor elements and no obvious interactions with molybdenum. Relevant measurements are given in Tables 1 and 2.

Both total and available soil molybdenum were relatively low, and plant molybdenum was normal to low. There appears to be no possibility of a direct toxic effect. Both inoculated and uninoculated clovers were depressed, more especially in replicate *B*, where the soil-available molybdenum, for some unknown reason, was higher. The results of analyses for plant constituents given in Table 2 show no gross abnormalities. When cut, the clovers, especially the red clover, had flowered and were stalky. This stage of growth at cutting may explain the rather low phosphorus, nitrogen and sulphur contents. The effect of a small amount of lime completely offset the depression due to molybdenum without greatly altering any plant constituent measured.

An attempt to reproduce this depression under glasshouse conditions has failed.

It is difficult to conceive of any mechanism which would account for this unusual happening. The cause probably lies within the general field of minor element interactions.

R. H. Jackman

Rukuhia Soil Research Station,
Hamilton, New Zealand.
Nov. 9.

A Small-scale Quality Test in Wheat Breeding

Dr. L. Zeleny, United States Department of Agriculture, Washington, D.C., has developed[1] and improved a lactic-acid wheat-flour sedimentation test for the grading of bulk wheat for quality. This test is in use at this Division as an aid to selection for high baking-quality wheats. In the preparation of the flour for the sedimentation test, wheat grain is passed through a 'C. and N. Junior' laboratory mill. By suitable pulleys the speed of the beaters is built up to approximately 14,000 rev./min. A metal screen fitted to the bottom of the mill has holes $\frac{1}{16}$ in. in diameter: eight holes to one inch. The ground wheat is sieved for $1\frac{1}{2}$ min. through cloth mesh 9×× using a 'Gallenkamp' laboratory shaker fitted with a time switch. The general procedure of the test follows that recommended by Dr. Zeleny (private communication).

The first application of the test was in the selection of good-quality single-plant progenies from a hybrid line. This line (derived from a single plant in F_2) had proved by F_{12} to be superior in yield and other agronomic characters to the standard New Zealand variety in large replicated trials in many districts; but was inferior in baking quality. One thousand single-plant progenies from this line were grown in short rows of twenty-five plants, and the sedimentation test was applied to the bulked grain from each row. Only ten progenies with high sedimentation scores were found. In the following year the residue of seed from these ten progenies was sown at wide spacing, to provide sufficient grain for a baking test. The baking score of the test loaves, based on loaf volume and crumb texture, was better than that of the standard variety.

It has been considered necessary to establish the validity of the sedimentation test over a range of varieties and localities in New Zealand. In 1954, sedimentation test figures were correlated with the baking scores of sixteen samples of one variety drawn from replicated field trials in different districts ($r = 0\cdot 89^{**}$). In 1955, samples were drawn from eight similar trials, each with seven varieties, in different localities. After the elimination, in the analysis, of differences due to varieties, high correlations were obtained over all localities between sedimentation test and two other tests of baking quality (Table 1).

Table 1

	Correlation coefficient
Sedimentation vs. baking score	0·88**
Sedimentation vs. total nitrogen (Kjeldahl)	0·85**
Total nitrogen vs. baking score	0·86**

It was found in the analysis of the set of trials, after the elimination of differences due to locality and error, that for varieties as a group, the correlation coefficient between the sedimentation test and baking score was only 0·08. Therefore it would appear that a calibration for individual varieties would be necessary before the general application of the sedimentation test. In a more extended series of trials covering further localities, the correlation coefficients for individual varieties ranged from 0·80 to 0·93. A graphical representation of the relationship between baking score and sedimentation test shows a set of variety regression lines which appear on preliminary evidence to be parallel.

The method has proved useful in the selection of single plants, grown at wide spacing, from hybrid bulks in the F_8 and F_9 generation. About 2 per cent. of the material sown is selected on agronomic characters; the individual plants are threshed, seventy-five grains are reserved for sowing, and the remainder are milled for the sedimentation test. 13 gm. of wheat, yielding 7·5 gm. of flour, are required for each test, but a less accurate test can be made on 8 gm. Grain from plants with sedimentation scores above the average for the particular bulk is sown for further observation. It is not desirable to set high limits for the selection of plants from each bulk: the test is accurate, but the relation between test score and baking score differs between varieties, and therefore between plants within a hybrid bulk. The value of small-scale quality tests is to allow the rejection, in the early stages of selection, of those plants or progenies which would have proved to be of poor baking quality. It has been found that, whereas the sedimentation test accentuates differences in quality at the higher end of the scale, other small-scale tests in use are not sufficiently critical at this level.

The application of the sedimentation test to hybrids in advanced generations has been successful and the use of the test in the early generations of wheat crosses is under investigation. It may be possible to select for flour quality at the same time as for other agronomic characters.

L. G. Copp

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Department of Scientific and Industrial Research,
Private Bag,
Christchurch, New Zealand.
Nov. 22.

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[1] Zeleny, L., *Cereal Chem.*, 24, 465 (1947).

Abnormal Hæmoglobins in the Kasai Province of the Belgian Congo

Hæmoglobin C was first detected among American Negroes, and figures for its incidence range between 1·4[1] and 3 per cent[2]. As the anomaly seemed virtually absent in the white race, it was reasonable to suppose that the gene responsible for it had been imported from Africa in the times of slave trade. This was soon confirmed by a survey of Edington and Lehmann[3], who found hæmoglobin C to be present in 12 per cent of 200 hospital out-patients in Accra (Gold Coast). Recently, individuals with this hæmoglobin have been reported from French North Africa[4]. It is also known to exist in Liberia and in French West Africa (Neel, J. V., personal communication).

In East Africa, surveys for abnormal hæmoglobins among natives from Uganda[5], Southern Sudan and Tanganyika[6] did not provide any specimens of hæmoglobin C. In South Africa, hæmoglobin C was found in 2 out of 219 blood specimens of Cape 'coloured' individuals[7]. However, as Lehmann points out, these sporadic cases may be the result of the introduction of slaves from West Africa.

As no results for hæmoglobin C are available for Central Africa, we undertook an investigation at Luluabourg, a town of 40,000 inhabitants, situated in the Kasai Province to the south of the Congo Basin. Blood specimens for paper electrophoresis of hæmoglobin were obtained from 500 unrelated and unselected natives. Most of them were young adults belonging to the important Baluba tribe. The apparatus and the technique used were those already described by one of us[8]. In addition to electrophoresis, all specimens were examined for sickling in 2 per cent sodium metabisulphite.

Of the 500 samples tested, 148 (29·6 per cent) showed sickling. In all these instances the electrophoretic pattern was that of the heterozygous sickling trait. All other hæmoglobin samples showed a single component corresponding to normal adult hæmoglobin. The pattern of homozygous sickle-cell anæmia was not encountered in our sample. Although sickle-cell anæmia is a very common disease at Luluabourg (75 new cases were seen during the past ten months) we were never able to diagnose the disease in adults beyond the second decade.

Apart from this investigation, 35 further specimens were selected from patients suffering from different symptoms suggestive of sickle-cell disease. The hæmoglobin of one of these patients showed the electrophoretic properties of a hæmoglobin S–C mixture, and was thus diagnostic for sickle-cell hæmoglobin C disease. This patient was a male adult with slight anæmia, numerous target cells and a high percentage of red cells sickling *in vivo*. His chief complaint arose from a mutilating necrosis of the femoral head. A complete case report of this patient has been published elsewhere[9].

The anthropological significance of this sporadic case has probably no more value than those found in the Cape 'coloured' population. The patient was originally from the enclave of Cabinda situated a few miles to the north of the Congo estuary. As there has been for generations a busy trade between the natives of Cabinda and those of the Guinea coast, the occasional presence of hæmoglobin C is not surprising. This study in association with other surveys provides further evidence that the diffusion area for the gene of hæmoglobin C does not extend south of the equator.

This investigation was supported in part by State of Washington Initiative 171 funds for research in biology and medicine.

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Seattle, Washington.

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[3] Edington, G. M., and Lehmann, H., *Trans. Roy. Soc. Trop. Med. Hyg.*, 48, 332 (1954).

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Orotic Acid as a Survival Factor in Rats Deficient in the Animal Protein Factors of Casein

Viviani *et al.*[1] have recently shown that orotic acid may be one of the growth factors for rats deficient in the animal protein factors of casein, but not for normal rats. These and previous[2,3] observations suggest a possible relationship between orotic acid and animal protein factors of casein. Therefore, in the present work, our investigations have been extended to the significance of prophylactic feeding of orotic acid upon the most dramatic aspect of the deficiency of animal protein factors of casein, namely, the high mortality of the newly born of the first generation and the total mortality of the second generation.

To this end, we have divided from weaning (21 days of age) thirty female rats of the Sprague–Dawley strain into three groups and placed them on the three experimental rations described in Table 1.

In these three groups of female rats and in the female rats of the subsequent filial generations, the survival of young from birth to weaning has been recorded. The results are reported in Table 2.

From the above results it appears evident that orotic acid may be a new factor for the survival of newly born rats deficient in the animal protein factors of casein.

Since orotic acid does not appear to be essential to survival, we think that orotic acid may be:

Table 1

Diets*	Basal	Devoid of casein animal prot. factors	Devoid of casein animal prot. factors + orotic acid
Ground cereals (wheat, maize, barley, oats, rye)	88	88	88
Crude rennet casein	5	—	—
Purified casein devoid of casein animal prot. factors (ref. 3)	—	5	5
Wheat germ	5	5	5
Calcium lactate	1·5	1·5	1 5
Sodium chloride	0·5	0·5	0·5
Orotic acid†	—	—	0·001

* The three diets are supplemented with carrots and fresh vegetables *ad libitum* twice a week.

† Orotic acid manufactured by Biochemical Inc., Co., Cleveland, Ohio

Table 2

Diets	Basal		Devoid of casein animal prot. factors		Devoid of casein animal prot. factors + orotic acid	
Generations	I	II	I	II	I	II
No. of animals	10	10	10	10	10	10
No. of young per litter	11	11	10·1	8·3	10·2	9·2
Mortality of young in 21 days (per cent)	2	2	72	100	6	7
Mean weight of young at 21 days (gm.)	48	48	32	—	46	43

(*a*) one of the animal protein factors ; (*b*) a precursor or a part of the animal protein factors, should the animal protein factors prove to be unique substances ; or (*c*) a substance with high sparing action on the animal protein factors of casein.

A. Rabbi
M. Marchetti
R. Viviani
G. Moruzzi

Istituto di Chimica Biologica,
Università di Bologna.
Dec. 14.

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[1] Viviani, R., Marchetti, M., Rabbi, A., and Moruzzi, G., *Nature*, **176**, 464 (1955).

[2] Moruzzi, G., Rabbi, A., Viviani, R., and Marchetti, M., *Acta Vitaminol.*, **8**, 135 (1954).

[3] Piccioni, M., Rabbi, A., and Moruzzi, G., *Science*, **113**, 179 (1951).

The Striped Marlin (*Makaira audax* Phillipi) in South Africa

Marlin fishes of the genus *Makaira* Lacépède, 1803, occur throughout almost all tropical and temperate seas, and are of interest not only to the scientist but are also the prime quarry of the big-game angler. The systematics of these large wide-ranging fishes is troublesome, since few scientists can hope to examine an adequate series of fishes from over a wide area, and the number of species accepted by workers varies from three to the patently unacceptable sixteen of Jordan and Evermann (1926).

Makaira audax Phillipi, 1887, the well-known 'striped marlin', has hitherto been regarded as confined to the wide area of the Pacific. Although variable in colour and markings more or less according to where it occurs, and though these variations have been described as different species, the species is in effect sharply defined by the elevated front lobe of the dorsal fin, which is never less than, but almost always higher than, the depth of the body below, and about one and a third in the upper caudal lobe. The lateral line is virtually obsolete. The spear is slender, its width at tip of lower jaw about one-seventh of the preocular length of the mandible. The body is usually clearly striped.

By most American workers this species is regrettably labelled *M. mitsukurii* Jordan and Snyder, 1901, even though *audax* Phillipi clearly has priority.

This characteristic fish has been reliably recorded from the Western Pacific coast of America, Hawaii, Fiji, the seas about Japan, the Philippines, Australia and New Zealand. It has not before been certainly recorded from the Indian Ocean. Morrow[1] states that specimens of this species were seen alive in the sea off the coast of Kenya, but not captured. He also regards *Makaira brevirostris* (Playfair), 1866, as possibly this species ; but from Playfair's description and the illustration[2], it is quite clear that Playfair's fish was a specimen of the widespread *indicus* Valenciennes, 1831.

LaMonte[3] records *Makaira mitsukurii* J. & S. (= *audax*) from Ceylon on the basis of a brief description and an illustration by Deraniyagala[4]. But it is quite plain that this Ceylon fish cannot be *audax*. In any event there is confusion, since in the first paper the fish figured is clearly only about 6 ft. in length, whereas the dimensions given in the "Atlas" show it as almost 12 ft.

The present account is based on a specimen captured by an angler off Mossel Bay, South Africa, at about lat. 34° 5′ S., long. 22° 12′ E. It was taken to Cape Town; but as there was doubt about its identity, on request of the Press I went by air to Cape Town to examine the fish, when I found that it was unquestionably *audax*. This is far south for any marlin to be captured, but is in line with their presence off New Zealand and the west coast of South America. It is noteworthy that specimens of the black marlin, *M. indicus* Valenciennes, have also been captured and many more have been seen at other parts along the shores of South Africa.

The main dimensions of this 160-lb. Mossel Bay specimen, in inches, are as follows : total length, 108 ; standard length, 89 ; snout tip, to eye, 21 ; to hind margin opercle, 34 ; to anal origin, $61\frac{1}{2}$; depth of body, $13\frac{1}{2}$; height of dorsal lobe, 18 ; of anal lobe, 11 ; upper caudal lobe, 24 ; lower, 23 ; tail spread, $34\frac{1}{2}$; pectoral fin, $20\frac{3}{4}$; pelvic fin, $14\frac{3}{4}$; width of spear at tip lower jaw, $1\frac{3}{16}$, at two inches from apex, only $\frac{3}{8}$. The colour was brilliant purple, the numerous conspicuous transverse stripes faint lavender. The specimen is in my possession and will be mounted for retention in this Department.

Assistance from the South African Council for Scientific and Industrial Research has enabled this specimen to be preserved.

J. L. B. Smith*

Rhodes University,
Grahamstown,
South Africa.
Feb. 12.

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* S.A. Council for Scientific and Industrial Research Fellow in Ichthyology.

[1] *Ann. Mag. Nat. Hist.*, (12), **7**, 819 (1954).

[2] Playfair, "Fishes" (Zanzibar, 1866).

[3] *Bull. Amer. Mus. Nat. Hist.*, **107**, Art. 3, 334 (1955).

[4] *Spolia Zeyl.*, **26**, 139, Pl. 1, Fig. *b* (1951) ; "Atl. Col. Vert. Ceylon", **1**, pl. 27 (1952).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 23

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C 2), at 5.30 p.m.—Informal evening on "Electronics and Automation". Mr. G. W. A. Dummer: "Automatic Assembly Systems for Electronic Equipment" (with films and demonstrations).

Tuesday, April 24

Institution of Chemical Engineers (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Thirty-fourth Annual Corporate Meeting. 12 noon—President's Address—"The Technological Awakening".

Society of Chemical Industry, Agriculture Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting. Mr. A. W. Marsden: "Future Trends in Agricultural Production".

Institution of Mechanical Engineers, Internal Combustion Engine Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are Diesel Engines Inherently Noisy ?"

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. H. Whitby: "The Development of Helicopter Transport".

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Prof. H. Kramers: "Dynamic Characteristics of some Neutralization Processes and of Glass *p*H Electrodes".

Wednesday, April 25

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting. Dr. R. C. Sutcliffe: "The Moisture Balance of the Atmosphere" (Presidential Address).

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C.1), at 6.30 p.m —Mr. M. Smith: "Radio and Television Interference—Its Growth and Effects".

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p m.—Dr. N. Grassie: "The Role of Abnormal Leakages in Polymer Degradation".

Institute of Metals (at 4 Grosvenor Gardens, London, S.W.1), at 6 45 p.m.—Prof. Cyril S. Smith (University of Chicago): "The Beginnings of Metallography".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting—"Vital Statistics in Psychiatry". Chairman: Prof. Aubrey J. Lewis. Speakers: Dr. Vera Norris, Prof. L. S. Penrose, F.R.S., and Dr. Peter Sainsbury.

Thursday, April 26

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Meeting for election of Foreign Members. Mr. R V. Coxon and Mr. R. J. Robinson: "Carbohydrate Metabolism in Blood Cells Studied by Means of Isotopic Carbon"; Mr. J. T. Davies, Mr. D. A. Haydon and Sir Eric Rideal, F.R.S.: "Surface Behaviour of *Bacterium coli*".

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. C. M. Gray: "The Snowy Mountains Scheme".

Chadwick Trust (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5 30 p.m.—Mr. J. Rawlinson: "The Centenary of London's Main Drainage System" (Chadwick Public Lecture).*

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. A. C. B. Lovell, F R.S.: Forty-seventh Kelvin Lecture on "Radio Astronomy".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. A. Andreotti (University of Turin): "The Problem of Complete Intersections" * (Further Lecture on May 3.)

Friday, April 27

Institution of Mechanical Engineers (joint meeting with the Institution of Civil Engineers and the Institution of Electrical Engineers, at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Sir Maurice Bowra "The Impact of Engineering on Society" (Graham Clark Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S: "Edmond Halley and His Work"

Saturday, April 28

British Psychological Society, Social Psychology Section (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 2.30 p.m.—Symposium on "Recent Developments in Survey Methods"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with research experience and preferably industrial experience) in Organic Chemistry; and an Assistant (Grade B) in Physics—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (April 25).

Physicist (with an honours degree) in the Department of Physics Applied to Medicine, for work concerned with the application of radioactive isotopes in clinical investigations—The Secretary, Physics Department, Middlesex Hospital Medical School, London, W.1 (April 25)

Analyst (with a university honours degree or Associateship of the Royal Institute of Chemistry, and experience in a Public Analyst's or similar laboratory, preferably dealing with water and sewage analysis)—City Analyst, 123 Mount Pleasant, Liverpool 3 (April 28).

Assistant Lecturer or Lecturer (with specialist knowledge in some aspect of microbiology or plant pathology) in the Department of Botany—The Registrar, The University, Liverpool (April 28).

Principal Scientific Officer (with a degree of high standard in mathematics or equivalent qualifications, extensive experience of theoretical work in supersonic aerodynamics, and ability to direct the work of others) in the Aerodynamics Division, Weapons Research Establishment, Salisbury. South Australia to initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow, and to collaborate with staff carrying out experimental work in this field, and to exercise supervision over the work of other scientific staff—The Senior Representative (A.P.42/1), Department of Supply, Australia House, Strand, London, W C 2 (April 30).

English Electric Research Fellow in Aeronautics for postgraduate research into problems of vibration or stability and control of aircraft—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

Assistant Advisory Bacteriologist (with an honours degree in bacteriology or equivalent, and postgraduate experience) at Perth Sub-Station—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (May 4).

Assistant Experimental Officer (with a degree in botany or an allied biological science) in the Department of Plant Breeding, to assist with cytological studies of horticultural crops—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (May 5)

Assistant Lecturer or Lecturer (preferably on the experimental side) in Physics—The Registrar, The University, Sheffield (May 5).

Mathematicians, Experimental Officer or Assistant Experimental Officer grade (preferably with a pass degree in mathematics, or at least H.S C (science) or equivalent) at the Ministry of Supply Ordnance Board, London, for work on ballistics (duties include analysis of experimental results and computation of gunnery data)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W.1, quoting A 126/6A (May 5).

Assistant Lecturer (with a good honours degree and some research experience) in Physical Chemistry—The Registrar, King's College, Strand, London, W.C.2 (May 11).

Lecturer or Assistant Lecturer in Physiology—The Registrar, The University, Sheffield (May 12).

Soil Mineralogist (with a university honours degree in science, with chemistry and geology as major subjects, and preferably soil research experience) in the Division of Soils, Commonwealth Scientific and Industrial Research Organization, South Australia, to conduct research into the mineralogy of soils, as part of a programme relating to chemical properties with mineral composition—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 270/123 (May 12).

Lecturer in Anthropology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 14)

Scientific Officer (with a science degree of a university in the U K, with passes in biochemistry, zoology or botany, etc., and preferably relevant postgraduate experience) at the Blood Transfusion Centre, Oxford—The Medical Director, Regional Blood Transfusion Centre, Churchill Hospital, Headington, Oxford (May 14).

Scientific Officers (2) (with an honours degree in animal husbandry or equivalent qualification) for experimental work with hill sheep and cattle; and Scientific Officers (2) (with an honours degree in botany, agricultural botany or principles of plant husbandry) in the Botany Department—The Secretary, Hill Farming Research Organization, 48 Palmerston Place, Edinburgh 12 (May 14).

Plant Physiologist (with an honours degree in science or agricultural science and postgraduate research experience in plant physiology) in the Department of Plant Physiology, Waite Agricultural Research Institute, for research in the general field of carbohydrate metabolism of economic plants—The Registrar, University of Adelaide, Adelaide, South Australia (May 15).

Dr. Lee's Professor of Experimental Philosophy—The Registrar, University Registry, Oxford (May 17).

Assistant in the Department of Geography; and a Lecturer (with special knowledge in the geography of climate, soil and vegetation) in the Department of Geography—The Assistant Secretary, The University, Edinburgh (May 19)

Assistant Lecturer (preferably with special qualifications and experience in animal husbandry) in Animal Husbandry, at the School of Agriculture, Sutton Bonington, near Loughborough—The Registrar, The University, Nottingham (May 19).

Lecturer in Mathematics—The Secretary, The University, Aberdeen (May 19).

Lecturer (with special qualifications in applied mathematics, and preferably an interest in fluid dynamics) in Mathematics—The Registrar, The University, Manchester 13 (May 19).

ASSISTANT LECTURER IN PHYSICS—Prof. K. G. Emleeus, Queen's University, Belfast (May 20).

ASSISTANT LIBRARIAN (preferably science graduate with professional diplomas and experience), at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 21).

LECTURER (with training and research experience) IN MATHEMATICAL PHYSICS—The Registrar, The University, Birmingham (May 22).

HENRY BELL WORTLEY CHAIR OF METALLURGY—The Registrar, The University, Liverpool (May 26).

LECTURER (with training and experience in experimental physics) IN PHYSICS, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 31).

SENIOR LECTURER (with a degree in science or engineering, with geology as a major subject, and field experience in mining and/or engineering geology, and preferably experience in mineragraphy and/or geophysical exploration) IN ECONOMIC GEOLOGY, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 1).

BIOCHEMIST (Senior grade) to the Rochdale Group of Hospitals—The Group Pathologist, Birch Hill Hospital, Rochdale, Lancs.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with a good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham

ENGINEERS and PHYSICISTS (particularly with electronics) (Experimental Officer and Assistant Experimental Officer grades), in Experimental Establishments, in the London, Portsmouth and Weymouth areas, Cheltenham and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.214/5A.

LECTURER (preferably with an honours degree, and teaching, research or industrial experience) IN PHYSICS; and an ASSISTANT LECTURER, Grade B (preferably with an honours degree, and teaching, research or industrial experience) IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

LECTURER (specializing in palæontology-stratigraphy) IN GEOLOGY, and a LECTURER (specializing in petrology-mineralogy) IN GEOLOGY—The Acting Dean, College of Arts and Science, Baghdad, Iraq

LECTURER (with a degree or equivalent in microbiology or bacteriology, and preferably some experience of industrial applications) IN MICROBIOLOGY—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

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SENIOR LECTURER IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

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SOIL SURVEYORS (with B.Sc (Agr.) or equivalent qualification) with the New South Wales Department of Agriculture, to carry out soil surveys in any part of New South Wales, prepare data and draft maps from surveys, laboratory work, etc.—The Agent General for New South Wales, 56 Strand, London, W.C.2.

TECHNICAL OFFICER (with a degree in botany or equivalent qualifications, and preferably practical experience of seed production) for herbage seed multiplication—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

TECHNICAL RESEARCH ASSISTANT IN THE BACTERIOLOGY DEPARTMENT—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Association of Scientific Workers Atomic Energy Progress Notes Vol. 1: Pp. ii+45. Third edition. 2*s.* 6*d.* Vol. 2: Pp. ii+32. Third edition. 2*s.* 6*d.* Vol 3: Pp. ii+24. 2*s.* 6*d.* (London: Association of Scientific Workers, 1955 and 1956.) [72

National Institute of Agricultural Botany. Farmers' Leaflets. No. 2: Varieties of Spring Wheats and Spring Barleys. Pp. 4. No. 8: Varieties of Winter Wheats. Pp. 4. No. 9: Varieties of Winter Oats and Winter Barleys. Pp. 2. No. 12: Rye. Pp. 2. No 13: Varieties of Spring Oats. Pp. 4. (Cambridge: National Institute of Agricultural Botany, 1956.) [72

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Instructions for Rearing and Breeding Locusts in the Laboratory. By P. Hunter-Jones. Pp. 9. (London: Anti-Locust Research Centre, 1956.) [72

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Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1, No. 1: The Structure of the Skin and Dermal Scales in the Tail of *Acipenser ruthenus* L. By Ian C Smith. Pp. 1–14+3 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 5*s.* 9*d.* [72

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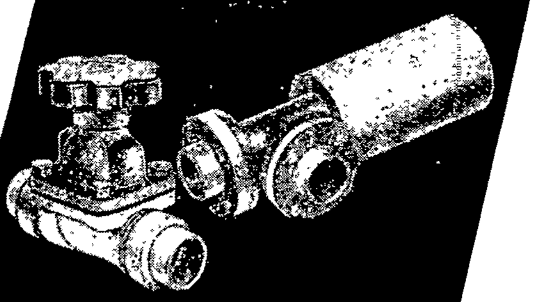

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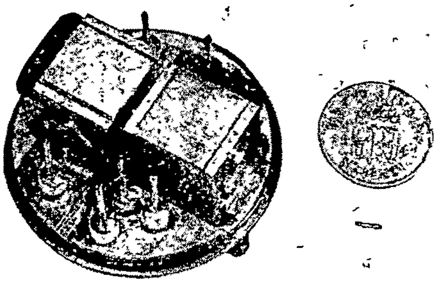

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G. L. BARNES,
Secretary

The University,
Birmingham, 15.

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GOVERNMENT SUPPORT FOR RESEARCH IN GREAT BRITAIN

THE report of the Advisory Council for Scientific and Industrial Research for the year 1954–55 (see p. 768 of this issue) discusses at some length the position of the research associations in the national organization for research; but this is only one of a number of major matters of policy that are dealt with in the report. During the year, the first financial year of the Department's five-year plan was completed, and the Advisory Council records that the provision of resources within the framework and terms of the plan has proceeded smoothly. The provision in the Ministry of Works Votes for services to the Department in 1955–56 is £2,039,200 against £1,497,500 in the previous year, the increase being due mainly to increased provision for major building works, notably for the National Physical Laboratory, the Mechanical Engineering Research Laboratory, the Radio Research Laboratory and the Building Research Station.

The one exception to the smooth implementation of the five-year plan is in regard to staff, the increase of 159 being again less than the 200 provided for in the plan. Continuous and expanded efforts were made to recruit suitable scientists, and the Advisory Council believes that the authority and financial resources are adequate for the objective. While it is admitted that on occasion difficulties in competing in remuneration may be a partial explanation, the shortage is attributed mainly to the increasing general demand for scientific and technical staff and to the shortage of scientists and technologists which the Government's plans for the expansion of technological and technical education are intended to relieve.

While those plans are coming to fruition, it is inevitable that the use which is made by the Department of its scientific and technical man-power will be the more closely scrutinized, and the estimate of the distribution of effort given in the present report will be of particular interest. Information supplied to the Advisory Council indicates that over the Department as a whole 25 per cent of effort is being applied to "Advisory work and *ad hoc* investigations", 45 per cent to "Applied Research" and 30 per cent to "Background (or basic research)". A quarter of the Department's effort is thus being spent in helping to ensure that the results of its work are widely known and applied in industry.

The Advisory Council stresses the importance of making every effort to get the results of the work of the Department's establishments widely known in quarters in which they can, and will, be applied to industrial practice, and it would be undesirable to take any steps which would discourage free approach to the establishments by potential users for scientific help to solve their practical problems. Nevertheless, it must be a matter for judgment as to what proportion of the Department's effort should be spent on such advisory and related work, and one which depends to some extent on the position and efficiency of the information services of the country and the existence within the individual industrial firms of those qualified to appreciate the significance of scientific and technological advance and its application to their own processes and problems. To this extent the problem is linked up with that of scientific and technological education.

While the Advisory Council's estimate that 25 per cent of the Department's effort should now be spent on this purpose may well be reasonable, the situation will obviously have to be watched. This the Council proposes to do, in order to prevent undue emphasis on advisory work, to the detriment of new scientific 'capital' for future application. It notes indeed that the establishment and development of information services by trade associations and research associations could be of service here; but it might well have urged the value of developing as a first priority the proposed Science Centre in London, as well as a national library of science and technology and a new science lending library. The regional developments which stem from such national facilities should at least relieve the Intelligence and Information Division of the Department of some of its present work.

The size of the latter Division and the scope of its activities obviously require consideration, not only in relation to the total effort of the Department itself but also in relation to the information services available in Britain as a whole. Since the Advisory Council discussed the functions of the Division in its report for 1952–53, expenditure on the Division has risen from £58,119 in 1952–53 to £71,365 in 1955–56 and to £79,674 in 1956–57; but the staff has changed but little, being given as 80 in 1955–56 and 83 for 1956–57, compared with 76 in 1952–53. The increase is in fact in the range of the smallest, proportional to present numbers, for which the Advisory Council provided in the gradual allocation of the six hundred additional posts for non-industrial staff available for the four years beginning April 1, 1955, coming with the five per cent for building research, seven per cent for forest products research and nine per cent for the National Physical Laboratory. At the other end of the scale are the 112 allocated for mechanical engineering research (an increase of 45 per cent), the increase for hydraulics research being 50 per cent and for radio research 31 per cent.

These distributions were based on the Advisory Council's considered views of how best to distribute resources made available to the Department, and on its assessment of the relative strengths of the needs of the individual stations; it should be noted that even the 9 per cent increase at the National Physical Laboratory represented the second largest allocation of staff—seventy—for the period. Availability of accommodation and the relative ease or difficulty with which special types of staff could be recruited also influenced the allocations ; but it is quite clear from this report that the Advisory Council is well aware that the total man-power demands of the Department have to be considered in relation to those of the country as a whole and that it takes a balanced view of its responsibilities.

The five-year plan has in fact provided a reasonably stable basis on which the various research boards and directors of research can plan their activities for the next few years ; but it is not suggested that it has made it possible for the Department to meet all the requests that it receives. The Industrial Grants Committee, the Scientific Grants Committee and the Nuclear Physics Committee have all pleaded for more money and for priority of claim on departmental reserves, and the Advisory Council also refers to the way in which universities look to the Department to provide the means for initiating new and promising lines of research for which the normal resources of a university are inadequate. Here, however, there arises a further consideration. The resources allocated by the Department in this way call for consideration in relation to Britain's total expenditure on fundamental research. It is not solely within the Department that it is desirable to keep current programmes in accord with available resources, and to review and adjust them constantly to meet changes in the relative importance of different objectives. No accurate information is available as to the proportion of the £34 millions of the vote for universities and colleges in the 1956–57 estimates which is spent upon research ; but the grant for research and development generally in the 1956–57 estimates is increased by some £25 million on last year.

This increase includes industrial as well as academic research ; but the two are not always sharply separated, particularly in the nuclear field, in respect of which misgivings have already been expressed as to the balance of research effort in Britain. The Advisory Council in this report points to the need for unhesitating reduction or elimination of effort on projects less likely to yield valuable results, in order to release resources for new projects, and emphasizes that it is not sufficient to be satisfied that a project is of value. Selection is equally essential if the national research effort is to be in balance, and if the resources of the Department of Scientific and Industrial Research are to be concentrated on the more urgent objectives and those with best prospects of success ; that, it is suggested, is the continuing responsibility of research boards and directors of research. The report does not discuss further this prime difficulty of selection, nor does it suggest that the problem of discontinuing research is being burked in the Department. There is, however, a comment that the boards and directors should be prepared to consider the abandonment of effort in a particular field when that which an establishment is able to make is small compared with what is being done elsewhere.

In this comment there is a clue to the Advisory Council's view of the broad function of the Department's research activities. That effort, it is implied, should in the main be concentrated on lines desirable in the national interest but which otherwise are unlikely to be pursued. It would follow that once research in these fields is firmly established and is being promoted by other bodies, either in industry, independent institutions or universities, government support should be gradually withdrawn. This would in effect make the function of the Department broadly similar to that of the independent foundation such as the Nuffield Foundation or the Carnegie Trust, with the difference, of course, that the Department cannot expect to enjoy quite the same freedom to experiment as the independent institution. Its activities must be more closely aligned to proposals clearly seen to be related to the immediate interests of the nation. It will step in where the independent institution has uncovered a promising lead, and withdraw when it seems a probable and reasonable expectation that other sources will provide the continuing support required.

That does not, however, dispose of the difficulty of the selection of research projects in the first instance or of deciding on the appropriate moment to withdraw or terminate support. It may, in fact, be more difficult for an executive than for an advisory body to make the latter decision, for in the last resort it is the scientist engaged in the project who alone can best judge how near the project may be to success, and even that judgment may easily err. What an advisory body can do is to bring to the notice of those engaged in the project external factors or conditions which may make its success of less concern from a national point of view or warrant handing over the project to some other organization by which it can be continued with greater resources or higher prospects of success. It should not be imagined that any external committee is better able to judge of the prospects of success than those scientists or technologists engaged in the project : all that can be done from outside is to advise, or decide, as to the appropriateness of continuing the project in the national circumstances of the moment.

Judgments as to the prospects of success and as to projects which are most worth while from the point of view of science or technology are best made —and only soundly made—by scientists and technologists themselves, and from that point of view too much stress cannot well be laid on the value of the Department's postgraduate maintenance grants to assist the universities in meeting the national need for trained research workers. These grants may well assume even greater importance as the expansion of technological education proceeds, and here is a further reason for urging that the supervision of technological education should be entrusted to some one body corresponding in functions and status to the University Grants Committee, if indeed the responsibility is too great to be discharged effectively by the latter body.

There is, however, another point at which the work of the Department of Scientific and Industrial Research impinges on technological education, and that is in the work of the research associations. That scheme is now some thirty-eight years old, and ten years ago it was announced that the Government would continue indefinitely its financial contributions through the Department, in the belief that co-operative research is an important means of increasing industrial efficiency but that industry is best fitted to decide what are its own scientific problems and the best means of solving them. The present report from the Advisory Council records at some length the progress and development in the research association movement over the past five years in the light of a report received from its Industrial Grants Committee.

In the first place, the Advisory Council stresses the autonomy of the research associations. Conditions attached to the Department's grants do not materially affect the powers of direction and control possessed by the council of any association, which is elected by the ordinary membership. The terms of government grants to a research association are designed to meet its particular circumstances, including its stage of development; and they are based on information which enables the Industrial Grants Committee to judge both the suitability of an industry for co-operative effort and the extent to which encouragement is justifiable in the national interest. The grant to be recommended is then assessed, after considering the programme of research, its significance to the industry, its cost and the scientific status of the association in question.

It may, of course, be objected that this is done from outside the industry, and that it is at variance with the belief expressed above that an industry is best fitted to decide what are its own scientific problems and the best means of solving them. No research association, it is true, can hope to select problems for investigation with the same certainty as to their industrial importance as the individual firm; but it can judge those likely to possess national importance as well, and it may promote the attack on problems which are better handled in collaboration and do not involve an element of competition. Moreover, the developments of the past five years indicate also the value of the research association as a means of distributing benefits to an industry and encouraging the attack on more general problems such as operational research, methods of quality control, the study of consumer needs and human factors in industry. During this period, the research associations have received under the Technical Assistance Programme of the United Nations Economic Co-operation Administration, later the Mutual Security Agency, and now the International Co-operation Administration, allocations amounting to about 800,000 dollars for equipment, 30,000 dollars for the provision of current and back numbers of books and periodicals to fill gaps in their information and library services, and 7,600 dollars for visits to the United States by scientific and technical teams to obtain information. They are at present receiving further assistance from the United States under 'Conditional Aid' for the promotion of productivity.

The work on human relations in industry and on individual efficiency in industry, much of which is financed by grants received under the Conditional Aid Scheme for the use of Counterpart Funds derived from United States Economic Aid, adds a fourth category to the three main fields of activity of the research associations, and the Advisory Council recognizes the need to pursue this type of work. The Conditional Aid Programme is due to end on, or shortly after, June 1956, and the Advisory Council suggests that increased resources should be made available for such research, and that it should not be undertaken merely at the expense of the older types of work. Careful consideration is being given to the possible basis of a long-term programme of work in this field financed from departmental funds.

Such work in itself is related to technical education, in that some of it is specifically concerned with the removal of misunderstandings and other difficulties which attend the introduction of new processes and new products or materials in industry. Besides this, the part which the research associations might play in support of technological and technical education was touched upon as a conference in June 1951 and was the sole subject of a conference held in November 1953, as a result of which the ties between individual research associations and technical colleges have been strengthened. The contribution which the research associations might make to technical and technological education is being increasingly recognized, though it was overlooked in the recent White Paper on Technical Education. Probably it is in promoting the recruitment of scientific and technical staff by an industry, as well as in making an industry more research-minded and receptive of new ideas, that the research associations exercise their major educational influence. Nevertheless, Dr. P. F. R. Venables did well to emphasize, in his recent book, the value of a greater interchange of staff between the technical colleges and research associations, as well as industry generally.

This question of technical education is the continuing problem presented alike by the small firm and the small yet well-defined industry unable to finance a fully constituted research association with the minimum overheads essential for really competent scientific guidance and work. For such industries the Advisory Council has sought to foster association of the smaller ones with existing and industrially related research associations. Examples of this relation which promise to meet with success are the arrangements made between the Cutlery Research Council and the British Iron and Steel Research Association, and between the latter and the File Research Council.

There are other problems presented by the small firm; but it should be remembered that, as the survey carried out for the Manchester Joint Research Council has indicated, a major difficulty is the absence in so many small firms of those competent to assess the significance of scientific and technical advance for the activities of the firm. This, however, is a matter of technical and scientific education. For the present, it appears to the Advisory Council that the past five years have demonstrated the strength and vitality of the research association movement as a whole, and the firm belief of most of British industry in the value of their associations. It concludes that industry as a whole has been spurred to increase its support of research associations by the economic situation during recent years and by some falling-off in the rate of increase of government support. Many associations, however, have far to go before their resources and activities are as large as their industries require and can reasonably be expected to support; nor are there any which, in the Advisory Council's opinion, could not usefully be expanded. Moreover, it believes that some of the terms of grant fixed in 1951 may prove to have placed too heavy a load of responsibility on the industry.

Although in terms of purchasing power there has been a substantial increase in the total income of the research associations and in industrial support, the Advisory Council is clear that inflation slows down the development of activities and sometimes causes serious financial embarrassment. It is in consequence in considerable doubt as to the adequacy of the funds at present expected to be available under the five-year plan for what was contemplated. This, it is clear, applies equally to the research establishments of the Department, and it is these and related problems that should be the prime concern of the Government at the moment. There is little evidence of misdirected effort but much of the need for clear thinking and careful assessment of the place of the Department in the nation's research organization, and it is to such problems that the Bill now before Parliament should primarily direct attention.

ORIGIN OF THE VERTEBRATES

The Origin of Vertebrates

By Prof. N. J. Berrill. Pp. viii+257. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 25*s*. net.

For a long time zoologists have accepted for embryological reasons the general proposition that vertebrates are more closely related to echinoderms than to arthropods or annelids, which they resemble superficially in segmentation. This belief has usually been combined with acceptance of the theory that vertebrate descent has involved neoteny, eliminating a sessile adult feeding phase. Willey and Garstang combined these two views in the supposition that the chordate, swimming by muscles, evolved from a ciliated echinoderm type of larva. Prof. Berrill is prepared to accept both the first two theses, but not to put them together as Willey and Garstang did. He believes that the ancestor of the chordates is to be found in the ascidian tadpole and that this was evolved not from a ciliated larva but as a special adaptive phase, concerned with the selection of a suitable location for the sessile adult.

To prove this thesis he draws on his great knowledge of tunicates, their ecology and their embryology. He points out that the tadpole's life is very short, sometimes as little as one hour. The animal consists almost wholly of a locomotor tail and receptor organs with which to guide it. Moreover, the tadpole is best developed in those species in which the adult requires a clean rock surface or some other relatively specialized surface upon which to develop. Such sites are usually at a premium—vertical or overhung surfaces, often swept bare by currents. They therefore have to be sought out by the larva. In groups such as the Molgulidae, where the adults live 'free' on a sandy bottom, the tadpole stage is absent.

His thesis that the tadpole is a new tunicate development is supported by a beautifully concise account of this exceptionally simple creature with its notochord of forty cells, with eighteen muscle cells on each side. He draws also upon investigations by Conklin and Dalcq into the localization of organ-forming substances in the egg and makes a bold suggestion as to how the whole tail structure could result from a simple mutation. If one part of the egg became changed so that a few of the cells of the gastrula swelled by formation of vacuoles to make a notochord, then, he suggests, the cells on either side would acquire myofibrils because of stretching and the nervous system would be pulled out into a tube. The chordal tissue would thus influence adjacent tissues, setting the pace of growth as he puts it, though he does not pursue the thought to the evocative powers of the vertebrate chordamesoderm. His point is that a crude form of tadpole could be produced by relatively simple changes of morphogenesis, though, as he observes, it would need receptor organs to guide its swimming.

Whether we follow Prof. Berrill in his hypothesis or not, it reminds us of the fascinating possibilities that these larvæ present for study. For example, the myofibrils run continuously through the cells all along the tail. All the control is from the front end and the 'neural tube' contains no nervous tissue. It has to be explained, however, how it comes to do so in the neotenous Appendicularia, in which development is otherwise very like that of other tunicates. Ingenious though the thesis is, it does not demonstrate conclusively that the simple ascidian tadpole represents the earliest type of chordate. It is difficult to exclude the possibility that its simplicity is due to the specialization for habitat-seeking to which he directs attention. Above all, it does not provide us with an answer to the question: What were the larvæ of our ancestors like before they were tadpoles? The enteropneust tornaria is so like an echinoderm larva that it is difficult to believe it can be dismissed as "an innovation far from primitive" as Berrill suggests. Similarly he dismisses hollow nerve cords and enterocœles as unimportant indicators of affinity, because they are due to a "simple process of folding". He several times introduces this concept that foldings of epithelial layers are the simplest form of morphogenetic process—an interesting topological and embryological question. We cannot, however, afford to discard clues in the similarities of developmental processes, at least until the underlying morphogenetic forces are understood. It is scarcely sufficient to say of an organ, as Berrill does of the nerve cord of *Balanoglossus*, that it is "inevitably situated where it is found".

He is equally provocative about the later stages of vertebrate evolution, interpreting the development of *Amphioxus* as derived from that of ascidians by a slowing of the rate of differentiation of all the tissues by a "weakening of the ascidian crescental agents", which might have come about by a relatively simple mutation.

These are only some of the ways in which the author has succeeded in showing the stimulating value of studies of the morphology and embryology even of such creatures as sea squirts. He provides some very interesting comments also on the adult structure of tunicates. There is a good account of the subneural apparatus and of the work of Huus and Carlisle on its possible receptor functions, with all that this implies for the origin of the vertebrate pituitary gland. Berrill adds the interesting suggestion that the dorsal cord, a strand of cells between the subneural gland and the gonad, controls release of the genital products by "neuroid or hormonal transmissions along its plasmal surface". Almost as an aside he introduces the conception of the tunicate epicardium as the ancestor of the coelom. All these and many other questions are discussed lightly, concisely and yet with full scholarly appreciation of their significance, making a book that every zoologist can enjoy.

J. Z. YOUNG

WILD-LIFE REFUGES IN THE UNITED STATES

Seeing America's Wildlife in our National Refuges

By Devereux Butcher. (Prepared under the Auspices of Defenders of Furbearers.) Pp. ix+338. (New York: The Devin-Adair Company, 1955.) 5 dollars.

WILD-LIFE refuges in the United States are so many, so far-flung and so astonishingly rich in vertebrates that to become familiar with the majority is an unattainable ambition for all but a very few, even of Americans. Most European naturalists have only the vaguest idea of them. One should therefore be grateful to Mr. Devereux Butcher for this highly informative book, with its three hundred and fifty excellent half-tone illustrations, which show a generous sample of the mammals and birds of the refuges, and a fair but smaller sample of the refuges themselves. Forty-one of them are briefly described, together with a number of national parks and other public and private refuges. Nevertheless, the author is compelled to dismiss more than a hundred other refuges of the Federal Fish and Wildlife Service alone, in a final ten-page summary, although several of these are each larger than all the nature reserves in Britain put together. Many hundreds of interesting State refuges cannot even be mentioned by name.

Mr. Butcher has made his selection wisely from a wide variety of habitats and regions, although coastal, desert and mountain refuges naturally come off best, and the representation of New England and the Middle West and Prairie states is disappointingly thin. He has packed his descriptions with accurate and up-to-date facts, with a minimum of padding but with a vivid and colourful presentation of what each has to show and of the achievement which it represents. The propaganda for the defence and expansion of the system and against rival interests, particularly shooting men, rings somewhat stridently to a British ear; but apart from differences in national character and tastes, it must be borne in mind that the problems created by some fifteen million 'hunters', or shooting men, have no sort of parallel in Great Britain, while threats to alienate national parks and refuges for economic or defence purposes have recently grown to very serious proportions in the United States just as much as in Britain. Nevertheless, the reader should not forget that the American restrictions on shooting wild-life, which receive bare mention in this book, are far more drastic and more strictly enforced than anything ever contemplated in Britain, and that not all who are in a position to judge would agree with, for example, the author's condemnation of the Department of Interior for permitting the New York State Throughway to be driven across the marshes of Montezuma Refuge, in view of the improved control of water-levels which it facilitated.

American wild-life is often astonishingly tolerant of human beings, who will no doubt be tempted by this most attractive book and by growing prosperity and leisure to flock to the refuges in alarming numbers. The author appreciates the danger, at any rate for the California condor, which can be prevented from feeding its only chick all day by one man showing himself within five hundred yards of the nest for a few minutes only.

Characteristically, but in contrast to British practice, the vegetation and invertebrate fauna are treated as little more than background for the main drama of the vertebrate actors. There is a certain amount of history but relatively little ecology, and little attention to the natural as against the human dangers to the successful management of refuges. It seems too much to hope that this fairly expensive work can be widely bought by private individuals in non-dollar countries but it should not be missing from any serious library concerned with Nature and its conservation.

E. M. NICHOLSON

CATALYTIC HYDROGENATION

Catalysis

Vol. 3: Hydrogenation and Dehydrogenation. Edited by Paul H. Emmett. Pp. vii+504. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 100s. net.

WITH the appearance of the third volume this comprehensive work on catalysis begins to take a new form, in that a specific type of catalytic reaction is considered in place of catalysis in general. The present collection of monographs deals with various aspects of catalytic hydrogenation. Much can be learned with regard to the mechanism of the catalytic activation of hydrogen itself from reactions such as the ortho-parahydrogen conversion and hydrogen–deuterium exchange, which are treated in an initial chapter by B. M. W. Trapnell. Catalytic hydrogenation, however, involves also the simultaneous activation of a second component, namely, the substrate to be hydrogenated; and the mechanism of this two-component process, in the typical case of the hydrogenation of ethylene, is discussed fundamentally and very clearly in the subsequent monograph by D. D. Eley. The next three sections, on the catalytic hydrogenation of olefinic hydrocarbons in general, by B. B. Corson, on the addition of hydrogen to acetylenic linkages, by G. C. Bond, and on the hydrogenation of nitro compounds, by H. A. Smith and W. C. Benoit, have largely a practical character and deal with aspects such as selective hydrogenation and the degree of specificity which can be exerted by variations in the hydrogenating metal and in the working conditions.

In connexion with a review of the present state of industrial reactions involving hydrogenation, a welcome emphasis is laid on the synthesis of ammonia. The general progress of the synthesis, including a discussion of the inherent requisites for good ammonia catalysts, is dealt with by W. G. Frankenburg on the basis of the necessary activation of the nitrogen, by chemisorptive linking of suitable bond-strength to the catalyst, in addition to the activation of the hydrogen. This is followed by a monograph by a group of chemists from the Dutch Staatsmijnen on research on the ammonia synthesis since 1940, the outstanding feature in this section being a clear exposition of the mechanism of promotion. The synthesis of methanol is discussed by G. Natta with special reference, first, to the necessary specificity of action which is required in the catalysts employed in order to avoid the formation of polymeric products, and, secondly, to the merits of particular catalysts. R. Feuge contributes a practical account of modern methods of working in the industrial hydrogenation of glyceride oils. In this, the discussion of forms of nickel catalysts alternative to kieselguhr-supported nickel prepared by the reduction of basic nickel carbonate is particularly valuable. Finally, the technical dehydrogenation of hydrocarbons in the petroleum industry is described, perhaps too briefly, by K. K. Kearby.

Considered as a whole, this volume represents a fair balance between the academic and the industrial aspects of hydrogenation. Its component articles are of a consistently high quality. It certainly stands out from the earlier volumes of the work, in particular from the point of view that chapters containing tables of largely undiscussed references to patent and other literature are absent; and Dr. Emmett is to be congratulated on assembling, within the compass of some five hundred pages, such an authoritative and internationally contributed description of catalytic hydrogenation.

E. B. Maxted

AUTOMATIC REGULATION

Servomechanism Analysis

(McGraw-Hill Electrical and Electronic Engineering Series.) By George J. Thaler and Robert G. Brown. Pp. xii+414. (New York and London: McGraw-Hill Book Company, Inc., 1953.) 60s. net.

At a time when so much is written and talked about the automation of manufacturing processes, the automatic control of aircraft, guided missiles and the like, a book is welcome which sets out to give the mathematical background for the analysis and design of servomechanisms. The present volume under review is written in a fluent and clear style and contains a great number of worked examples and of problems enabling the student to ascertain whether he has grasped the contents of the chapters he has read and to gain some experience in handling actual problems of control. A very welcome feature is a brief and sufficiently clear introduction to the theory of Laplace transformations which are used throughout the book.

As problems of electric circuits can usually be solved with not too great difficulty either directly or with the aid of analogue computers, electrical analogues are set up of mechanical, thermal, hydraulic and pneumatic systems. The book then deals with the transient analysis of servomechanisms, that is, the derivation, solution and discussion of their differential equations for determining the main criteria of performance, the speed of response, the steady-state error, the maximum overshoot and the resonant frequency for the case when changes in input or output occur. Proportional as well as derivative and integral control are dealt with.

The next chapter deals with transfer functions and their graphical representation, the transfer function being defined as the complex ratio of the output of the device to its input (p. 112). The authors seem to be not quite consistent in that a few pages later (p. 126) they call this ratio the frequency response function, while the direct transfer function is defined as the ratio between output and error, this latter being the difference between input and output. The reason for this apparent inconsistency is given on p. 140 and following.

Simplifications are made for the mathematical analysis by replacing complicated schematic drawings by equivalent block diagrams and by introducing a shorthand notation for the transfer function, representing it as the product of a constant factor K and a complex factor G. The symbols K and G are replaced by A and F respectively if a control element is used in the feedback path. Frequency response curves and curves of direct and inverse transfer functions are given in rectangular and polar co-ordinates, respectively. Then the performance of servomechanisms is analysed from equations and plots, stability criteria are discussed at some length, a classification of the systems is given and figures of merit are defined. Only very brief chapters deal with the introduction to design and with gain adjustment. A trial-and-error method and direct methods for the gain adjustment are given.

Where gain setting alone is not sufficient for obtaining the desired values of resonant frequency and steady-state error, some kind of compensation must be applied either in the main circuit or in a parallel circuit. Series and parallel compensation are therefore dealt with at some length in the next two chapters. Then it is shown how, by the use of logarithmic co-ordinates, analysis and design may be simplified in many cases. A brief chapter deals with relay servomechanisms as these find wider and wider application. Here electromechanical relays are used for applying full power to the output when the error is excessive and to maintain it until the error is sufficiently reduced. The final chapter, dealing with the 'root-locus method', might be of particular interest, as this method claims to combine to some extent the advantages of the transient and the transfer function analysis. But, due to limitations of space, only the elements are given and the chapter is somewhat sketchy.

The authors do not claim originality for the material contained in this book, but have found in their teaching practice that the arrangement and detail of presentation are well suited for the student. This is also my impression. While the various systems of servomechanisms are treated in the text in a rather abstract manner, the student will find in the appendixes, apart from some useful tables, more detailed physical and technological descriptions of the components used, like error detectors, *controllers*, servomotors and compensating devices. A subject-matter index and a bibliography of 206 items complete this well-produced book. As is not uncommon in American publications, only very few references are made to British and Continental sources.

R. Neumann

Index of Mathematical Tables from All Branches of Sciences

Prepared by Dr. Karl Schütte. (Index Mathematischer Tafelwerke und Tabellen aus allen Gebieten der Naturwissenschaften.) Pp. 143. (München: R. Oldenbourg, 1955.) 14.50 D. marks.

BEFORE reviewing the contents of this book, it is of some interest to recall a few facts concerned with the relatively short history of such works. It was in 1873 that British mathematicians first conceived the idea of publishing a survey of available tables, and their efforts were responsible for the appearance in 1875 of the "Encyclopaedia of Mathematics" which listed some 750 tables in all. In the meantime, with the growth of technological research, involving as it does much detailed computation, the number of tables has steadily increased, and the comparatively recent "Index of Mathematical Tables", by Fletcher, Miller and Rosenhead, of 1944, gives a selection of more than two thousand.

The author of the book under review explains that his own work was begun before the Second World War and was temporarily halted for the duration thereof; on examining Fletcher's "Index" in 1946, he found that nearly four-fifths of his entries were not in fact shown in that work; he thus decided to complete it, there being in any event no German counterpart of recent date. He claims some twelve hundred entries, of use to "calculators" of various kinds, belonging to all the branches of applied science. He also claims, justifiably I feel, that its comprehensiveness and clear order enhance its value considerably, pointing out at the same time that out-of-date tables and all three-figure ones have been omitted.

The book is divided into sixteen chapters, with sub-sections where appropriate. The first four deal with general calculating (including harmonic analysis), logarithms, natural circular functions, and logarithms of these. Of the remaining twelve, those worthy of special mention deal with the theory of numbers (including primes), gamma functions, elliptic functions, Bessel functions and the many other varieties with which mathematicians and physicists are familiar. It would be unfair to omit mention of those referring to chemistry, astronomy, meteorology, geophysics and navigation. A very full (and almost formidable) list of authors whose publications are listed is provided, together with a similar list of institutes.

J. H. PEARCE

General Physics

By Prof. Oswald Blackwood and Prof. William Kelly. Second edition. Pp. x+704. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 54*s.* net.

Introductory Applied Physics

By Norman C. Harris and Edwin M. Hemmerling. Pp. viii+729. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 50*s.* 6*d.*

EACH of these beautifully produced books from the United States is written for a specific purpose which is somewhat different from that of the ordinary text-book. Profs. O. Blackwood and W. Kelly give an introductory course based on no more initial background than awareness of the obvious impacts of physics upon everyday life. Indeed, their hints on the solution of simple equations, arithmetical extraction of square roots, and the pronunciation of unfamiliar words, show that they assume a fairly low threshold for some students. They are also quite determined that this shall be no excuse for being content with a superficial knowledge of the principles of physics. A thorough understanding of the simpler processes of physics, and a sensible appreciation of its applications, are brought within the grasp of any careful reader, and this is no mean achievement. As in most books of this kind from American universities, the treatment of elementary mechanics is particularly good. The price puts it beyond the reach of British schoolboys (and, *a fortiori*, of their teachers), and it is in any event difficult to see where it would fit into any ordinary scheme of instruction in Britain; but it can be recommended to the librarian with a surplus to expend.

N. C. Harris and E. M. Hemmerling, writing for students in junior technical colleges, also assume only an elementary knowledge of mathematics; but having a much fuller background of scientific knowledge to exploit, they work at a more exacting level. Here the emphasis is on industrial applications. Heat engines, refrigeration and air-conditioning are pursued in great detail, and there is a very thorough treatment of alternating current and electronics. The standard is not advanced in the academic sense, and the whole is within the capacity of the young technical student, who should find it an inspiring book. This also is priced at library level.

G. R. NOAKES

Chemistry for Our Times

By Elbert C. Weaver and Laurence S. Foster. Second edition. Pp. vi+666+8 plates. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 30*s.*

ALTHOUGH written as a text for American high schools and university freshmen, the theme of the book is chemistry as it affects the citizen. In the preface to the first edition (1947) the authors maintained that the atomic age called for a new approach to the study of chemistry. In framing this, fundamental principles and industrial applications were treated in due proportion and always with the humanistic appeal. Thus, while the factual chemistry was not much more than that required for British O-level examinations, it was accompanied by many literary quotations, and an abundance of information on such topics as the cyclotron, cosmetics, dyes, nuclear energy, and accounts of economic applications of chemistry. Numerous striking and even sensational stories, and many good illustrations in half-tone, heightened the effect. The idea seemed to be to attract students to the study of chemistry by extolling its spectacular advances. The theoretical explanations, clear but nowhere deep, were clever in their simplicity.

In this, the second edition, the authors have deleted the more sensational stories and pictures, have shortened the literary quotations, recast the appendixes, removed the coloured frontispiece but inserted eight coloured plates, and added items to make their work more of the style of the conventional text-book. These changes in their aggregate reduce the number of pages from 737 to 666. Yet this remains a remarkable book. Many plates have been replaced by others depicting more recent procedures. Although expensive, and scarcely suited as a class-book for any British examination, it should appeal to the student of humanities desirous of having chemical achievement introduced and interpreted to him: it would also make a welcome addition to a school library.

G. FOWLES

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1954–55

THE annual report of the Department of Scientific and Industrial Research for the year 1954–55* includes the report of the Committee of the Privy Council for the year ended September 30, 1955, over Lord Salisbury's signature, and the fortieth report of the Advisory Council, signed by Sir Hugh Beaver, which gives the usual summary of work carried out by the various research stations and boards and research associations. Besides the summary of the Department's expenditure for the year ended March 31, 1955, there are appended lists of assessors to the Advisory Council, of the various committees of the Advisory Council, of research boards of the Department and their membership, of grants for special researches in progress or authorized during the year, of students awarded maintenance allowances for postgraduate training in research and a 49-page list of publications issued during the year. The Advisory Council can fairly claim at the outset that the Summary of Work and Appendixes afford a valuable means of obtaining easily detailed information regarding the work of the Department in widely varying fields; but the question as to whether the present organization is adequate to deal efficiently with matters of public relations remains to be determined. The persistence and the character of Parliamentary questions suggest that the problem is not yet solved, and it is improbable that an annual report of this type can contribute greatly to a solution.

The gross expenditure of £6,685,400 compares with £5,865,279 in the previous year and is reduced to £5,898,016 net by various receipts (£370,536 being from the National Physical Laboratory) for work done for government departments or for industry, the net increase on 1953–54 being £643,674; the estimates for 1955–56 provide for a further increase of £630,154, and those of 1956–57 for a net increase of £1,023,930. On October 1, 1955, the Department employed 4,379 staff of all grades (including 190 part-time) compared with 4,220 (164 part-time) in the previous year. Annual grants to research associations totalled £1,335,125 (compared with £1,254,088 in 1953–54), grants for special researches amounting to £315,425 (£412,431 in 1953–54). Grants to students amounted to £323,022, an increase of £27,603, the number of students in training in 1954 being 1,052, and in 1955, 1,022, compared with 1,009 in 1953; and of these, 381 in 1954 and 379 in 1955 were new. Of eight senior research awards in 1954 and in 1955, two in 1954 and five in 1955 were new, and 26 new grants for special researches in 1954 and 15 in 1955 brought the total of such grants to 64 and 53, respectively, compared with 58 in 1953 and 70 in 1952. Of the grants for special researches, 37 in 1954 and 33 in 1955 were in physics; for chemistry the figures were 9 and 9; for biology and also for engineering, 6 and 4; and for mathematics and astronomy, 3 and 1. In 1954 chemistry claimed 428 and in 1955, 399 of the students receiving grants; in physics the corresponding figures were 301 and 262; in engineering, 104 and 91; in biology, 97 and 107; in mathematics and astronomy, 60 and 86; in geology and mineralogy, 36 and 42; and in metallurgy, 26 and 23.

Expenditure of £926,971 gross or £556,435 net on the National Physical Laboratory was slightly more than in 1953–54 (£513,049 net), and this is true of expenditure on all branches of the Department's activities, except fire research, which decreased by £2,922 to £22,433; the increase on 1953–54 was, in general, about 10 per cent, apart from the contributions to European Nuclear Research, which increased from £42,483 to £359,787. Expenditure on mechanical engineering research only increased, however, by £1,154 to £315,561. Net expenditure under the other major headings in 1954–55 was as follows, the increase over 1953–54 being given in brackets: building research, £453,049 (£41,455); food investigation, £373,208 (£81,090); road research, £343,516 (£37,984); fuel research, £270,419 (£23,535); geological survey and museum, £223,410 (£12,670); chemical research laboratory, £136,350 (£11,997); forest products research, £116,487 (£15,235); radio research, £107,298 (£12,901); hydraulics research, £76,169 (£14,607); water pollution research, £74,321 (£11,648); pest infestation, £68,145 (£9,388); headquarters administration, etc., £247,915 (£27,536).

The contribution to the European Organization for Nuclear Research was increased to £520,000 in the 1955–56 estimates and further to £930,000 in those for 1956–57, while of the grants for special researches some £250,000 of the total £315,425 is for support of nuclear physics research in universities. This total was increased to £422,200 in the 1955–56 estimates and to £497,000 in those for 1956–57. These grants were provided for the installation and operation of the large particle-accelerating machines for research in nuclear physics in the Universities of Birmingham, Cambridge, Glasgow, Liverpool and Oxford, and the Advisory Council has endorsed the recommendation of the Nuclear Physics Committee for supplementary grants of £7,720 to the University of Glasgow and £14,200 to the University of Liverpool. A grant of up to £82,000 to the University of Manchester for the installation of a 6-MeV. Van de Graaff generator for research on nuclear structure has also been recommended by the Advisory Council.

Although the European Organization for Nuclear Research receives the major part of the Department's contribution to international co-operation, developments during the past year in desalting brackish waters have provided an interesting example of the difficulties as well as the possibilities of international co-operative research. A working party concerned with this subject, after considering a report on existing and potential processes for desalting, recommended that meetings should be called by the Netherlands to discuss electrodialysis with ion-exchange membranes, by the United Kingdom to discuss the prevention of scale formation in distillation equipment, and by France (in Algeria) to discuss solar distillation and certain aspects of ion exchange. Out of these meetings during the current year has come an agreement signed by Algeria (for France), Australia, South Africa, the Netherlands and the United Kingdom, under which, in return for a share of the development costs, the United Kingdom will have a voice in the development of the process of electrodialysis with ion-exchange membranes in the Netherlands and rights under Netherlands patents. Under a less formal agreement on scale-prevention work, the Department has contributed funds to permit expansion of the existing Admiralty research group, and the Netherlands have provided an additional research worker for the team.

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* Department of Scientific and Industrial Research. Report for the year 1954–55. Pp. 321. (Cmd 9690.) (London: H.M. Stationery Office, 1956.) 7s. 6d. net.

Government Establishments

The Advisory Council's report refers again to the urgent need for a new Fuel Research Station and, as a prelude to planning a new station, has reviewed the policy which should govern the future work of the Fuel Research Organization. As a result, the Council has recommended that the Fuel Research Station should maintain its position as a national centre for the study of fuel problems free from political considerations and pressure of sectional interests; that the Station should aim at becoming the central organization in Britain for long-term basic research on fuel; and that it should not usually undertake applied research beyond the stage at which this can properly be transferred to other organizations engaged on fuel research. On this basis, it recommends construction of a new Fuel Research Station as a matter of first priority, and it is understood that the Ministry of Fuel and Power is in broad agreement with this policy and that the Committee of the Privy Council for Scientific and Industrial Research has adopted these recommendations.

About one-fifth of the total effort of the Station is now applied directly or indirectly towards reducing pollution of the atmosphere by the treatment and utilization of fuels and their products. Semi-automatic equipment for the elimination of smoke has been devised and tested on the Lancashire boiler at the Research Station with satisfactory results, and attention is also being given to coal-fired and oil-fired central-heating boilers with the object of increasing efficiency while decreasing emission of smoke. Work on the removal of oxides of sulphur from boiler flue gas by the use of ammonia has shown that by working the process in two or more stages the sulphur can be recovered as ammonium sulphate with an efficiency of 96 per cent and loss of only 3 per cent of ammonia, and as a result of these experiments the Central Electricity Authority is erecting at the Nottingham generating station a pilot plant to treat 2 million cubic feet of flue gas per hour. After examining the fluidized catalyst process for the Fischer–Tropsch synthesis, attention has been given to the 'liquid phase' or slurry process, in which synthesis gas is bubbled through a suspension of powdered catalyst in heavy oil or molten wax; and studies continued of the changes occurring in residual fuel oils on storage that makes them difficult or impossible to pump, with the view of devising a test that will make it possible to predict the behaviour of a freshly prepared oil. Examination of the industrial processes to which coal is submitted indicated that on carbonization of coals containing 6–10 parts of germanium per million, up to 90 per cent of the germanium remains in the coke, and that the germanium contents of the dusts collected in heating-flues of the coke-burning producer of a coal carbonization plant rose to a maximum of three per cent in the recuperator.

The research stations with the work of which the Advisory Council's report is this year particularly concerned are the Fire Research Station and the Forest Products Research Laboratory. Both were visited by the Advisory Council, which was well satisfied with what it saw. It is convinced that the Fire Research Station is a continuing success. Although administered in detail as a government research establishment, it is a joint organization controlled by the Department and the Fire Officers' Committee, each contributing one-half of the running and capital costs. Under a new agreement recently concluded between the partners, the current annual expenditure will be increased from just under £90,000 to a maximum of £125,000, and the non-industrial staff will be gradually increased from just under 80 to more than 100. Extensive new buildings and equipment are to be provided at a cost of up to £365,000, and one of the new buildings, towards which and towards the general site the Fire Service Research and Training Unit has made a grant of £70,000, will provide facilities for the study of fires in large-scale models under controlled conditions. Work during the year has included an inquiry into the effect of heat on various types of high-tensile steel used in the construction of pre-stressed concrete, and the development of a new roof test and a new test for combustible wall linings; and a committee has been established to advise on a research programme on industrial fires and explosions.

Some 35 per cent of the staff effort at the Forest Products Research Laboratory (and also at the Building Research Station) is at present devoted to advisory and related work—a proportion which the Advisory Council regards as too high, and it hopes that the industrial research organizations will in future relieve the Laboratory increasingly of this type of work, leaving it freer to conduct more fundamental investigations. In particular, the Research and Information Committee of the Furniture Development Council and the Research and Development Committee of the Timber Development Association are expected to assume increasing responsibility for applied research in this field. Work during the year has included experiments with growing English ash which indicated that the degree of lignification of the fibre walls (which affects the strength of wood) is at least partly controlled by the illumination received by the leaves. A series of tests of the moisture gradient of wood carried out over a year indicates that where, as in boats or vats, the wet face cannot be painted, the dry face should also receive no paint, or at most only a thin pervious coat. Estimates of the strength of laminated timber have been extended to the study of beams from two different species, and research is being carried out on the permeability of woods to liquids and gases, on the factors that govern the susceptibility of various zones of Corsican pine to infestation by the furniture beetle and the house longhorn beetle, and on the bending vibration and damping of wooden beams and rectangular plates.

The proposals for the organization of practical trials in collaboration with the National Federation of Building Trades Employers met with a good response from the members, and a series of trials with aerated mortars has been completed, while the Building Research Station has also made good progress in developing a process for the production of light-weight aggregate from pulverized fuel ash. In designing large rigid frames, the main problem is to find a method which is sufficiently accurate while avoiding heavy design costs. It has now been shown that the behaviour of a frame to be designed can be deduced by reference to an idealized substitute frame which has already been analysed, and a new method of design for stanchions is being developed which will lead to further economy. Particular attention is being paid to the problem of measuring the stress in the linings of deep tunnels in clay and, as a result of the work on schools which has continued for some five years in collaboration with the Ministry of Education architectural development team and the Hertfordshire County Council, a body of essentially new information has been made available to designers, in terms of which they have been able to plan for fuel economy and design economy in schools.

Commenting on the work of the Chemical Research Laboratory, the Advisory Council expresses the opinion that the present programme of the Laboratory is well chosen and that, although the Laboratory's work on semi-permeable membranes, including membranes with ion-exchange properties, is limited, it has already made important contributions and should be continued and if possible extended. During the past year the trades concerned have been steadily brought into closer contact with the preparation of the Food Investigation Organization's programme and its work and, in the Fish Division in particular, close liaison has been effected with the White Fish Authority and the Herring Industry Board. The trawler *Northern Wave* has been chartered for a joint experiment in freezing at sea on a commercial scale, and special attention is being given to research on smoke-curing with the view of developing more convenient, controllable and economical procedures and of producing cures of white fish and herrings of consistently high average palatability and keeping quality. Plans have been drawn up for an experimental unit to be attached to a new centralized abattoir, and studies of fresh and frozen beef have continued. Recent storage trials have indicated that pears could be kept for longer periods at 30–31° F. without suffering low-temperature injury, and work is also being continued on the effect of field factors on the chemical composition and storage life of apples. A coating of sulphonated polystyrene on diatomaceous earth has proved valuable in the chromatographic purification of insulin and a similar method has been developed for purifying meat myoglobin.

The Geological Survey has made continuous progress since the War with the primary six-inch survey, which is the basis of all Geological Survey work, and with the first six-inch re-survey of areas of economic importance; it has also re-published ninety-two one-inch to the mile maps in colour-printed editions and extra editions of ten other maps printed to show solid geology only, making a total of 102. But only four of the twenty-four quarter-inch geological maps of England and Wales have been re-published and nineteen of the sixty-two one-inch sheets of Scotland, with fourteen additional sheets showing drift geology. All ten of the seventeen quarter-inch geological maps of Scotland published before the War have been reprinted. The Geological Survey has also statutory obligations under the Mining Industry Act (1926) and the Water Acts of 1945 and 1946, while the Museum of Practical Geology, which again had a record number of visitors (374,353), has acted as a study centre for geological research and exhibition of collections of minerals, gem-stones, rocks and fossils. During 1954, 270 square miles in Great Britain were covered by primary six-inch survey, and 253 square miles, including 75 square miles in Northern Ireland, by revision survey. Boreholes drilled during recent years continued to provide much material calling for specialized petrological investigation, and during 1954 more than eight hundred boreholes were notified to the Geological Survey under the terms of the Mining Industry Act and more than 300,000 ft. of strata were examined, identified and described. The Survey itself is drilling four boreholes in the Ashover district north-east of Matlock to ascertain the sequence and structure of the Millstone Grit and higher parts of the Carboniferous Limestone between the Derbyshire coalfield and the limestone country west of Matlock. The task of encouraging the search for the mineral raw materials necessary for the Atomic Energy Authority's programmes remains with the Atomic Energy Division of the Geological Survey, and besides further searches for uranium, attention is being given to a search for thorium deposits and to the development of new methods of geophysical and geochemical prospecting, particularly to fundamental research as to the most profitable lines for conducting geological exploration.

The work of the National Physical Laboratory and the Chemical Research Laboratory for the period have been reviewed in these columns fairly recently, so no more need be added here than that the Digital Electronic Universal Computing Engine (Deuce) was installed early in 1955, and the construction of the final Automatic Computing Engine started. The High Temperature Fatigue Laboratory has now been transferred to the Mechanical Engineering Research Laboratory, the staff of which increased by 13 per cent during the year. Two further symposia, dealing with precision electrical measurements (November 1954) and boundary layer effects in aerodynamics (March 1955), have been held in the National Physical Laboratory.

The first stage of the main hall of the Hydraulics Research Station was completed in January 1955 and arrangements have been made with river boards and coast protection authorities to collect data on beach movements and all matters bearing on coastal protection; analysis of these observations will provide valuable information on long-term trends of erosion or accretion. The investigation into the behaviour of storm surges in the Thames Estuary has been extended to examine the effect which a barrage would have in reducing storm surges of various magnitudes, and the large model of the River Thames is being used for investigating the general pattern of estuarine circulation and its relation to the tendency for serious silting to occur in the so-called "Mud Reaches" immediately downstream of the Royal Docks. A model of the tidal reaches of the River Trent is being constructed. A second model has been built in connexion with the Severn River Board's scheme for the relief of flooding on the River Severn; this includes 24 miles of the river downstream from Shrewsbury to Buildwas, and it is being used for ensuring that the reduction of floods in the neighbourhood of Shrewsbury will not lead to more serious flooding elsewhere along the river. Basic experiments in the 54-ft. wave tank have indicated that a screen of spaced piles offshore from a sand beach did not cause the beach to build up but halted or almost halted erosion, and two-dimensional wave tests have been carried out for the Kent River Board on a model of a section of the proposed Dymchurch sea wall. The proposed design of a new harbour to be constructed at Tema on the Gold Coast is being investigated in Wave Basin No. 2.

Biological research in the Pest Infestation Laboratory included field-work on residual populations of insects in farm buildings, in an old watermill and in disused dock storage sheds. Research on grain storage was largely confined to the experimental storage of damp grain in airtight silos; that on insecticides included a new method for the chemical assay of pyrethrins, the control of bean weevils with insecticidal dusts, the mechanical protection of goods from infestation by sheeting, and the relative susceptibility of different insect species to pyrethrins. Long-range biochemical work was concerned with the nature and significance of insecticide residues in foodstuffs and mechanisms of insecticidal action.

In the Radio Research Organization the main emphasis continued to be on the factors which affect radio waves during transmission between the transmitting and receiving stations; but the importance of the work on semiconductors and on ferromagnetic materials is also stressed, the former being concerned with noise generation in germanium and components made from it and with measurements on transistors. In the field of navigational aids, the main interest is in low-frequency and very low-frequency position-fixing applications and, at higher frequencies, in radio direction-finding.

A main group of researches carried out by the Road Research Laboratory seeks to provide road engineers with the basic information needed for decisions as to the most satisfactory and economical types of road construction for particular conditions of soil, traffic and climate; and the Ministry of Transport and Civil Aviation's programme of new road construction will provide the necessary opportunities for full-scale experiments. A scheme has been introduced by which the results of research are embodied in agreed specifications for use on selected sites under conditions of good normal commercial practice. Evidence is accumulating that the separation of motor traffic from other road users decreases accidents, and a study has been made of eighty-six sites reported as the scene of repeated skidding accidents. The Laboratory's work on non-destructive tests for measuring the strength of concrete by an ultrasonic pulse technique has been summarized and the equipment required is now being manufactured.

The new Water Pollution Research Laboratory at Stevenage was officially opened on June 20, 1955, and investigations in progress include a detailed study of the effects of pollution on rivers and estuaries, fundamental work on processes of sewage treatment and the investigation of methods of treating industrial waste waters. Progress was made in studying the oxygen balance of the Thames Estuary and in attempts to predict the effect of polluting discharges on the content of oxygen in the estuary water. Observations on the effect of sewage effluent on the River Colne near Watford have been completed, and tests with seven popular proprietary washing powders indicated that 50 per cent of rainbow trout were killed in about seven days in a solution containing the equivalent of rather less than 6 p.p.m. sodium dioctylsulphosuccinate.

The work of the Intelligence and Information Division of the Department is mostly directed towards the improvement of industrial productivity, and altogether a programme of twenty-nine projects concerned with human factors in industry and costing more than £155,000 from Conditional Aid Funds is guided by the two joint committees of the Department and the Medical Research Council and serviced by the Division. Most of the projects are being carried out by the universities, independent research institutions or research associations; but one concerned with problems of work study, including those of introduction, such as the reasons for suspicion and resistance, the assessment of results in terms of the impact on efficiency and human relations within firms, and problems of continuing application, is being undertaken within the Division. Work has continued on the sample survey of research expenditure of private industry, and an economist was appointed to help the Food Investigation Organization and the Pest Infestation Laboratory assess the economic relevance and application of their current work. The Industrial Operations Unit has demonstrated the value of a more systematic study of industrial operations, particularly of improved methods of planning and controlling work, and a survey has been initiated of technical developments leading to automatic processes in industry and of the broad economic and social implications of these developments. During the year, following successful pilot-plant trials of a suggestion that effluents might be treated with ammoniacal liquors from gas works to produce ammoniacal sulphate and a hydrated iron oxide, the Gas Council decided to erect a full-scale plant. The iron oxide will be mixed with peat and used for sulphur recovery, and besides reducing imports of bog iron ore the new process will reduce the demand of the gas industry for sulphuric acid.

(*To be continued*)

CHROMATOGRAPHY AND PARTITION OF CELLS AND CELL FRAGMENTS

By PER-ÅKE ALBERTSSON

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THE study of isolated cell particles has given much information about the organization of the cell. The method which is generally used for fractionation of the particles from a homogenate is differential centrifugation. In that method, differences in the sedimentation velocities of the particles are utilized for their separation, and differences in sedimentation velocities depend mainly on differences in size, density and form of the particles. Ultracentrifugation in density gradients has also been used for the same purpose. Here the difference in particle density is the determining factor. It should be possible, however, to utilize differences in other properties, too; for example, physical and chemical properties of the surface and the electrical charge of the particles.

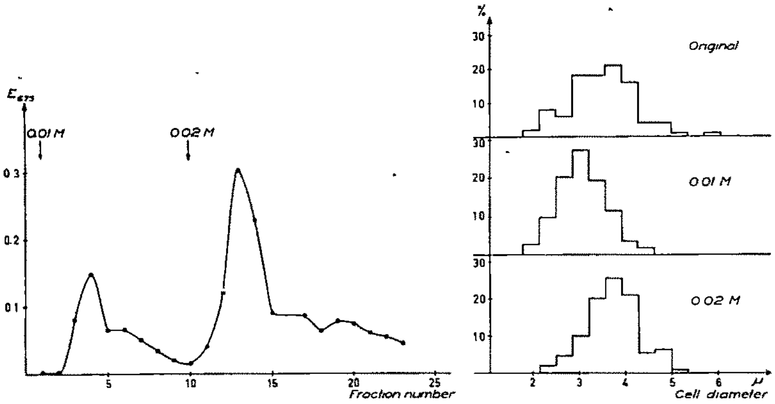

Fig. 1. Chromatography of *Chlorella pyrenoidosa* on calcium phosphate. Left: the two peaks which are obtained by elution with 0·01 *M* and 0·02 *M* phosphate buffer *p*H 7. Right: distribution polygons of cell diameters in the original suspensions and the two elution peaks. Temperature, + 4° C.

These properties, among others, determine the adsorption behaviour of the particles on an adsorbent, which means that it should be possible to apply the method of chromatography. Further, these properties determine the affinity of the particles to the two phases of a liquid–liquid system, which means that fractionation could be performed by partition. This article will describe some experiments which have been carried out in order to apply these two methods to cells and cell particles.

Chromatography. Tiselius[1] refers to the successful chromatography of proteins of high molecular weight[2], viruses[3] and cytoplasmic granula[4] and points out that the upper limit of the size of the particles to be chromatographed has not yet been reached. Recently bacteria have been chromatographed[5], and human platelets have been concentrated by an adsorption technique[6].

When an attempt is made to chromatograph cells and cell fragments many practical difficulties are encountered. Often the particles have a tendency to aggregate on the adsorbent or to be irreversibly adsorbed by it. In addition, due to their size (usually 0·1–10μ) the particles often cannot pass through the pores of the adsorbent. This latter problem, however, can be solved by one of the three following procedures.

The first and simplest one is to use an adsorbent with very large grains compared with the particles to be chromatographed. It has thus been possible to use a very coarse calcium phosphate preparation from ignited bones according to W. F. Anacker (personal communication) for the chromatography of *Chlorella pyrenoidosa* Pringsheim. A suspension of the algae from a conventional culture was allowed to pass through an ordinary column packed with this calcium phosphate. The cells were adsorbed and could then be eluted by step-wise increase in concentration of phosphate buffer *p*H 7 [2]. The amount of *Chlorella* in the different fractions was followed by the extinction at 675 mμ measured in a Beckman *DU* spectrophotometer. As is seen from Fig. 1, peaks were obtained for 0·01 and 0·02 *M*. Fractions from these were analysed in the microscope and the cell diameter was measured. As is seen from Fig. 1, larger cells have been eluted at higher phosphate concentrations. It was found, too, that the concentration of dividing cells was about ten times higher in the 0·02-*M* peak. There was no significant difference in cell diameter between fractions within a peak.

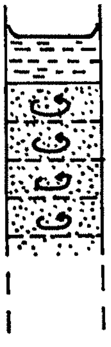

Fig. 2

This experiment suggests that chromatography can serve as a method for obtaining more uniform suspensions of micro-organisms. It has also recently been demonstrated by Maruyama and Yamagata[5].

The second method is to work batchwise by shaking the suspension with the adsorbent, allow the latter to sediment, then decant the supernatant and eventually make this procedure continuous, as is done in Craig's counter-current extraction. In this way a suspension of disintegrated *Chlorella*, obtained by vibrating a suspension in the Mickle disintegrator[7], was shaken with 'Dowex 3' at *p*H 6·5 (0·2 *M* phosphate). All particles except the starch particles were adsorbed. After these had been washed away, the cell walls could be eluted in a very pure state by changing the *p*H to 7·5.

The third alternative is to perform the separation in a column in which the adsorbent grains steadily move so that the particles to be chromatographed can penetrate the column. The ideal movement of the adsorbent should then be such that mixing of the grains occurs only within thin horizontal layers (see Fig. 2). In practice, however, a vertical mixing between the layers is difficult to avoid, so that an adsorbent grain 'diffusion' takes place which will cause broadening of zones. Despite this disadvantage, a column has been constructed according to this

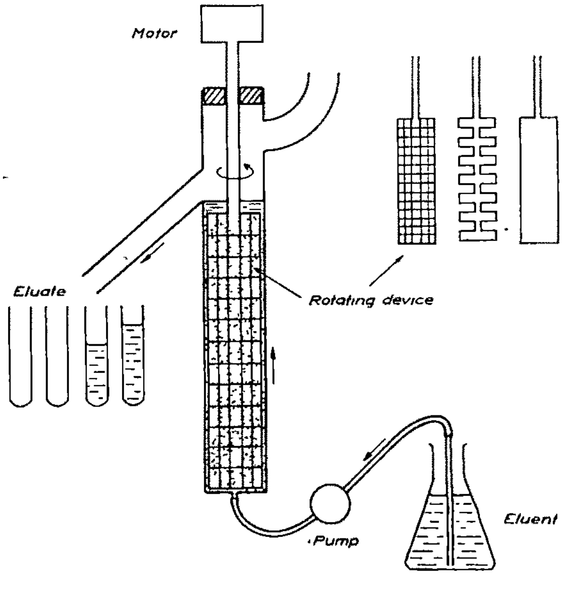

Fig. 3. Chromatography column with rotating adsorbent layers. The rotating device can have one of the indicated forms (upper right). The two to the right are made of 'Plexiglass'; the one to the left, which is the most effective, is made of a net of metal wire

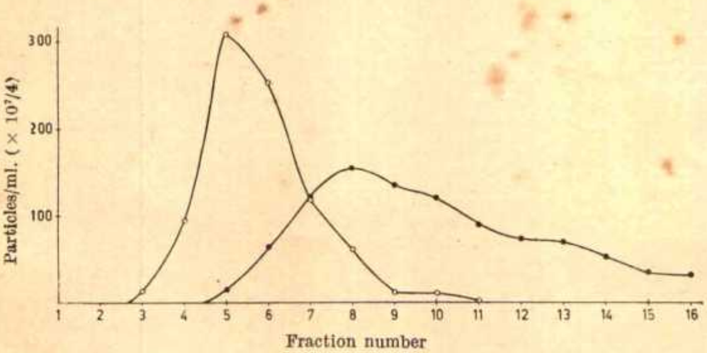

Fig. 4. Chromatography of disintegrated *Chlorella pyrenoidosa* on calcium phosphate. Elution of cell walls and starch particles with 0·2 *M* phosphate buffer, *p*H 7. Temperature, + 4° C. ○, cell walls; ●, starch grains

principle (see Fig. 3). It is made of 'Plexiglass' and provided in the centre with a rotating device which can have different shapes and is driven by a motor (4 revs. per min.). This rotation makes the adsorbent grains move around mainly horizontally. The solvent is introduced at the bottom by means of a pump (about 8 ml. per hr.). Ascending flow is preferred in order to make the packing of the adsorbent weaker and hence the resistance against the rotation smaller. The eluate is collected through a side tube into a fraction collector. A suspension of disintegrated *Chlorella pyrenoidosa* in 0·2 *M* phosphate buffer was pumped through such a column packed with a fine-grade calcium phosphate preparation, according to Ö. Levin (personal communication). In the eluate cell walls and starch particles appeared. In each fraction the number of these particles was counted in a counting chamber. The result is shown in Fig. 4, where the concentration of each particle is plotted against fraction number.

Table 1. PARTITION OF SOME CELLS AND CELL FRAGMENTS IN THE TWO-PHASE SYSTEM WATER/POTASSIUM DIHYDROGEN AND DIPOTASSIUM HYDROGEN PHOSPHATE/POLYETHYLENEGLYCOL 4000

Particles	System I*	System II†
Serratia marcescens	*B*	
Chromobacterium sp.	*B*	
Corynebacterium sp.	*B*	
Nocardia sp.	*T*	
Ophiostoma multiannulatum	*B*	*I*
Chlorella pyrenoidosa	*B*	*I*
Disintegrated *Chlorella* :		
Chloroplast fragments (microscopic)	*I*	*I*
Chloroplast fragments (submicroscopic)	*T*	*T*
Cell walls	*B*	*I*
Starch grains	*B*	*B*
Spinach chloroplast	*I*	
Starch grains and fragments of cell wall of spinach	*B*	

* I = 79·6 per cent H_2O; 10·5 per cent $KH_2PO_4 + K_2HPO_4$; 9·9 per cent polyethyleneglycol (per cent by weight).

† II = 77·3 per cent H_2O; 13·9 per cent $KH_2PO_4 + K_2HPO_4$; 8·8 per cent polyethyleneglycol.

B = Bottom phase. *T* = Top phase. *I* = Interphase

Partition. According to Brönsted[8], the higher the molecular weight of a substance subjected to partition between two liquid phases, the greater the quantity which tends to go into one of the phases. While one can still measure finite partition coefficients for proteins[9], the coefficient for a cellular particle, which has a very high 'molecular weight', will be either zero or infinite. This means that if a liquid–liquid system is shaken with a suspension of identical particles, we should find all these, according to Brönsted's theory, either in one phase or the other. In practice, however, adsorption occurs in some cases on the interphase between the two phases. This phenomenon can be explained if it is looked upon from the point of view of surface tension. Depending upon the values of the interfacial tensions between a particle and the two phases and the interfacial tension between the two phases, the particle will be stable either in one of the two phases or at the interface[10].

The system which has been studied in order to apply these phenomena to fractionation of cellular particles is water/a mixture of potassium dihydrogen plus dipotassium hydrogen phosphate, *p*H 7/polyethyleneglycol 4000 ('Carbowax'). At certain concentrations this system will give two liquid phases similar to those systems which have been used for partition chromatography of proteins[11]. Some whole cells and disintegrated cells have been shaken with this system and their partition is shown in Table 1. At the composition I of the system (see Table 1), *Chlorella pyrenoidosa*, for example, goes to the bottom phase. If the system is changed to composition II, most of the cells are found at the interface. This process is reversible. If disintegrated *Chlorella pyrenoidosa* are shaken with the system at composition I, large fragments of the chloroplasts go to the interface, the smaller ones to the top phase, while the cell walls and starch particles go to the bottom phase. If now the bottom phase is separated and the particles in it are shaken with a system of composition II, the cell walls go to the interface. Fig. 5 is a photomicrograph of cell walls isolated in this way.

In the experiment with spinach chloroplasts, a suspension of whole chloroplasts was made by conventional differential centrifugation. The chloroplasts went to the interphase while starch particles and fragments of cell wall went to the bottom phase. Thus particles with similar sedimentation velocities have been separated.

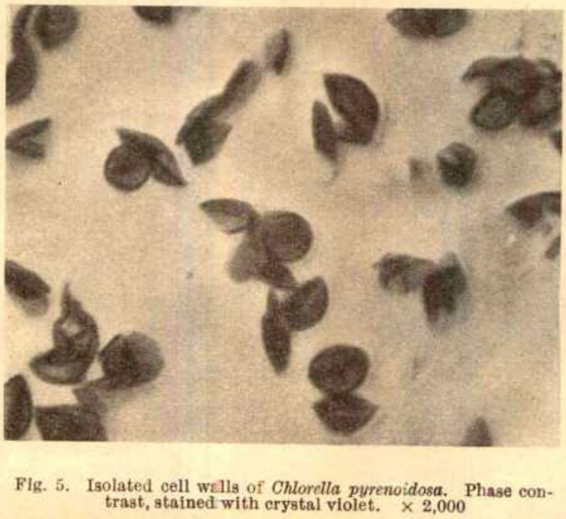

Fig. 5. Isolated cell walls of *Chlorella pyrenoidosa*. Phase contrast, stained with crystal violet. × 2,000

A detailed report of this work will be published elsewhere. I wish to thank Prof. A. Tiselius for his interest and advice. [Feb. 11

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OBITUARIES

Dr. F. Sherwood Taylor

The death of Dr. Frank Sherwood Taylor, director of the Science Museum, on January 5, at the early age of fifty-eight, has removed from the scientific life of Great Britain one whose interests transcended the narrow limits of his original specialist studies in chemistry and who had become widely known as a historian of science and as a very skilful expounder of the intricacies of modern science to the layman.

Born on November 26, 1897, Taylor was educated at Sherborne and at Lincoln College, Oxford, where he was elected to a classical scholarship. The First World War interrupted his studies and deflected his interests from classics to chemistry. After graduating, he taught chemistry at various schools, including Gresham's and Repton, and during 1933–38 he was assistant lecturer in chemistry in Queen Mary College, London. In the meantime, he had obtained the degree of Ph.D. in the University of London for his historical researches on Greek alchemy as the first student in the newly established Department of the History and Method of Science in University College. In 1940 he became curator of the Museum of the History of Science, Oxford, where he remained until he was appointed director of the Science Museum, London, in 1950.

Sherwood Taylor, as he was generally known, was always deeply interested in alchemy and the alchemists; he would spare no pains in attempting to understand the most obscure writers and in trying to explain their words in more familiar and comprehensible terms. It was with the greatest enthusiasm, therefore, that he took a most active part in founding in 1937 the Society for the Study of Alchemy and Early Chemistry and in acting as honorary editor of its journal, *Ambix*, from its first appearance in 1937. A similar enthusiasm marked his support of the British Society for the History of Science when it was founded in 1947, and he served the Society as president during 1951–53.

Apart from many papers in specialist journals, such as *Ambix* and the *Annals of Science*, Taylor wrote extensively on the history of science, on chemistry and on alchemy, and also on religious topics. His earliest books were text-books of chemistry, and these were marked by a clear and attractive style as well as by the high standard of presentation of the material. He will, however, be best remembered for his books on the history of science: "Galileo and the Freedom of Thought" (1938), "A Short History of Science" (1939), "The Century of Science" (1940), "Science Past and Present" (1945), "The Alchemists" (1952), "An Illustrated History of Science" (1955), embodying the Christmas Lectures that he gave at the Royal Institution in 1953, and "A History of Industrial Chemistry" (1955). To the general reader he was also known for his remarkable presentation of modern science in "The World of Science" (1936), a work of more than a thousand pages that has retained its well-deserved popularity after the lapse of twenty years.

In the later part of his life Taylor was received into the Roman Catholic Church. He was always deeply concerned in religious matters, although not given to parade his views. Those who had known him long were aware of a strong mystical element in his thought. His writings on religion include "The Fourfold Vision" (1945) and "Two Ways of Life" (1947). His scholarship, his tolerance, his gentle ways, his regard for science as part of man's cultural heritage will long be remembered. Few of those who recall him will know that he was severely wounded at Passchendaele on October 10, 1917, while serving with an infantry unit of the Honourable Artillery Company, and fewer still know that he was at the time voluntarily taking the place of an older man.

Douglas McKie

Dr. E. W. Gudger

The death occurred on February 19 of Dr. Eugene Willis Gudger, one of the oldest staff members of the American Museum of Natural History; Dr. Gudger would have been ninety in August.

Dr. Gudger was born on August 10, 1866, in the mountain section of North Carolina, the son of a circuit judge. Both his parents were descendants of the British settlers of that area and he was very proud of the fact that the name Gudger had originally been Macgregor. He was educated at southern schools and took his doctorate at Johns Hopkins. He then taught general science, first in a secondary school in Little Rock, Arkansas, where his pupils were little younger than he, and then for twenty-five years in the North Carolina College for Women. For many years he went to reunions of the Little Rock class he had taught, and some of his old pupils there remained his closest friends.

In 1919, Dr. Gudger went to the American Museum of Natural History to edit the third volume of Bashford Dean's "Bibliography of Fishes", and after Dr. Dean's death, in 1928, took on the difficult task of editing the Dean Memorial volumes, and was in charge of the Dean Memorial Library and of the card catalogue which until 1938 continued the Bibliography.

In 1921 he was appointed associate in ichthyology, and in 1935 this title was changed to the regular staff appointment of associate curator of fishes. In 1938 Dr. Gudger became one of the honorary staff of the Department of Fishes, but continued as librarian of the Dean Memorial Library. In 1952, his age and his failing eyesight compelled him to stop work at the Museum and he retired to his former home in Waynesville, North Carolina, where he died.

Dr. Gudger's bibliography was enormous: chiefly articles on odd facts about fishes, old natural history myths and the distribution and habits of the whale shark. He was primarily a library worker, with an extraordinary knowledge of ancient natural history literature. He conducted a vast correspondence on all sorts of topics, ranging from fishes to inaccuracies in magazine illustrations of steam engines. The arrival of his mail and his southern home-town paper brought him to the Museum early every morning before the main doors were open or the corridor lights on.

Dr. Gudger was an impressively tall, rosy-cheeked, silver-haired man with peering, bespectacled blue eyes. Due to his unusual appearance, his determined and emotional personality—as booming in enthusiasm as in anger—his departure from the Museum deprived us of one of our most colourful figures.

Dr. Gudger never married. He is survived by a brother.

F. R. LaMonte

Prof. J. R. H. Whiston, O.B.E.

Prof. J. R. H. Whiston, head of the Applied Chemistry Branch in the Royal Military College of Science, died on February 28 after a short illness.

John Reginald Harvey Whiston was born at Gonalston on January 3, 1893, and attended Nottingham High School during 1902–11, when he obtained an open Exhibition in Natural Science at Jesus College, Oxford, where he obtained a first in chemistry in 1914. During the First World War he served (1914–16) as an officer in the Sherwood Foresters, and from 1916 to the end in the R.F.C. as an experimental officer in the Seaplane Experimental Establishment at Martlesham Heath.

In 1919 Whiston returned to Oxford as a demonstrator in the Jesus College Laboratory, where he worked with the late D. L. Chapman on the hydrogen – chlorine reaction, particularly on the effect of oxygen, and with Sir Henry Tizard on indicator problems. After two further years in Oxford as a research chemist to the British Dyestuffs Corporation, he joined the staff of the Military College of Science at Woolwich in 1922.

The remainder of Prof. Whiston's career was spent in the Royal Military College of Science—he became an associate professor in 1936 and stayed with the College throughout its travels from Woolwich to Lydd, from Lydd to Stoke and from Stoke to its new permanent home in Shrivenham. At first his work was mainly on lubricants and on the improvement of petrols; but later he specialized more on Service explosives, and several government publications, including part of the new Services text-book of explosives, were written by him. In 1946 he was made O.B.E.

Prof. Whiston built up, in the College and outside, a reputation as an outstanding teacher and administrator, and he will be long remembered by the students, more than two thousand in number, who were taught by him. The staff of the College will always be grateful to him for his long labours on their behalf in official negotiations and for his never-failing help and kindness to the junior members. He is survived by his widow, their married daughter, and by two grandchildren.

E. C. Baughan

Mr. John Pryce-Jones

The unexpected death of John Pryce-Jones, so soon after his retirement because of ill-health, came as a profound shock to his many friends. He had been in indifferent health for some time, and early this year he had to undergo a major operation.

Pryce-Jones, who was sixty-two years of age, was born in Pencader, and was educated at Llandyssul Grammar School and the University College of Wales, Aberystwyth. He belonged to an age which thought of university education as a great privilege, and throughout his life he maintained the academic interests of a true scholar while engaged in the chemical and administrative affairs of a prosperous industrial firm. After service in the R.N.V.R. as a meteorologist at Scapa Flow during the First World War, he joined the staff of Reckitt and Sons, Ltd., in 1919, and he remained with Reckitt and Colman, Ltd., until his retirement last September. During this time he became known as a leading expert on the manufacture and uses of ultramarine blue, and in 1950 he was appointed a director of Reckitt's (Colours), Ltd., when that company was formed.

Pryce-Jones was interested in all aspects of the chemistry of ultramarine, and among his fine collection were specimens of many shades. In particular, he was interested in its structure and in the influence of particle size, and he made important contributions to the improvement of the manufacture and application of this unusual material. His interest in lapis lazuli was such that he acquired a deep knowledge of its uses in medieval times, and he had a remarkable knowledge of art, in particular of the pigments used in paintings. He was an accepted authority, too, on oils and paints, and was keenly interested in oil paintings and in methods used in the faking of old masters.

During the nineteen-thirties, Pryce-Jones began to develop his interests in rheology, and his papers in the *Journal of the Oil and Colour Chemists' Association* on this subject were soon recognized as having more than a technical importance. They were, indeed, the beginning of a series of studies in the field of rheology which he continued up to the time of his death, and they constituted a very considerable contribution to knowledge.

Pryce-Jones was especially interested in the various modifications of the phenomena associated with 'thixotropy', and he designed several instruments for their investigation. He was strongly of the opinion that there are two distinct modes of behaviour involved in reversible loss of consistency as a result of shearing, corresponding to lyophobic and lyophilic colloidal conditions, respectively. He differentiated clearly between 'thixotropy' proper and 'false-body', though admitting that these can occur together in mixed systems. His nomenclature was sometimes unusual, but always lucid; for example, he insisted that any measurable rigidity should indicate the use of the term 'gel', the term 'sol' being strictly reserved for liquids. He designed an ingenious 'double Couette' viscometer consisting of two concentric cylinder instruments in series, with which he studied many rheologically anomalous materials. His work as an industrial chemist led him to take as wide an interest in suspensions as in sol–gel systems.

Pryce-Jones was one of the first to observe the phenomenon now generally named after Weissenberg (when a material climbs up a vertical rotating rod), which he characteristically referred to as the

"Mae West Effect". As a result of his work on the thixotropy of honeys from certain floral sources, he became a leading authority on honey in general, and he wrote with considerable insight and knowledge about honey and about bee-keeping.

He was a fascinating lecturer and speaker, and both in Great Britain and abroad he had given lectures to various societies on his different specialisms. He had not only a great facility for explaining intricate problems to specialists, but also the ability of giving a simple, and yet scientifically accurate, picture to the layman. He was an omnivorous reader and bibliophile, and he could always be relied upon to make an illuminating contribution to any discussion.

His passing is a great loss to science, for he did much to stimulate scientific interests, particularly in the East Riding of Yorkshire. He was a former chairman of the Hull Branch of the Oil and Colour Chemists' Association and a past president of the Hull Chemical and Engineering Society.

He will be sadly missed at the meetings of scientific bodies and by his innumerable friends and associates in every walk of life: he was perhaps the perfect mixer.

He married, in 1921, Miss Helen Bune, who survives him. Their only son was lost in a tragic accident some years ago.

Paul G. 'Espinasse
Brynmor Jones

NEWS and VIEWS

Geological Survey of New Zealand: Dr. L. I. Grange

Dr. L. I. Grange has retired from the post of director of the Geological Survey of New Zealand. Dr. Grange was born at Castlecliff, Wanganui, and in 1913 he won from Waihi School of Mines a Mines Department scholarship to attend the University of Otago. After war service in France during the First World War and further study at the University, he joined the N.Z. Geological Survey. Dr. Grange's professional career can be divided into three main phases: his work as a volcanologist in the Central North Island, his career as a pedologist culminating in his directorship of the Soil Bureau, and his return to the Geological Survey as director. For the Central North Island his bulletins on the geology of the Tongaporutu–Ohura and Rotorua–Taupo districts still remain authoritative publications. The last-named bulletin is a particularly important contribution to the world's knowledge of thermal activity. As a result of his work on soils, Dr. Grange became leader of a soil survey section of the Geological Survey, and in 1935 he was appointed director of a newly-formed Soil Survey Division. In 1940 he initiated a 4 miles/in. survey of the North Island, and followed this up by applying the results of the survey to practical problems. By 1946 physicists and biologists had been added to the soil team, and the Division was renamed the Soil Bureau. Later he extended his work beyond New Zealand to tropical soils in the Pacific Islands, where soil use in relation to population and food supplies is a problem. In 1952 Dr. Grange returned to the Geological Survey as director. During his term of office he has renewed his early interest in volcanology, and has compiled a departmental bulletin on "Geothermal Steam for Power in New Zealand", which gives a full picture of the work so far carried out in Wairakei. He recognized the probable impact on New Zealand of the important discoveries of radioactive minerals in Australia and after a visit to that country prepared and published a booklet, "Prospecting for Radioactive Minerals in New Zealand". In geology, soil surveys and soil conservation, Dr. Grange has made a notable contribution to New Zealand, and to the welfare of its people.

Mr. R. W. Willett

Mr. R. W. Willett has been appointed director of the New Zealand Geological Survey in succession to Dr. L. I. Grange. Mr. Willett was born in Dunedin in 1912. He was educated at Otago Boys' High School, the University of Otago and the Victoria University College. He joined the Geological Survey in 1936; he served as district geologist at Invercargill during 1942–48, and geologist-in-charge of the Coal Survey Section at Wellington during 1948–51. During 1951–54 he was seconded to the British Commonwealth Scientific Office (London) as liaison officer, and was the first to hold this office. Since returning to New Zealand he has been administrative assistant to Dr. Grange. Mr. Willett has published many scientific papers both in New Zealand and overseas. While in the United Kingdom he prepared a series of papers on the mineral resources of the British Commonwealth, and in 1954 was awarded the Silver Medal of the Royal Society of Arts for his paper on mineral resources of the British Commonwealth. His work in New Zealand has taken him into much of the mountain country of the South Island. He is at present foundation president of the Geological Society of New Zealand.

Zoology at Calcutta: Prof. J. L. Bhaduri

The sudden death of Prof. H. K. Mookerjee in August 1955 left vacant a key post in zoological education in India. This has now been filled by the appointment to the Sir Nil Ratan Sircar professorship and head of the Department of Zoology in the University of Calcutta of Dr. J. L. Bhaduri, a former student of the University. There he graduated B.Sc. with first-class honours in zoology in 1924, and M.Sc. two years later. After two further years, as teaching assistant, in the Zoology Department, he joined the Zoological Survey of India in 1929, and gained valuable field experience, under the guidance of Dr. Baini Prashad and the late Dr. S. L. Hora, in faunistic surveys in the Andamans and in studies of the frogs and toads of the Khashi Hills in Assam. In 1933 he was recalled to his old University as assistant lecturer, and there with increasing responsibility he has combined his recognized skill in teaching with enthusiasm for research. Dr. Bhaduri's main investigations have been concerned with Amphibia Salientia, their systematics, structure and ecology. He studied for two years in the Zoology Department of the University of Edinburgh, and the thesis on "The Urinogenital System of Salientia", for which he obtained the degree of D.Sc. in that University in 1947, contained, among other matters, a revealing correlation between structural modifications in the genital system and unusual breeding habits in certain species which no longer deposit their eggs in water. His latest field survey (1954) has been a special study of the Salientia in the region of the Western Ghats. Apart from his amphibian researches, he has published papers dealing with mollusca, fishes, reptiles and birds. With his forceful personality, boundless energy, and enthusiasm for teaching and research, the appointment of Dr. Bhaduri promises well for the future of zoology in the University of Calcutta.

Zoological Society of London: Mr. R. N. Fiennes

Mr. R. N. Fiennes, senior lecturer in animal health and veterinary science in the University College of the Gold Coast, Achimota, has been appointed animal pathologist to the Zoological Society of London, and is expected to take up his new duties in September. Mr. Fiennes will be responsible for the post-mortem examination of animals which die in the Zoological Gardens, and he will also carry out research in animal pathology. Mr. Fiennes was educated at Winchester and Magdalene College, Cambridge, and at the Royal (Dick) Veterinary College at Edinburgh, and served for some twenty years in the Colonial Veterinary Service, in Uganda and Kenya. He has published a number of papers on trypanosomiasis, and has also worked on other protozoans, on helminths, bacteria and viruses. His appointment is yet another indication of the importance which the Zoological Society places upon the scientific study of animal health.

New Fellowship at University College, Oxford

In 1954 Mr. James George Weir, C.M.G., C.B.E., gave to University College, Oxford, £25,000 to found a fellowship in memory of his son, Colin Weir, to be devoted to the study of politics with special reference to international affairs. He has now presented to the College a further sum of £25,000 to found an additional fellowship which will be devoted to the study of one of the natural sciences. The fellowship may be given for purposes of teaching or research, or both, and will be known as a Weir Fellowship. The College intends to make an election, if possible, in time for the next academic year.

Swimming-Pool Reactor at Harwell for the Study of Shielding Problems

A research reactor of the 'swimming-pool' pattern, named LIDO, is at present under construction at the Atomic Energy Research Establishment, Harwell, and a model of it is included in the display by the United Kingdom Atomic Energy Authority at the British Industries Fair in Olympia, London. The reactor is specifically designed to enable shielding problems to be investigated; hitherto relatively little effort has been made to minimize shielding size and weight, although this is a problem of great importance in the design of mobile reactors and also in keeping down the capital cost of power-station reactors. LIDO is of the thermal type, employing enriched uranium as fuel and light water as both moderator and coolant. The core is suspended in a tank of water from a trolley which enables it to be moved to any part of the tank. Sufficient depth of water is maintained over the core to provide vertical shielding, and horizontal shielding is effected by the concrete walls of the tank. In two areas, one of which is a corner of the tank, the concrete is cut away and replaced by aluminium 'windows'. These form the working faces to which experiments can be built up adjacent to them on the outside, and when measurements are to be made, the core can be moved closer to them on the inside. Experiments can also be assembled inside the tank, and for this the core can be moved into a small bay at one end of the tank and isolated from it by a watertight door. The reactor is due to be completed towards the end of this year.

International Geophysical Year

During the forthcoming International Geophysical Year (July 1957–December 1958) certain days have been designated as Regular World Days, and during these periods special observations will be made at frequent intervals. In addition, there will be Special World Intervals, chosen at shorter notice, to coincide with expected unusual magnetic, ionospheric and auroral activity, etc In order to estimate how many organizations wish to be sent the 'alert' signal so that they are ready to make special observations of any unusual phenomena, it is requested that the names, addresses and telephone numbers of the persons directly responsible for the measurements, in Great Britain and Colonies, should be sent to the Assistant Secretary, Royal Society, Burlington House, London, W.1, as soon as possible, so that the matter can be considered by the British National Committee for the International Geophysical Year.

Marlow Medal of the Faraday Society

The Faraday Society has instituted a new award, to be known as the Marlow Medal, which, together with a grant of not more than fifty pounds, will be made annually for work over the preceding three years on any subject normally (but not necessarily) published in the *Transactions* of the Society. The Medal is restricted to members of the Faraday Society not more than thirty-two years of age. Applications for the first award should be made before January 1 next to the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

Atoms for Peace Awards

Last year, at the suggestion of Mr. Henry Ford II and his two brothers, the Ford Motor Company Fund made an appropriation of a million dollars to be used for granting each year for ten years an Atoms for Peace Award of 75,000 dollars and a suitable medal to an individual or group of individuals, of any nationality, in recognition of the most outstanding contribution to the peaceful uses of atomic energy (see *Nature*, October 29, p. 814). The organization set up for making this Award has recently published a brochure giving the background of the whole idea and the general principles to be followed in making the Award. Nominations for the first such Award are invited. The brochure and further information can be obtained from the Executive Secretary, Atoms for Peace Awards, Inc., 77 Massachusetts Avenue, Cambridge 39, Mass.

Auca Indians

The recent slaying of five missionaries by Auca Indians of eastern Ecuador has aroused concern about the name and nature of these remote South American aborigines. Dr. M. W. Stirling, director of the Smithsonian Institution's Bureau of American Ethnology, states that comparatively little is known about these Indians (*Smithsonian News Release*, February 25). The term 'Auca' does not refer to any particular tribe but is a Quechua term used in the Andean highlands to refer to any pagan Indian groups as contrasted with those who have been converted to Christianity. The group who did the killing belongs to the Zaparo tribe and lives in the area between the Curare and Napo Rivers. The Franciscans, the Jesuits and the Dominicans established a number of missions among them in the sixteenth, seventeenth, eighteenth and nineteenth centuries. Much of what is known is based on the work of Alfred Simson, an Englishman who spent considerable time with the Zaparos in the 1870's.

White interference has been generally disastrous to the Aucas for several reasons, principally because of factors that upset the normal equilibrium of their lives. Among these were the introduction of the white man's diseases and the unhealthy effect of compelling them to wear clothes in a tropical rainforest environment. Although the Indians were normally quite nomadic, they were often compelled to work in the fields and perform other tasks unfamiliar to them. Then, too, they resented interference with their own religion and the attempt to substitute for it ideologies completely foreign to their own background and completely incomprehensible to them. They also found objectionable the suppression of many of their own deeply rooted social habits. The white man's ban on polygamy they found especially intolerable. "Because of the hazards of warfare and hunting there were typically more women than men; thus many women found themselves without a normal home and family life, and the men without the prestige of a large family. Inevitably, the Indians revolted against this restriction on their liberties. In the more remote regions where there was virtually no other white population, as among the Zaparos and Jivaros, these revolts were successful and the mortality among missionaries was high."

The Word 'Protoplasm'

DR. GARRETT HARDIN, of Santa Barbara College, U.S.A., suggests that careful consideration of the term 'protoplasm' indicates that its various meanings are so contradictory and have such uncertain reference to facts that to call the term meaningless is no more than an act of simple charity (*Sci. Mon.*, 82, No. 3; March 1956). In published statements about protoplasm there are many incompatibilities. In some, protoplasm is a substance; in others, a mixture of substances. Sometimes protoplasm is an entity common to all organisms, while at others 'it' is different in all organisms and even in different tissues of a single organism. Hardin believes that the conceptual framework implicit in the word protoplasm has probably impeded scientific progress. Research workers who are most actively engaged in determining the facts to which protoplasm supposedly refers have the least use for the term.

Leaf Morphogenesis

STUDIES of morphogenesis in leaves by E. Njoku are concerned with the effect of light intensity on leaf shape in *Ipomoea caerulea* (*New Phytol.*, 55, 1, 91; 1956). In this paper the author has made a useful contribution to our knowledge of heteroblastic development. Observations are recorded of the changes in leaf shape from node to node in plants of *Ipomoea caerulea* grown under varying intensities of light. These show that the amount of leaf lobing decreases with decreasing light intensity, and lobing is completely suppressed in 0·23 daylight and lower intensities. Plants already producing lobed leaves in full daylight revert to the production of entire leaves when transferred to deep shade, and shade plants producing entire leaves soon begin to produce lobed leaves on transfer to full daylight. There is no correlation between the changes in leaf shape and changes in leaf area, cell size and cell number. The shape of the leaf is determined early in ontogeny and is not appreciably altered during the later growth of the leaf. The effect of light intensity on leaf shape is compared with the effect of length of day reported by Ashby (1950). Length of day has no effect on leaf shape during the vegetative phase of development; but by accelerating or retarding flowering at the apex, length of day exerts a small effect on leaf shape; the leaves just below the terminal inflorescence are usually simpler in shape. The experimental results are discussed with reference to current views on the factors controlling heteroblastic development, and it is concluded that more work is required before the effect of light intensity on leaf shape can be definitely referred to factors as specific as carbohydrate nutrition or auxin supply.

Society of Instrument Technology, Ltd.

THE Society of Instrument Technology, Ltd., has been functioning until recently by the efforts of its honorary officers, and for some time the need has been felt for a full-time staff and permanent headquarters in London. The Society's membership, in all classes, is nearly fourteen hundred, and with the increasing recognition of the need for automation in industry, its activities are growing day by day. An office has now been taken at 20 Queen Anne Street, London, W.1, the headquarters of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., and a full-time secretary and clerical staff engaged. The secretary is Commander A. A. W. Pollard, who recently left the Royal Navy after more than thirty-one years of service in the Executive Branch. Dr. Harold Moore will continue for the time being as honorary editor of the Society's *Transactions*. All correspondence should be sent to the above address.

Society of Biological Chemists, India

THE Society of Biological Chemists, India, was founded in 1930 and has recently celebrated the first quarter-century of its existence by publishing a "Silver Jubilee Souvenir" (pp. 262; from the Society, Bangalore, 1955). This consists of about fifty short papers contributed by biochemists from many different countries, and the list of authors contains many distinguished names. Some of the papers are descriptions of original work; others are short summaries and discussions of recent discoveries in particular fields of biochemical research. The Society publishes an *Annual Review of Biochemical and Allied Research in India*, and *Proceedings* which summarize the papers read at its ordinary meetings and at its annual symposia. By means of these publications and meetings, the Society helps to co-ordinate the activities of workers in biochemistry in the different parts of India.

Helminthological Society of India

AT the annual general meeting of the Helminthological Society of India, held in Agra on January 3, the following officers were elected: *President*, Prof.

M. B. Mirza (Aligarh); *Vice-Presidents*, Dr. G. S. Thapar (Lucknow) and Dr. H. D. Srivastava (Izatnagar); *Chief Editor*, Dr. G. S. Thapar (Lucknow); *Honorary Secretary and Treasurer*, Dr. B. S. Chauhan (Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta 12); *Foreign Secretary*, Miss N. G. Sproston (Mandapam, Camp); and *Business Manager*, Dr. Kr. S. Singh (Lucknow). At the meeting it was decided to draw up a scheme for a National Parasitological Laboratory in India, and a committee of four was appointed with Dr. Thapar as president and Dr. Chauhan as secretary.

University of London

The following appointments in the University of London have been announced: Prof. E. M. Glaser, professor of physiology in the University of Malaya, to the University readership in physiology tenable at the London Hospital Medical College; Dr. B. C. L. Weedon, lecturer in organic chemistry at the Imperial College of Science and Technology, to the University readership in organic chemistry tenable at that College. The title of professor of genetics in the University of London has been conferred on Dr. Hans Grüneberg, in respect of his post at University College.

The Night Sky in May

New moon occurs on May 10d. 13h. 04m., U.T., and full moon on May 24d. 15h. 26m. The following conjunctions with the Moon take place: May 3d. 04h., Mars 7° S.; May 11d. 20h., Mercury 2° N.; May 13d. 13h., Venus 6° N.; May 17d. 03h., Jupiter 7° N.; May 24d. 09h., Saturn 3° N. Mercury sets at 21h. 30m. and 21h. 05m. on May 1 and 15, respectively, but after this draws too close to the Sun for favourable observation; its stellar magnitude is 0·3 and 2 at the beginning and middle of the month, respectively, the decrease in brightness being due to the decrease in the visible portion of the illuminated disk from 0·450 to 0·098. Venus sets at 23h. 45m., 23h. 30m. and 22h. 35m. on May 1, 15 and 31, respectively. Its stellar magnitude remains almost −4·2 throughout the month, although the visible portion of its illuminated disk decreases from 0·400 to 0·140; this constant magnitude is due to the fact that its distance from the Earth decreases from 98 to 77 million miles, the decreasing distance almost balancing the decreased portion of the illuminated disk. Mars rises in the early morning hours, at 2h., 1h. 30m. and 0h. 50m. at the beginning, middle and end of the month, respectively; it is close to θ Capricorni on May 3, and its eastward motion is easily noticed by comparing its positions with this star over a few nights. Jupiter, visible throughout the night, sets in the early morning hours, at 2h. 20m., 1h. 30m. and 0h. 30m. on May 1, 15 and 31, respectively, and is conspicuous in the constellation Leo. Saturn rises at 21h., 20h. and 18h. 45m. at the beginning, middle and end of the month, respectively, setting in the early morning hours; it lies rather low in the constellation Scorpius but is easily recognized, its stellar magnitude remaining 0·3 throughout the month. No occultations of stars brighter than magnitude 6 occur in May. The η-Aquarid meteors are active in the first week of the month. There will be a partial eclipse of the Moon on May 24, invisible at Greenwich but visible in Australasia; the end will be visible in South Africa. The Moon enters the umbra at 13h. 48·7m. and leaves it at 17h. 13·8m.

Announcements

The Twentieth International Physiological Congress, organized by the Belgian Society of Physiology under the auspices of the International Union of Physiological Sciences, will be held in Brussels during July 30–August 4. An international meeting of pharmacology will be held during the Congress. Further information can be obtained from the secretary of the Congress, Prof. J. J. Reuse, Faculté de Médecine, 115 Boulevard de Waterloo, Brussels.

The eighth of the annual symposia on "Phytopharmacie et de Phytiatrie" will be held in the State Agricultural Institute, Ghent, during May 7–8. Further information can be obtained from the Secretary of the Symposium at the Rijkslandbouwhogeschool, Coupure Links 233, Ghent.

The laboratories and technological sheds of the British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, will be open to visitors on May 10 and 11. There will also be a special open day for textile teachers on July 6, when Mr. L. Gibson and Dr. A. S. Roberts will speak on "Direct Spinning on the Stains Machine", and Dr. J. Mann on "Recent Researches on the Fine Structure of Cellulose".

The Institute of Personnel Management and the National Institute of Industrial Psychology are jointly arranging a five-day course on "The Use of Statistics in Personnel Management", to be held during May 14–18 in the latter body's headquarters at 14 Welbeck Street, London, W.1. The course is designed for personnel officers and others with no previous training in the use of statistical methods and their application to personnel administration. The fee for the course is ten guineas. Registration forms and further information can be obtained from the Courses Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

The Bourke Lectures of the Faraday Society for 1956 will be given by Prof. J. J. Hermans, of the Laboratory of Inorganic and Physical Chemistry, University of Leyden, as follows: May 1, the physical properties of polymer solutions (at 5.15 p.m. in the Physical Chemistry Lecture Theatre, Imperial College of Science and Technology, London); May 3, polyelectrolytes (at 4.30 p.m. in the Chemistry Department, University of Birmingham); May 4, light scattering by solutions (at 5 p.m. in the Nicholson Lecture Theatre, University of Liverpool). The lectures will be open to the public, without ticket. Further information can be obtained from the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

The firm of Shell Austria, A.G., has established two scholarships, each worth about £70 a year, for the study of chemistry or some allied technical subject for six years at an Austrian university. Two more scholarships will be awarded each year so that, from 1960 onwards, there will always be twelve such Shell students. The selection of candidates will be made by Shell in close collaboration with the Austrian Ministry of Education.

Erratum. In the communication entitled "Influence of a Magnetic Field on Thermal Convection Patterns", by W. C Levengood, in *Nature* of March 31, p. 631, the lower part of Fig. 2 has been reversed.

EDUCATION GROUP OF THE INSTITUTE OF PHYSICS

ANNUAL CONFERENCE

AT the annual conference of the Education Group of the Institute of Physics, held in London during April 5–6, the topic on the first day was the teaching of atomic and nuclear physics. On the succeeding day the conference discussed the adequacy of the Advanced Level examinations of the General Certificate of Education as criteria for university selection.

Opening the first session, Prof. P. B. Moon and Prof. W. E. Burcham (University of Birmingham), in a joint paper read by the latter, described the modern physics content of their honours physics courses at Birmingham. At school, the student would have acquired some awareness of the applications of nuclear physics and would use the concepts of atom and electron in chemistry, but with no detailed knowledge of quantum theory. The university course aims at showing the development of modern physics from the basis of classical physics, withholding the more difficult concepts until the student is mature enough to grasp them—quantum mechanics, for example, belonging to the postgraduate courses. The inter-relation of physics with other studies, such as chemistry and engineering, means that the courses must be planned in co-operation with other faculties; and the inter-relations between various parts of physics can provide analogies to introduce modern concepts, since the main difference between atomic physics and ordinary classical physics is simply one of scale. The first year of the honours physics course at Birmingham is a consolidation of school work, without any particular emphasis on physics itself.

The second-year course includes ionization, radioactivity and spectroscopy as an introduction to the Bohr-orbit atom. Descriptive lectures on nuclear physics are given in the third-year, with some advanced lectures on special topics such as luminescence and high-energy machines; and some of the practical work at this stage is done as an assistant to a research team. A good deal of formal instruction is given in the postgraduate courses, during which time the student's capacity for original thinking is developed.

Mr. A. L. Chick (Associated Electrical Industries, Ltd., Aldermaston) spoke of the training of the research worker as an individual, and the creation of a research team as a unit. The modern research laboratory is also a teaching institution, and the lecture courses at Aldermaston include mathematics, electronics, vacuum work, and nuclear physics. Mr. Chick described how a research group convened to design and operate a small research reactor was trained on a project of almost comparable scale, the erection of a Van de Graaff generator and its use on a programme of fundamental research on the spin and parity of nuclear energy levels. While valuable results were obtained incidentally, the real aim was to train the team in the techniques they will apply to the reactor.

The chairman of the Education Group, Dr. J. Topping (principal of Acton Technical College), gave, with his colleague, Dr. J. W. Warren, an outline of the part-time day-release courses at Acton. Among special topics in the syllabus are instrumentation, heat transfer, the use of boiling liquid metal coolants, the properties of materials at high pressures and temperatures, the effects of radiation on materials, the processing of active material, and health physics. Practice in numerical computation and some experimental work are also included. The whole outlook of the course is practical, differing entirely from that given at a university where the ambient atmosphere is one of preoccupation with fundamental research. Indeed, as Dr. Warren added, the only theory really needed is the mass–energy relationship.

The next speaker, Mr. W. O. Peacocke (St. John's School, Leatherhead), then described the work he has been doing with sixth-form boys, using apparatus very largely made by the boys themselves. Given a Geiger counter, a scaling unit and suitable radioactive sources, several good demonstrations to illustrate the historical development of nuclear physics can be presented. The dozen or more class experiments, as performed by boys using microcurie quantities for safety reasons, were impressive in the extreme. Mr. Peacocke, like Joule and Tyndall, is able to relax even amid the rigours of an Alpine holiday and enjoy a little physics; and, having taken his nuclear emulsion plates to a mountain-top, he gave his pupils an excellent project of plate-searching and mosaic-building which produced fine photographs of cosmic ray events. Enterprise of this kind, while enriching the experience of a few fortunate pupils, has a far wider effect in opening the eyes of other teachers to the possibilities available.

Dr. J. M. A. Lenihan (Western Regional Hospital Board, Glasgow) gave his personal impressions of the Geneva Conference on the Peaceful Uses of Atomic Energy. He felt that the participating countries had really laid down their cards, and seemed in fact to have been following almost the same lines independently. In the United States, a long-term programme to discover the most efficient type of reactor is being planned; the U.S.S.R., some way behind, seems urged rather by the propaganda value of the achievement than the actual need for power. Great Britain, he said, urgently needs power to supplement coal resources and is committed to a rather unsophisticated type of reactor to yield results reasonably soon.

The discussion on the adequacy of the Advanced Level examinations of the General Certificate of Education as a guide to university selection was opened by Miss K. E. Parks (North London Collegiate School) and Mr. J. A. Ratcliffe (Cavendish Laboratory, Cambridge). Remarking that the examination was never intended as a university entrance test, Miss Parks suggested that both the syllabus and the number of questions to be answered should be reduced. General fitness for further education might be tested separately, say by means of an essay; and a clearing-house system like that of the teacher-training colleges might simplify matters. Final selection for entry into a special honours course might well be postponed until the end of the first university year; and, whether or not future promise can be assessed beforehand, the actual progress made by a student when he is there depends on the effectiveness of the tutorial guidance at the university. Mr. Ratcliffe also expressed a preference for a shorter syllabus, and a more intelligently searching kind of question. From the point of view of the university, which aims at training people to think, he felt it unfortunate that so many students go up having done physics at school; for they arrive completely misunderstanding the fundamentals, complacently superior towards the important simple things, and loving mathematical proofs for their own sake. After naming specific topics which he would like to see omitted from the Advanced Level syllabus, he said that he regards electricity as the most satisfying part of the work, since it compels a logical treatment; and he noted with interest the Science Masters' Association report on "The Teaching of Electricity", with its logical treatment quite different from the usual historical approach.

During the discussion, Dr. H. R. Lang (secretary of the Institute of Physics) said that physics could certainly be started at the university, and the new transfer scholarship scheme of Imperial Chemical Industries, Ltd. (see *Nature* of March 31, p. 606) would soon be promoting this. This scheme, incidentally, may miss some of the best boys, since those who have never done science at school might be unaware of the satisfactions it offers.

At the final session of the conference a short paper on sandwich diploma courses, by Prof. M. R. Gavin (University College of North Wales, Bangor), explained the aims and organization of the four-year courses that he had inaugurated at Birmingham, the standards expected, and the award to be given at the end. This was followed by some figures on specialization in the sixth forms of grammar schools, collected by Dr. N. Thompson (University of Bristol). He felt that the proportion of the time allotted to specialist subjects was excessive; but schoolmasters in the discussion were divided on the point, since the really relevant matter is the way the remaining time is used.

G. R. NOAKES

ENRICO FERMI AND HIS CONTRIBUTIONS TO PHYSICS

HALF of an issue of the *Reviews of Modern Physics* (27, No. 3, 249; 1955) is dedicated to the memory of the late Prof. Enrico Fermi, one-time president of the American Physical Society, who died on November 29, 1954, and consists of the proceedings of the memorial symposium held at the Washington meeting of the Society on April 29, 1955, over which Prof. H. A. Bethe presided. It contains addresses by F. Seitz, E. J. Konopinski, E. Segrè, W. H. Zinn and H. L. Anderson, together with photographs of sample pages from Prof. Fermi's numerous notebooks which are now being preserved in the Harper Memorial Library of the University of Chicago. The speakers were introduced individually by Prof. Bethe, who referred, in his opening remarks, to Fermi as "unique among the great physicists of the twentieth century in being one of the greatest in experimental physics and at the same time being one of the greatest theoretical physicists. He was unique also in the width of contributions. He may have been one of the last physicists who knew almost all of physics and used it in his research".

Prof. Seitz spoke about Fermi statistics and its applications, and Prof. Konopinski about Fermi's theory of beta-decay, and these two lectures illustrate how two small theoretical articles originally contributed by Fermi to the *Zeitschrift für Physik* in 1928 and 1934, respectively, came to have such tremendous influence on the progress of physics in recent years. Profs. Segrè, Zinn and Anderson deal with different aspects of Fermi's experimental work during the past twenty years. Prof. Segrè gives an interesting description, including many personal reminiscences, of the work on neutrons performed by Fermi and his school in Rome during 1934–35 and for which Fermi was awarded a Nobel Prize in 1938. Early in 1939, just about the time when the news of uranium fission reached America, Fermi arrived in the United States and became engaged on the work—atomic energy—which was to occupy his attention for the rest of his life. Prof. Zinn, in describing the part played by Fermi in the atomic energy project, considers three separate periods: the first, January 1939 to May 1942, when Fermi's work was centred on Columbia University; the second, May 1942 to the winter of 1943–44, when Fermi's work was mainly directed towards bringing about the self-sustaining chain reaction and the construction and operation of the production piles at the Hanford Engineering Works of the Manhattan District; and the third, after May 1944, when Fermi transferred to the Los Alamos Laboratory in New Mexico and finally to Chicago.

In Chicago Prof. Anderson was actively associated with Fermi and was engaged on scattering experiments using intense beams of mesons obtained from a large synchrocyclotron. Prof. Anderson describes in his talk the close personal interest, even to the actual construction with his own hands of several pieces of apparatus and the observation of various instruments, that Fermi took in the experiments. The object of the investigation was to uncover the part that π-mesons play in the nuclear interaction; and though Fermi did not live long enough to see all his predictions verified, his clear understanding of this, in addition to many other similar problems, pointed the way to the present knowledge of the pseudoscalar nature, strong coupling, short-range interaction, charge-independence and causal behaviour of π-mesons.

THE BOSE INSTITUTE, CALCUTTA

THE thirty-eighth anniversary meeting of the foundation of the Bose Institute was celebrated on November 30, when (the late) Dr. Sunder Lal Hora delivered the seventeenth Acharya Jagadish Chandra Memorial Lecture. He chose as his subject "Conflict versus Co-operation as Factors in Evolution".

The director, Dr. D. M. Bose, in his report reviewed the activities of the Bose Institute for the past year. He said that the Institute had submitted to the Central Government plans and estimates for expansion of activities during the second five years. All the plans for expansion of the research activities of the Institute depended on the provision of additional buildings for laboratory accommodation. For this purpose additional land for building purposes is necessary, as there is very little land available in the present location of the Institute. He pointed out that to the west of the Institute the Corporation of

Calcutta has a plot of land lying vacant at present, which he hoped the Corporation may give on lease to the Bose Institute.

The Institute is developing the recently acquired area at Shamnagar as an experiment farm. A donation of Rs. 40,000 from the Government of West Bengal is being utilized for the erection of a laboratory. It is proposed to concentrate at Shamnagar most of the investigations on the effects of different kinds of radiation in producing mutation in plants. So far, only the mutants of economic plants possessing improved economic properties compared to their parents have been isolated and propagated. It is now proposed to devote more attention to the Mendelian characters of the mutant produced. The sources of radiation employed up to now have been X-rays and β-rays from radioactive phosphorus and sulphur. Recently, Dr. K. T. Jacob, head of the Department of Botany, has returned from a scientific tour extending from Sweden to the United States, visiting many of the important plant-breeding stations, where the effects of irradiation on plants growing in fields are studied. The method generally employed is to use a powerful source of gamma-radiations from cobalt-60. The radioactive cobalt, which is produced rather cheaply in atomic reactors, is used in strengths varying from 100 to 200 curies and more. Special techniques for handling such unusually powerful sources are necessary. Experimental plots of size of about 10–15 acres of land are required for field experiments. Dr. Bose expressed the hope that with the co-operation of the Department of Agriculture, West Bengal, it may be possible to undertake such large-scale investigations. This field irradiation method is now recognized as one of the most promising methods of improving crops of economic plants. Besides producing rust-resistant wheat, radiation from cobalt-60 is being employed as an alternative method in storing potatoes. The sprouting of potatoes can be partially to completely inhibited by exposing them to gamma-radiation of total strength varying from 5,000 to 20,000 r. This method of potato storage may ultimately replace the more expensive cold storage method now in use.

Reference was also made to the international co-operative work to be undertaken for the International Geophysical Year 1957–58, in connexion with which the Bose Institute proposes to make continuous records of intensities of different components of the cosmic rays with apparatus installed in the Mayapuri Research Station, Darjeeling.

Dr. Bose also pointed out that in 1958 will occur the hundredth anniversary of the birth of Sir J. C. Bose, the founder of the Institute; he hoped his fellow-countrymen will celebrate the centenary in a befitting manner. He disclosed that on request from the Ministry of Education, the Government of India, he has sent a script on the life and activities of Sir J. C. Bose for the preparation of a documentary film.

RELATIVITY AND SPACE TRAVEL

It has long been evident that the special theory of relativity is very imperfectly understood, even by mathematical physicists of high distinction. More than fifteen years ago, in two articles in *Nature*[1], I directed attention to one type of mistake, and the abundant correspondence that followed, though it showed that some clarification had been achieved, was on the whole disappointing because of the depth and variety of the misconceptions that it revealed. However, no further action then seemed possible, and the only thing to do was to wait for some major error to occur which would force physicists to re-examine their assumptions.

A new factor, however, has now entered the situation. Space travel at high velocity is being regarded as a serious possibility in the not enormously distant future. Sir George Thomson, for example, in his recent fascinating book, "The Foreseeable Future", p. 89 (Cambridge, 1955), discusses a journey to the nearest star and back in just over seventeen years by terrestrial clocks. He states, however, that owing to "the relativistic contraction of time", the travellers would have "aged" by only 14½ years, and adds the following footnote: "The bearing of the relativistic contraction of time on this problem has been questioned, since it leads to an apparent paradox, but the best opinion is that the contraction would occur and that the returning astronaut would, in fact, find that time had gone more rapidly on the earth than on his space ship".

There could be no stronger confirmation of the misunderstanding to which I have referred than the fact that, fifty years after Einstein's clear and logical paper[2], this can be called a matter of "opinion". It is still more serious that the "best" opinion can be regarded as that which is simply a direct denial of the principle of relativity, but of that hereafter. The point to notice at the moment is that the question is no longer an academic one; it has become a matter of profound social and philosophical importance, no matter whether space travel is imminent or not. It needs little imagination to see that if the public is led to believe that there is scientific sanction for the idea that it is *possible* to postpone the date of one's death by space travel, some very undesirable consequences might ensue. It is therefore necessary to bring the matter forward again, so that there shall no longer be differences of opinion on a matter of straightforward logic.

The calculation by which Sir George Thomson arrives at the figures quoted above is based on a formula given by Prof. W. H. McCrea[3] in a discussion of the famous 'clock paradox'. Two observers, M and R, separate and then re-unite at uniform linear velocity. The clock of the moving one will run slow, and so will be behind on reunion. But since either can be supposed to have moved, M's clock will be behind R's and R's behind M's, which is impossible. McCrea purports to show that, in fact, on reunion M's clock will be behind R's by an amount $2T(1 - \alpha)$, where T is the time of the one-way journey at uniform velocity V, and $\alpha = (1 - V^2/c^2)^{1/2}$, c being the velocity of light.

One possible difficulty can be removed at the outset. McCrea is not concerned with the brief accelerations which must occur at the beginning, middle and end of the journey. Since T is independent of them, it is supposed so great that their effects, if any, are by comparison negligible. The retardation given above, calculated by the formulæ of special relativity alone, is therefore at least a close approximation to the supposed truth.

It is not necessary (though it is not difficult) to analyse McCrea's calculation in order to see that his result must be wrong. It would, in fact, be misleading to do so, for it would suggest that he had made a mathematical error, whereas the error is in the pre-mathematical ideas. The fundamental principle of relativity, in its application to the case of two bodies in uniform relative motion, is simply that the motion is a relation between them and not something belonging to one or the other, so that all its effects, if any, must apply equally to both. If, then, the two clocks in question, which would have continued to agree if they had not separated, show different times on reunion, something must have happened to one which did not happen to the other, and nothing is in question except their relative motion. Hence they cannot show different times on reunion.

But those familiar with the customary phraseology of the theory will ask what is meant by the familiar statement that a moving clock runs slow. How can that be, they will ask, if the clock can equally well be said to be at rest (and so running normally) or moving (and so running slow)? It simply means that its reading is behind that of an imaginary stationary clock at the same place, which is synchronized with the observer's stationary clock. The synchronization of the two 'stationary' clocks is the determining factor; nothing at all happens to the moving clock.

The revolutionary fact that Einstein pointed out in 1905 was that we have no intuitive means of assuring ourselves that two similar clocks at different places are synchronized—or, in other words, that two events happening at different places are simultaneous. Hence we must give up the idea that simultaneity of separated events is a phrase needing no explanation, and choose *by definition* what it shall mean. To be of practical use, the definition must be in terms of some physical process actually performable. We can imagine several such processes; but they all involve some assumption about the passage of light unless we include that passage in the definition.

Einstein therefore defined synchronism as follows. R (stationary) regards a clock at X as synchronized with his own when, if he sends a beam of light to that clock and receives it back, the time shown by the clock at X is half-way between the times, by his clock, of emission and return of the light. But this requires that M (moving towards X) will get a different result from the same process. Suppose M, at the time of R's emitting the light, is adjacent to R with his clock agreeing with R's. Then obviously M will receive the returning light earlier than R, and the time which it shows the clock at X to indicate will *not* be half-way between emission and return of the light by M's clock. Hence the clock at X will not be synchronized with M's. We cannot say that, because R is at rest and M moving, R is right and M wrong, for M might equally well retort that it is R who is moving. Hence our definition of synchronism, or of simultaneity, demands that two observers in relative motion will have different ideas of what events, occurring at different places, are simultaneous with one another.

We can now see what happens when our space traveller sets off. Nothing happens to his clock; but to compare it with a terrestrial one you must read them at the same time, otherwise you can get any result you like. The terrestrial observer, choosing what he calls the same moment, finds that the traveller's clock is slow. The traveller, however, says that the terrestrial observer has compared them at different moments; he makes the 'right' choice and finds the terrestrial clock to be slow. Both are right —which would be impossible if the effect were something that happened to a clock instead of to a judgment of simultaneity. When the observers meet again they are both at the same place and relatively at rest. Their judgments of simultaneity agree, and so their clocks agree. All this applies also to heart-beats. The observers will have 'lived' the same time and made the same progress towards the tomb.

What I have written here is simply a paraphrase of Einstein's original paper on the subject. After all allowance has been made for the mental effort required to discard deeply rooted prejudices, it is impossible after fifty years to justify the wholesale abandonment of even elementary reasoning which physicists have allowed themselves to sanction. This outstanding triumph of reason over prejudice has been distorted into a triumph of magic over reason, and the state of mind thus engendered exposes us to dangers which it is impossible to exaggerate. I first directed attention to it nearly thirty years ago and have done so at intervals since[4]; yet the mistaken interpretation of the FitzGerald contraction and clock retardation persists. It is necessary to give a few examples.

Prof. P. S. Epstein[5] makes a relayed appeal to authority, a device that became unscientific at the close of the Middle Ages. Dr. R. A. Millikan had told him that H. A. Lorentz had said that the FitzGerald contraction was "no less real than . . . the variations that are produced by changes of temperature". The meaning of this depends, of course, on what one means by "real", but, whatever that may be, the quotation is irrelevant since it misses the essential fact that if one of two equal rods is cooled, that one unambiguously contracts, whereas if one is moved, you can equally well say that it or the other has "contracted". Prof. L. Infeld[6] tries to save the situation by claiming that a journey covering an exact number of hours will show that a moving clock has slowed down; but if the minute hand has to be read also the whole test becomes meaningless. He adds, however, that the matter cannot be fully elucidated without reference to the social attitude which the physicist takes. Prof. McCrea[7] has to say that his observer M sees that R, after reaching a distance αX, " 'cheats' by rushing out to distance X and back again to distance αX in negligible time". Cheating indeed! In Sir George Thomson's example light would take a little more than a year to cover the distance which M sees R cover in negligible time.

I know of no other example in the history of science in which such fantastic propositions have been put forward as sober scientific truth. The theory of relativity is unique, not merely in its difficulty, which is solely one of discarding prejudices and is excusable, but in its paralysing effect upon the reason, which is not excusable. It looks as though the reaction from excessive rationalism that marked the beginning of the modern scientific era has gone too far, and that a course in traditional logic should be included in the training of all science students. Physicists should not have been misled by such words as 'contraction' and 'retardation' into supposing that the objects said to experience these effects suffer changes analogous to those produced by lowering temperature or by lengthening a pendulum. Sooner or later the lesson will have to be learnt. Let us hope that it will be before some patriarch embarks on a trip to the Andromeda nebula in an attempt to outlive his great-granddaughter.

One other point must unfortunately be mentioned, as it will undoubtedly be raised if this article has the desired effect of making readers turn to Einstein's paper. That paper contains a most regrettable error, in a statement that a clock moving in a closed curve will be found, on returning to its starting point, to be behind a stationary clock. That this is an error there is no question, for such a motion is continuously accelerated and with such motions the special theory of relativity is powerless to deal. But in fact the result given did not follow even from the special theory. At that stage, when Einstein was introducing a fundamental modification of physical theory, he did not concern himself with details of mathematical rigour, which could be left for later investigation, and he wrote: "We assume that this definition of synchronism is free from contradictions, and possible for any number of points; and that . . . If the clock at A synchronizes with the clock at B and also with the clock at C, the clocks at B and C also synchronize with each other". We know now that this assumption is only partially valid; two Lorentz transformations in different directions do not commute. Consequently, the theory cannot be applied to motion in a polygon and then extended to a closed curve. This incidental passage in Einstein's paper has therefore no relevance to the present problem.

HERBERT DINGLE

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[1] *Nature*, **144**, 888 (1939); **146**, 391 (1940).

[2] *Ann. der Phys.*, **17**, 891 (1905). English translation in "The Principle of Relativity", by A. Einstein and Others (Methuen, 1923).

[3] *Nature*, **167**, 680 (1951).

[4] For example, *Nature*, **122**, 673 (1928); **133**, 818 (1934); **139**, 784 (1937); *Mon. Not. Roy. Astro. Soc.*, **113**, 393 (1953).

[5] *Amer. J. Phys.*, **10**, 207 (1942).

[6] *Amer. J. Phys.*, **11**, 219 (1943).

[7] *loc. cit.*

PROF. DINGLE's exposition of relativity theory is wrong and a plain reply is needed.

Consider the example given by Sir George Thomson and quoted by Dingle. For definiteness, suppose Thomson's traveller starts from rest on the Earth, visits the nearest star and comes to rest on it, then returns so as to come to rest again on the Earth. The traveller needs some form of engine in order to gain speed at the start of his journey, to stop himself at the star, to gain speed for his return journey and, finally, to stop himself at the Earth. Over most of his journey, his engine may be cut out. His path, while his engine is cut out, we shall call a free path. His career from any time before his departure to any time after his return consists essentially of four free paths: a free path with the Earth until he leaves it, a free path most of the way to the star, a free path most of the way back, and again a free path with the Earth after returning to it. These do not add up to a single free path: no matter how long the man waits on the Earth without switching on his engine, he will not find himself on the way to the star, nor, without again using his engine, will he ever find himself on his way back again. Nevertheless, the duration of the journey does not depend essentially upon the duration of the parts when the engine is in use. The same uses of the engine would equally well enable the man to visit the star were it, say, a million times farther away.

On the other hand, the career of a second observer who remains on the Earth is a single free path.

This distinction between the two observers is an *absolute* distinction. That it is so is shown by the simple fact that one of the men has to use an engine and the other not. This common-sense distinction cannot, of course, be removed by any 'principle of relativity'. Even if the traveller chooses to regard himself as at rest and the Earth as departing and returning, it is still he and not the man on the Earth who has to use the engine. Therefore, no mere appeal to a principle of relativity enables us to say whether or not the two men agree as to the duration of the journey.

In particular, there is no relevance in saying, as Dingle does, that nothing has happened to the traveller's clock and so it must show the same time as the clock on the Earth. The question is not, What has 'happened' to the clocks? It is, What have the clocks measured? Dingle's statement that the clocks must agree has no more validity than a statement that the milometers of two cars that take different routes to the same place should agree as to the distances travelled.

The answer given by the theory of relativity is very simple. For what we have been calling a free path corresponds in relativity theory to a segment of a geodesic world-line. The world-line of the observer on the Earth is a geodesic; the world-line of the traveller is not a geodesic (though it can be made up of parts of four different geodesics). In the case of this kind of geodesic, the geodesic interval between two events is the longest interval between them (not the shortest as in some other cases). The interval or proper-time, in accordance with the theory of relativity, is what is measured by a clock having the same world-line. Therefore, the clock on the Earth records a longer time than the clock carried by the traveller. This is the result given by Thomson and is a strictly correct inference from relativity theory. (The above argument is sufficient for the simple case considered. In other cases, the geodesic need not give the longest interval except in comparison with neighbouring world-lines between the same two events, and the geodesic need not be unique.)

Regarded geometrically, Dingle's assertion that the clocks must agree is equivalent to saying that the interval between two events or the distance between two points in four dimensions is the same along every path joining the events or points. His assertion would require relativity theory, in the accepted sense, to be rejected and the universal time of classical theory to be reinstated. It is, in fact, evident that Dingle still believes such a time to exist. Otherwise his contention that "you must read them [the clocks] at the same time" is meaningless.

Dingle's "paraphrase" of Einstein's paper is a travesty. He purports to explain special relativity without once mentioning the all-important postulate of the existence of inertial frames of reference. So far as what Dingle is trying to explain is concerned, Einstein was considering only observers at rest in inertial frames. For present purposes, these are equivalent to observers whose world-lines are geodesics.

In my example of the clock paradox, observer *R* remains at rest in an inertial frame, that is, he remains in a free path; observer *M* transfers from one inertial frame to another, that is, he transfers from one free path to another and these different free paths do not combine into a single free path. Once again, this is an absolute distinction between *R* and *M*.

My purpose was to point out how this absolute distinction results in a distinction between the ways in which *R* and *M* describe the relative journey. Therefore, the usual relativistic result cannot, in fact, be made to yield a paradox. My purpose was not to re-establish the usual result. Had it been, I need only have remarked that two curves with the same end-points in general possess different lengths. But it is this obvious result that Dingle now denies.

In spite of what Dingle writes, physicists and mathematicians are quite certain about what follows rationally from the postulates of relativity theory. What no one can be certain about in the same way is the extent to which the actual universe conforms to the postulates. By reason of the many tests of the theory, most of us are convinced that the theory can be correctly applied to the phenomena here considered. However, Dingle might be entitled to question this applicability. What he is not entitled to state is that someone else's calculations "must be wrong" for unspecified reasons.

W. M. McCrea

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Prof. McCrea wanders widely from the point, and I do not propose to follow him. Of course. the traveller must be accelerated in order to start, turn and stop again, and this may infinitesimally affect his clock. As McCrea agrees, the accelerations may be extremely brief, so the clock cannot lose much time in them or it would go backwards. The 2½ years in question is a function of *T*, the time of what he now calls "the free path", during which the engine is cut out. Hence the "absolute" distinction, arising from the use of the engine, is eliminated. McCrea makes no comment on the remarkable feat of *R* in beating light to a standstill. His remarks about geodesics are a wide and needless generalization of the problem; he has said nothing in answer to the definite statements I made.

One or two minor points in his letter require brief comment. First, he says, "The question is not, 'What has 'happened' to the clocks? It is, What have the clocks measured?" The question is simply, Will one clock differ from the other or not? That is all. What they have measured, if anything, is a metaphysical question; it does not enter the problem.

Secondly, McCrea says that I must believe in the classical universal time because I say "you must read them [the clocks] at the same time". My article stated specifically that "the same time" for one observer was not "the same time" for another, so how can this imply belief in the classical universal time?

Thirdly, McCrea calls my paraphrase of Einstein's paper "a travesty" because I have not mentioned "the all-important postulate of the existence of inertial frames of reference". I have looked through Einstein's paper again, and find that he also fails to mention this all-important postulate: he speaks only of "stationary" and "moving" systems, as I did. This may make his paper a travesty of reason, though I do not think so; but I cannot accept it as a criticism of my paraphrase.

Fourthly (and this, of course, is the really serious aspect of the matter), McCrea says, "physicists and mathematicians are quite certain about what follows rationally from the postulates of relativity theory". How, then, does he explain the number of different solutions of the clock paradox, a few of which he mentioned in his first letter, and how is it that it has been left for him to be the first to discover, after forty-six years, that there is no paradox at all?

Finally, he says that I am not entitled to state "that someone else's calculations 'must be wrong' for unspecified reasons". I claim that my article did specify the reasons.

Herbert Dingle

PERFLUOROALKOXY RADICALS

By D. A. BARR, W. C. FRANCIS and Dr. R. N. HASZELDINE
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It is reasonably well established[1] that primary alkoxy radicals react either (*a*) by hydrogen abstraction from a molecule *QH*:

$$R\mathrm{CH_2.O}\cdot + Q\mathrm{H} \longrightarrow R\mathrm{CH_2OH} + Q\cdot$$

for example,

$$R\mathrm{CH_2O}\cdot + R\mathrm{CH_2O}\cdot \longrightarrow R\mathrm{CH_2OH} + R\mathrm{CHO}$$

or (*b*) by loss of formaldehyde to give a radical of shorter chain-length:

$$R\mathrm{CH_2.O}\cdot \longrightarrow R\cdot + \mathrm{HCHO}$$

It is now clear that perfluoroalkoxy radicals $R\mathrm{CF_2.CF_2.O}\cdot$ behave somewhat similarly. Such radicals can abstract hydrogen in a manner analogous to that in (*a*) above; in absence of compounds containing hydrogen, however, a disproportionation reaction, for example,

$$R\mathrm{CF_2.CF_2.O}\cdot + R\mathrm{CF_2.CF_2.O}\cdot \longrightarrow R\mathrm{CF_2.CF_2.O.F} + R\mathrm{CF_2.COF}$$

is not observed, and is indeed unlikely, since it would require fission of a C—F bond. On the other hand, loss of carbonyl fluoride, the fluorine analogue of formaldehyde, from such radicals:

$$R\mathrm{CF_2.CF_2.O}\cdot \longrightarrow R\mathrm{CF_2}\cdot + \mathrm{COF_2}$$

appears to be a general reaction in fluorocarbon chemistry, and is illustrated by the following three examples.

(1) Photochemical oxidation of a perfluoroiodoalkane such as C_3F_7I is extremely rapid and yields only carbonyl fluoride and (by attack on the glass reaction vessel) silicon tetrafluoride[2]. Facile breakdown of a perfluoroalkyl group by conventional reagents is usually extremely difficult to achieve, and

the ease of breakdown by photochemical oxidation indicates a novel chain reaction visualized, after taking other evidence into consideration, as follows:

$$C_3F_7I \xrightarrow{h\nu} C_3F_7\cdot \xrightarrow{O_2} C_3F_7\cdot O_2\cdot \xrightarrow{C_3F_7I} C_3F_7.O.OI$$

$$C_3F_7.O.O.I \xrightarrow{h\nu} C_3F_7.O\cdot + \cdot OI$$

$$C_3F_7.O\cdot \longrightarrow C_2F_5\cdot + COF_2$$

$$C_2F_5\cdot \xrightarrow{O_2} C_2F_5.O_2\cdot \xrightarrow{C_3F_7I} C_2F_5.O.OI \longrightarrow C_2F_5\cdot O\cdot$$

$$C_2F_5\cdot O\cdot \longrightarrow COF_2 + CF_3\cdot \xrightarrow{O_2, C_3F_7I} COF_2\ (+SiF_4)$$

etc.

Such a branching chain mechanism, involving formation of perfluoroalkoxy radicals such as $C_3F_7.O\cdot$, $C_2F_5\cdot O\cdot$ and $CF_3\cdot O\cdot$ followed by loss of COF_2 to give a perfluoroalkyl radical of shorter chain-length, makes understandable a reaction that was initially quite anomalous in fluorocarbon chemistry[2].

(2) Heptafluoronitrosopropane is obtained when heptafluoroiodopropane is photolysed in the presence of nitric oxide[3,4]. In the absence of mercury, which removes from the reaction zone the nitrogen dioxide produced by photolysis of nitric oxide, the formation of heptafluoronitrosopropane is accompanied by the production of heptafluoronitropropane and by extensive breakdown of the perfluoroalkyl chain to give carbonyl fluoride and low yields (2–5 per cent) of pentafluoronitrosoethane and trifluoronitrosomethane as well as smaller amounts of the corresponding nitro-compounds. The formation of nitroso- and nitro-derivatives of the shorter-chain radicals C_2F_5 and CF_3 is best explained as follows[4]:

$$C_3F_7I \xrightarrow{h\nu} C_3F_7\cdot + I\cdot$$

Formation of nitroso-compound:

$$C_3F_7\cdot + NO \longrightarrow C_3F_7.NO$$

Formation of nitro-compound:

$$C_3F_7\cdot + NO_2 \longrightarrow C_3F_7.NO_2$$

Formation of nitrite:

$$C_3F_7\cdot + NO_2 \longrightarrow C_3F_7.O.NO$$

Chain degradation *via* alkoxy radical:

$$C_3F_7.O.NO \xrightarrow{h\nu} C_3F_7.O\cdot + NO$$

$$C_3F_7.O\cdot \longrightarrow C_2F_5\cdot + COF_2$$

$$C_2F_5\cdot + NO \longrightarrow C_2F_5.NO$$

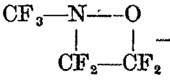
$$C_2F_5\cdot \xrightarrow{NO_2} C_2F_5.O.NO \xrightarrow{h\nu} C_2F_5.O\cdot \longrightarrow COF_2 + CF_3\cdot \xrightarrow{NO} CF_3.NO$$

$$CF_3\cdot \xrightarrow{NO_2} CF_3.O.NO \xrightarrow{h\nu} CF_3.O\cdot \xrightarrow{SiO_2} COF_2 + SiF_4$$

that is, by formation of the nitrite, which undergoes O—N fission to give a perfluoroalkoxy radical; this, in turn, gives a perfluoroalkyl radical of shorter chain-length.

Similar breakdown of the perfluoroalkyl chain is observed when heptafluoroiodopropane is irradiated in the presence of nitrogen dioxide, since $C_3F_7.NO_2$ (38 per cent), $C_2F_5.NO_2$ (7 per cent), and $CF_3.NO_2$ (17 per cent) are produced as well as carbonyl fluoride[4].

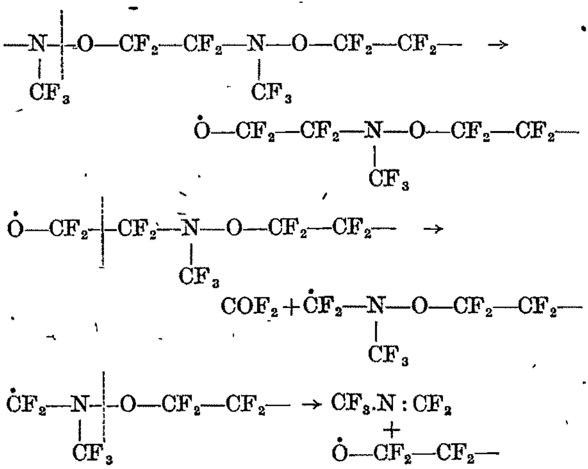
(3) Trifluoronitrosomethane reacts with tetrafluoroethylene to give, quantitatively, perfluoro-2-methyl-1 : 2-oxazetidine (I) and a polymer of formula —[$\cdot N(CF_3).O.CF_2.CF_2.$]$_n$— and molecular weight greater than 7,000[4]. Pyrolysis of the oxazetidine, or of the polymer, gives, quantitatively, equimolar amounts of perfluoro(methylenemethylamine), $CF_3.N:CF_2$, and carbonyl fluoride. Heptafluoronitrosopropane and tetrafluoroethylene react in a similar manner[4]. These pyrolyses are readily explained if it is assumed, not implausibly, that N—O fission occurs initially, since carbonyl fluoride elimination from the resultant perfluoroalkoxy radical would be the next step:


(I)

$$\xrightarrow{550°} CF_3.\dot{N}.CF_2.CF_2.\dot{O}$$

$$CF_3.\dot{N}.CF_2.CF_2.\dot{O} \longrightarrow COF_2 + CF_3.\dot{N}.\dot{C}F_2 \longrightarrow CF_3.N:CF_2$$

and similarly



$$-\underset{\substack{|\\ CF_3}}{N}-\mid-O-CF_2-CF_2-\underset{\substack{|\\ CF_3}}{N}-O-CF_2-CF_2- \rightarrow \dot{O}-CF_2-CF_2-\underset{\substack{|\\ CF_3}}{N}-O-CF_2-CF_2-$$

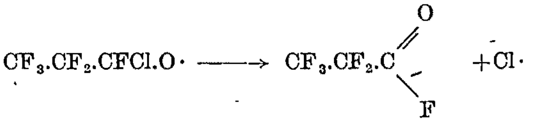
$$\dot{O}-CF_2-\mid-CF_2-\underset{\substack{|\\ CF_3}}{N}-O-CF_2-CF_2- \rightarrow COF_2 + \dot{C}F_2-\underset{\substack{|\\ CF_3}}{N}-O-CF_2-CF_2-$$

$$\dot{C}F_2-\underset{\substack{|\\ CF_3}}{N}-\mid-O-CF_2-CF_2- \rightarrow CF_3.N:CF_2 + \dot{O}-CF_2-CF_2-$$

It does not follow from the above three examples that all perhalogenoalkoxy radicals will decompose by elimination of COX_2. There is already some evidence[2] that when chlorine or bromine is present as well as fluorine on the carbon next to the oxygen atom, a chlorine or bromine atom is expelled in preference to carbonyl halide elimination; for example[2],

$$CF_3.CF_2.CFClI \xrightarrow{h\nu} CF_3.CF_2.CFCl\cdot \xrightarrow{O_2} CF_3.CF_2.CFCl.O_2\cdot$$

$$CF_3.CF_2.CFCl.O_2\cdot \xrightarrow{CF_3CF_2CFClI} CF_3.CF_2.CFCl.O.OI \xrightarrow{h\nu} CF_3.CF_2.CFCl.O\cdot$$



$$CF_3.CF_2.CFCl.O\cdot \longrightarrow CF_3.CF_2.C(=O)F + Cl\cdot$$

so that breakdown of the chain is prevented and products useful for synthesis can thus be obtained. Doubtless other modes of decomposition of these reactive and useful poly- and per-halogenoalkoxy radicals will be found.   [Dec. 14

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Genetic Effects of X-Rays in Relation to Dose-rate in *Drosophila*

VARIATION in dose-rate has generally been observed to be ineffective in determining the incidence of mutations and structural changes produced by X-rays in *Drosophila* spermatozoa[1]. However, since it is now clear that a considerable fraction of the genetic damage brought about by radiation results from an indirect path of action, intensity effects might be expected to operate under certain conditions. Chemical mutagens induced by radiation must have a finite life-span before they are removed or rendered ineffective by one or another metabolic pathway. Therefore very high dose-rates, leading to an accumulation of mutagens, should effect a greater amount of damage as a result of diffusion of the active substances to other regions within the nucleus. Sobels's observations[2] that pretreatment with cyanide or azide increases the yield of sex-linked lethals obtained from irradiated *Drosophila* males suggests that the accumulation of chemical mutagens can be facilitated by the concurrent use of suitable enzyme inhibitors.

Haas *et al.*[3] have indeed reported recently that they observed an intensity effect while studying the production of translocations in *Drosophila* sperm. Using dose-rates of 100 r./min. and 2,000 r./min., we have been able to confirm that, for a given dose, a greater amount of genetic damage is produced if the radiation is delivered at high intensity. With a total dose of 2,000 r., the high dose-rate gives an increase of up to 25 per cent in the yield of recessive sex-linked lethals and of translocations. If, just prior to irradiation, the flies are injected with 0·005 *M* sodium azide in saline, the intensity effect is enhanced. The figures in Table 1 illustrate the effects of such an injection on the production of sex-linked recessive lethals by 2,000 r. of X-irradiation delivered to spermatozoa within the spermathecæ of inseminated females.

An especially interesting feature of high-intensity treatment is the production of numerous F_1 females that prove to be mosaics for a sex-linked lethal. By subculturing a single female from those F_2 cultures which fail to yield a lethal, a further crop of mutations may be obtained in the F_3 generation at a frequency of about one-tenth that observed in the preceding generation. This delayed appearance of lethals recalls the similar effects produced by chemical mutagens such as mustard gas[4]. Delayed mutations may also be obtained by mating males that have received high-intensity radiation to attached-*X* females and then crossing the F_1 males to Muller-5 females in the usual way. It should be emphasized that such delayed effects are quite rare if the same dose of radiation is administered at an intensity less than 1,000 r./min. Further study is needed before it can be decided whether the lethals recovered in the F_3 generation are really instances of delayed mutation or whether they are the result of partial breakage of a multi-strand chromosome, followed by sorting out of a mixture of broken and unbroken chromonemata.

Table 1. SEX-LINKED LETHAL MUTATION-RATE

Dose-rate	Inseminated females received 2,000 r. preceded by an injection of 0·2 μl. of:	
	0·7 per cent NaCl	0·005 *M* NaN_3 in 0·7 per cent NaCl
100 r./min.	6·3% ± 0·8	7·6% ± 1·0
2,000 r./min.	8·4% ± 0·6	13·1% ± 1·2

Table 2. PRODUCTION OF HYPERPLOID FEMALES

Treatment	Total No. females	Hyperploids	Standard error	*P*
A	1,875	1·07%	0·24	
B	1,718	1·16%	0·26	= 0·3
C	1,772	1·52%	0·29	< 0·01
D	2,316	0·52%	0·15	

A, undivided dose; *B*, four equal fractions, 1 min. between each; *C*, four equal fractions, 5 min. between each; *D*, four equal fractions, with a 30-min. interval between each. Temperature, 16° C. Total dose, 4,000 r.

In an attempt to estimate the duration of life of the active substances produced by the high-intensity irradiation, fractionation experiments were carried out with varying time-intervals between successive treatments. The experiments were scored by recording the proportion of hyperploid females obtained from a single 24-hr. mating of attached-*X* females (homozygous for the recessive gene, yellow) to Canton *S* males that had received a total dose of 4,000 r. delivered at high intensity (Table 2). At a temperature of 16° C., division of the dose into four equal fractions does not reduce the incidence of hyperploids obtained unless the time-interval between successive doses of radiation is more than five minutes. The critical time-interval would, of course, be expected to be related to the magnitude of each fractional dose, but clearly the effects may persist long enough for further experimental analysis to be practicable.

Full details of this work will be published elsewhere.

A. M. CLARK

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Jan. 6.

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A Ventral Ectodermal Ridge of the Tail in Mouse Embryos

THE limb buds of mammalian and avian embryos show a thickening of the ectoderm on the margin of the foot plates, the so-called apical ectodermal ridge, and it is known that this ridge plays an important part in the growth and differentiation of the limbs[1,2]. It has recently been discovered that a similar thickening of the ectoderm is present on the ventral side of the tail in 10- and 11-day old mouse embryos. In 10-day old embryos (crown-rump length 3·4–4·2 mm.; lens invaginations still widely open), there occurs a very conspicuous zone of columnar epithelium on the ventral aspect which extends from the very tip of the tail in a proximal direction for roughly 250 micra; the exact length of the zone is difficult to determine as it gradually disappears

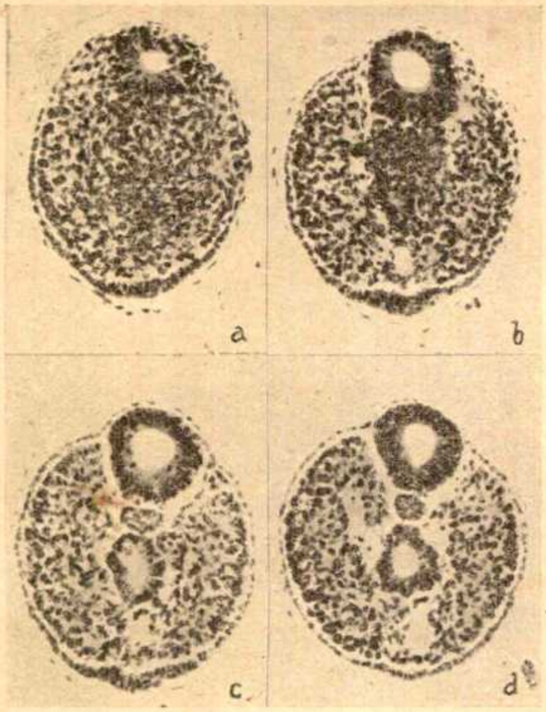

Fig. 1

proximally. The accompanying photomicrographs (Fig. 1) are four transverse sections through the tail of such an embryo (crown-rump length 4·1 mm.; Bouin fixation; hæmatoxylin and eosin; 7·5 micra; × 125) at intervals of about 68 micra; (*a*) is the most distal and (*d*) the most proximal of these sections. The columnar zone of epithelium is obvious in the first three sections but has disappeared in the fourth. In 11-day old embryos (crown-rump length 5·3–5·7 mm.), the structure is rather less conspicuous, and in one out of three such embryos it occupied a position somewhat proximal to the tail tip. In 12-day old embryos the structure has virtually disappeared.

In 9- and 9½-day old embryos (crown-rump length 2–3 mm.), the origin of the ventral ectodermal ridge is traceable to the cloacal membrane. Where entoderm and ectoderm are in direct contact, the latter assumes a columnar structure. Soon afterwards, as the tail bud elongates, the columnar zone spreads in a distal direction; the continuity between ventral ectodermal ridge and cloacal membrane is lost in embryos of about crown-rump length 3 mm.

That the ventral ectodermal ridge of the tail may have a function comparable to that of the apical ectodermal ridge of the limb buds is suggested by the following fact. In the recessive mutant vestigial-tail (*vt*) in the mouse[3], there is almost no tail in the adult except for a short stump or a thin filament. A rudimentary tail (which disappears again later in development) is present in 10-day old embryos, but this rudimentary tail of vestigial embryos has a greatly reduced ventral ectodermal ridge. The situation thus seems similar to the gene for wingless in the domestic fowl[4], where the apical ectodermal ridge of the anterior limb buds is missing or greatly reduced.

There exists in the mouse a type of anomaly which can be brought about by a variety of genotypes, the uro-recto-caudal syndrome[5]; in affected animals, defects of derivatives of the cloaca are associated with reduction or absence of the tail. It may be suggested that cloacal and caudal defects occur together because of the origin of the ventral ectodermal ridge of the tail from the cloacal membrane.

A detailed account of this work will be published elsewhere.

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in Inherited Diseases,
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Dec. 17.

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A New Muscle Preparation for the Study of Optical Changes during Contraction

LIVE squid muscle is remarkably transparent. Sereni and Young[1] noted that it becomes more opaque when stimulated. We find that in healthy living muscle the increase in opacity is only transient and that even in response to single shocks this phenomenon is visible to the naked eye. It is therefore easy to record, and thus makes squid muscle particularly suited for studies of optical changes during contraction. Such work is now in progress.

Preliminary experiments have been done on board the research ship *Sarsia* with freshly caught animals. After decapitation, removal of the stellate ganglia and of the skin covering the mantle, a rectangular piece of mantle muscle was cut out and pinned securely under sea water in the path of a parallel beam of light. A vacuum photocell mounted about two inches above the muscle recorded on a cathode ray tube the changes in light transmitted in the incident direction. Square-wave stimuli were applied by means of platinum electrodes to nerves innervating the area of muscle under observation. Mechanical changes were recorded isometrically with an *RCA* 5734 transducer. Records could be obtained within three minutes of killing the animal and nerve-muscle preparations remained in good condition for several hours. The threshold for stimulation of the preparation is approximately 0·3 volt, 150 μsec. width.

The opacity changes during a twitch are shown in Fig. 1, together with electrical (muscle action potential) and mechanical (tension) changes. About 30 per cent more of the light is scattered at the peak of the twitch. At high amplification an initial small decrease in opacity is observed (Fig. 1,*a*); it coincides with the falling phase of the action potential (Fig. 1,*b*) and precedes the first sign of tension change. The latency for opacity decrease at room temperature is about 12 m.sec., the peak of the decrease being reached within 22 m.sec., while the first sign of tension change occurs at 19 m.sec. (These values include nerve conduction time.) The early opacity decrease corresponds to a similar phenomenon observed by Hill[2] in frog muscle where it starts at the same time as latency relaxation. However, in squid muscle, we can find no sign of latency relaxation—if it exists it must be less than 10^{-5} of the twitch tension (in frog muscle the early tension drop is about 10^{-3} of twitch tension[3]). The absence of latency relaxation has already been noted in other molluscan muscles[4].

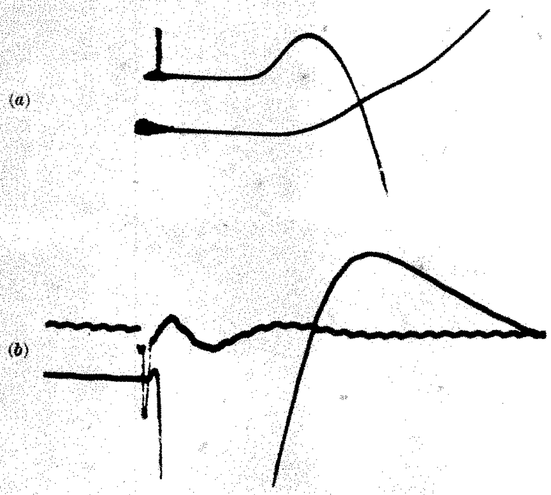

Fig. 1. Responses of squid mantle muscle to single shocks. Records read from left to right. *a*, upper trace: opacity change (increase downwards); lower trace: development of tension (increase upwards). Duration of sweep, 50 m.sec. *b*, upper trace: muscle action potential; lower trace: opacity change recorded at lower amplification than in (*a*). 50 c./s. oscillation imposed on upper trace. (Note that in (*b*) the trace of the optical change at the end of the twitch crosses the base-line: this is an artefact due to recording with a condenser-coupled amplifier)

We are grateful to Prof. A. L. Hodgkin and Dr. R. D. Keynes for directing our attention to the transient nature of opacity changes in squid muscle, and to Mr. F. J. Warren for his unfailing assistance. Part of the electrical apparatus was purchased with a grant from the Royal Society.

Note added in proof. Polar diagrams of the light scattered by resting and active mantle muscle have now been obtained. There is a decrease in transmitted light at angles less than about 15° to the incident direction and the phenomenon is reversed at greater angles.

The early opacity change is not due to diffraction: the muscle is unstriated and shows no regular diffraction bands.

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March 5.

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Phospholipid Metabolism of Skin

During work on the metabolism of skin, it was found that a scissors mince of rat skin could incorporate phosphoric acid-^{32}P into the lipid fraction. On completion of the work, our attention was directed to the work of Leonhardi *et al.*[1], who had found no *in vitro* synthesis of phospholipid, and had concluded as the result of this and some *in vivo* feeding experiments that rat skin depended for supplies of phospholipid on the liver via the blood. In view of Zilversmit's[2] comment that "rat skin has been shown to be one of the few tissues that cannot synthesize its own phosphatides *in vitro*", it has been thought desirable to record some contrary observations that have been made. The point is obviously of major importance in the metabolism of skin.

The abdominal skin of male albino rats was mechanically clipped and carefully scraped free from subcutaneous tissue, which has a distinctive pink tinge. A scissors mince was prepared, of which 100–400 mgm. portions were incubated at 34° in Krebs–Henseleit saline containing 10 m.molar substrate and 5 μc. phosphoric acid. Each animal yielded about 1 gm. of mince. At the end of the experimental period sufficient 100 per cent (w/v) trichloracetic acid was added to bring the final concentration to 5 per cent, and the mince was washed thrice more with 5 per cent trichloracetic acid. Two water washes removed most of the acid. Lipid was extracted by either of two procedures: (1) three 1-hr. refluxings with ethanol–ether (3 : 1, v/v), evaporation to dryness in the presence of 1 ml. *M* disodium hydrogen phosphate and re-extraction with chloroform; (2) three 1-hr. refluxings with chloroform–methanol (1 : 1, v/v) followed by a wash with 0·1 *N* hydrochloric acid[3]. The final chloroform extract was made to 10 ml. and portions taken for determination of lipid-phosphorus[4].

The radioactivity of the resulting blue solutions was measured in a liquid counter. In every set of experiments a zero-time control was run, in which the trichloracetic acid was added at the beginning. The fact that the specific activity of the lipid-phosphorus of this control never exceeded 5 per cent of that of the 3-hr. experimental portion with glucose as substrate shows that the procedures effectively removed contaminating acid-soluble phosphorus. The rate of synthesis of phospholipid during the first four hours is shown in Fig. 1, and some results with different substrates and inhibitors in Table 1.

The discrepancy with the *in vitro* findings of Leonhardi *et al.*[1] is difficult to explain. Unfortunately, pressure of other work has prevented repetition of some of the work using their technique, and of any of the *in vivo* work. Consequently a full discussion of their results and conclusions would be out of place, although attention is directed to two points. First,

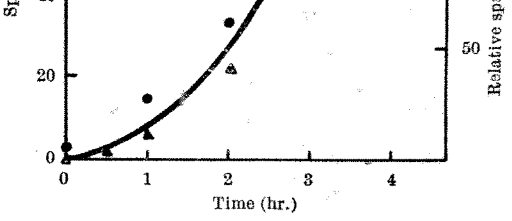

Fig. 1. Time-course of incorporation of phosphorus-32 into rat skin lipids *in vitro*. Specific activities, counts/min./μgm. lipid-phosphorus, uncorrected. Relative specific activities, ratios of specific activity of lipid-phosphorus to that of acid-labile phosphorus (trichloracetic acid extract) of saline medium. Two separate experiments

Table 1. THE SYNTHESIS OF PHOSPHOLIPID BY RAT SKIN *in vitro*

Substrate (10 m.molar)	Percentage specific activity of lipid-phosphorus in 3 hr. relative to glucose
No substrate	69 (87, 59, 62)
Succinate	72 (79, 87, 50)
Glycerol	68
L-Malate	45 (44, 39, 53)
DL-Lactate	52
Acetate	53
Oleate	31 (15, 44, 30, 16, 52)
Palmitate	44
Stearate	42
Glucose, anaerobic	19 (18, 15, 23)
Glucose, iodoacetate (1 m.molar)	11 (6, 15)

the criteria deduced by Zilversmit *et al.*[5] for showing the derivation of a substance from its immediate precursor are not obeyed by the data of their Fig. 2. Hence it is difficult to argue that liver phospholipid is the precursor of skin phospholipid. Secondly, conclusions from an experiment involving the feeding of labelled phospholipid are drawn from observations at a single point of time, 48 hr. Reiner[6] has argued that, in tracer work, observations at a single point of time are often susceptible to more than one interpretation. It seems likely that if Leonhardi *et al.*[1] had not failed to demonstrate *in vitro* synthesis of phospholipid by skin, they could have placed an entirely different interpretation on their *in vivo* experiments.

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Enzymic Synthesis and Properties of a Polynucleotide from Adenosine Diphosphate

THE well-known viscous nature of solutions of lysed cells of *M. lysodeikticus*, attributed in part to nucleic acids, led to the search for an active nucleotide polymerase in this organism. Preliminary studies with ^{14}C-labelled adenosine diphosphate (ADP) (the initial paper chromatographic studies were done in collaboration with Dr. Peter Olmsted) and the technique described by Grunberg-Manago and Ochoa[1] revealed the presence of such an enzyme. The present communication deals with the enzymic synthesis and properties of the polymer $(AMP)_n$.

The enzyme has been obtained in a partially purified and highly active form from aqueous extracts of lysed cells fractionated with ammonium sulphate at *p*H 8. The major portion of the activity is associated with the 30–40 per cent saturation fraction. The enzyme activity is determined by measuring the rate of formation of acid-insoluble material or rate of disappearance of acid-soluble material. A typical assay consists of a 2-ml. mixture containing 10^{-3} *M* ADP, 0·025 *M* tris buffer, *p*H 10, 5×10^{-3} *M* magnesium chloride and dialysed enzyme. The reaction is stopped at the end of ten minutes with the addition of 2 ml. of 5 per cent perchloric acid. The precipitate is centrifuged down, washed once with perchloric acid and twice with 95 per cent ethanol, and finally dissolved in 3 ml. of 0·1 *M* tris buffer, *p*H 8·0. The absorption peak of the solution is then measured at 257 mμ. A usual range of optical density values may be from 0·1 to 1·0. A blank which is run for determination of bacterial nucleic acid may be as low as 0·025.

The rate of synthesis of the polymer is proportional to both the enzyme concentration and the ADP concentration, the latter up to 5×10^{-3} *M*. The rate of polymer formation appears to follow zero kinetics until the reaction is more than 90 per cent completed. However, the picture is complicated by the action on ADP of a myokinase and possibly a phosphatase in the enzyme preparation. Chromatographic studies of the reaction mixture consistently reveal a low ATP/AMP ratio. Nevertheless, the results are consistent with the hypothesis that the enzyme has a stronger affinity for the polymer than for the monomer and that once the initial conditions have established the maximum concentration of the polymer, the rate is afterwards determined by the 'product' rather than by the 'substrate'. The reaction will not take place in the absence of magnesium chloride. The *p*H optimum of the reaction depends upon the concentration of magnesium chloride but is greater than 10 at low concentrations. The activation energy over the temperature-range of 8–39° is 11·8 k.cal. at *p*H 8. An apparent equilibrium is in favour of the polymer to the extent of about 70 per cent at *p*H 10 and 37° (it decreases with lower *p*H); but it is independent of enzyme or magnesium chloride concentration. Inorganic phosphate (dipotassium hydrogen phosphate) at concentrations of 0·01 *M* strongly inhibits the polymerization reaction and brings about a rapid decrease in the amount of polymer formed when added to the reaction mixture. The viscosity of the reaction mixture increases at a rate which depends in part on the experimental conditions; but under optimal conditions the viscosity increment may exceed 500 per cent and be only partially dependent upon the amount of polymer formed. Addition of inorganic phosphate brings about a rapid decrease in viscosity. The enzyme preparation is also active with other nucleotide diphosphates in the following order of rates: CDP > ADP > UDP ≫ GDP (no activity at 10^{-3} *M* concentration).

The polymer has been isolated in relatively pure form and subjected to several physical-chemical studies. Its absorption spectrum is similar to that of AMP, but the peak is shifted to 257 mμ and the extinction coefficient is reduced approximately 50 per cent. Addition of a strong alkali such as sodium hydroxide results in a progressive hydrolysis of the polymer associated with a sharp increase in the absorption throughout the ultra-violet range. The polymer readily dissolves in water or alkaline solution to form highly viscous solutions from which gossamer threads can be spun. In a semi-dried state it forms a rubber-like mass which can be stretched to give a well-oriented birefringent structure. X-ray diffraction studies are being made of the spun fibres. The sedimentation coefficient of one preparation at a concentration of approximately 0·007 per cent was 16×10^{-13} at 20°. Electron micrographs show unbranched chains, similar in many ways to those of DNA but irregular in width and smaller in diameter. A Zimm plot of data from light-scattering studies of another preparation showed a molecular weight of $1 \cdot 86 \times 10^6 \pm 20$ per cent with a length of 2400 A. (assuming monodispersed material).

These results should be compared with those previously reported from Dr. Ochoa's laboratory[1,2].

The ease of reversing the polymerization reaction supports the thesis that the primary biological role of RNA may be that of a source of readily available high-energy polyphosphate mononucleotides. The enzyme preparation displays a very strong phosphorylase activity toward the nucleic acid of the bacterium.

This investigation was supported by Research Grant C-2550 from the National Cancer Institute, National Institutes of Health, U.S. Public Health Service. I wish to acknowledge the technical assistance of Mrs. G. Olson in this study and the generous co-operation of the following persons who carried out the work on the polymer: X-ray diffraction studies were under the supervision of Dr. R. S. Bear with Dr. R. S. Morgan; ultracentrifugation studies were made by Dr. D. A. Yphantis; electron microscopy studies were under the supervision of Dr. C. E. Hall; and the light-scattering measurements were made by Dr. R. F. Steiner.

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Effect of Pinealectomy on the Rat Pituitary

PINEALECTOMY in rats has been variously reported as resulting in no change[1] or as causing a hypertrophy of the pituitary, with an increase in the proportion of acidophils of the anterior lobe, and some degeneration of the basophils[2].

Blind subdural pinealectomy has been attempted on a small series of young male rats, aged two to four months. Those surviving the operation were killed six to twelve weeks afterwards. Histological examination of the brain confirmed that in eight animals the pineal body had been totally removed, whereas in the remaining seven it was still in its normal position, and apparently undamaged. The pituitary bodies of these two series of animals were fixed in Zenker-formol, sectioned and stained by Pearse's method[3]. Modified Rasmussen[4] cell counts of the anterior lobes were then made, approximately five thousand cells being counted in each gland. The results are shown in Table 1.

These figures show that there is no significant difference between the cellular constitution of the anterior lobe of the pituitary of pinealectomized and non-pinealectomized animals. Successful removal of the pineal did not give rise either to a marked increase in the numbers of acidophils or to basophil degeneration. Colloid formation and development of 'signet ring' forms in the basophils were not significantly increased.

Table 1

	Mean percentages ± mean standard error	
	Pinealectomized	Non-pinealectomized
Acidophils	42·2 ± 1·6	41·3 ± 1·3
Basophils	6·0 ± 0·8	6·6 ± 0·8
Chromophobes	51·8 ± 1·7	52·1 ± 0·8
Percentage of basophils showing colloid formation	4·3 ± 1·6	2·7 ± 1·1

These findings indicate that the pineal body has no effect on the anterior lobe of the pituitary of the young male rat, and suggest that if gonadal changes such as have been reported[5] do occur, they are not mediated via the pituitary.

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Incomplete Wound Contracture and the Phenomenon of Hair Neogenesis in Rabbits' Skin

IN rabbits, the healing of extensive wounds produced by excision of the full thickness of the skin of the trunk is the outcome of two distinct, though to some extent overlapping, processes which provide in turn a temporary and a definitive repair[1]. During the course of the first week or two, the defect becomes filled with granulation tissue, which is progressively epithelialized by the migratory ingrowth of epithelium from the wound margins. Closure of the raw tissue surface in this manner marks the completion of temporary repair. The definitive repair is brought about by contracture, a forced inward movement of the wound margins as a consequence of tensile forces generated within the substance of the granulation tissue or its derivatives[2]. Contracture, so it has been shown, is accompanied by a compensatory expansion of the integument surrounding the wound through intercalary or intussusceptive growth[1].

Recent experiments by Billingham and Russell[3] have shown that the process of contracture in experimental full-thickness wounds, ranging in area from about 10 cm.^{2} to 50 cm.^{2} and of various shapes, including rectangles and circles, proceeds at a constant specific rate; that is, obeys the exact opposite of the familiar compound interest law of growth. The logarithm of the area of a wound decreases linearly with time, at least until the wound is not more than a few square centimetres in extent. The actual values of the specific rates of contracture fell within the range 5–8 per cent of the wound area per day. In one series of extensive wounds, 20–40 cm.^{2} in area, produced by excision of the full thickness of the skin down to, but not through, the panniculus on the trunks of thirty-two full-grown rabbits, contracture approached its theoretical end-point so closely in nineteen (that is, about 60 per cent) that only a narrow linear scar remained. In these animals the re-apposition of the skin of the original wound margins was virtually complete. In the remaining thirteen animals, however, the process of contracture terminated abruptly after the areas of their wounds had been reduced to about 5 cm.^{2} or less.

Incomplete wound contracture was also observed in a further group of seven animals, of which three had been adrenalectomized before the excision of their cutaneous wounds, and four received daily administrations of 10 mgm. of cortisone acetate, commencing on the day of operation and continued for at least thirty days. Besides slowing down the rate of contracture, both treatments greatly increased the incidence of incomplete contracture.

Once their contracture had terminated prematurely, the areas of most of the wounds underwent very little change. Their margins remained incisive. In a few animals it was observed that incompletely contracted wounds actually underwent a slow expansion, attaining by about the hundredth day a final area which was approximately double the minimum which contracture had produced by about the fiftieth day.

We have observed that from the smooth, bald surfaces of all incompletely contracted wounds fine hairs begin to emerge, commencing at the periphery, within about forty to fifty days of the operation. The time of appearance of these hairs seemed to depend, among other things, upon the age of the subject: in a group of three animals which were only fifty days old when their wounds were prepared, new hairs had already begun to pierce the surface as soon as the twenty-ninth day. With the production of these hairs the originally smooth scars may be said to have become transformed into a sort of *ad hoc* skin. The hair crop was invariably white in colour, despite the fact that all the rabbits used were of pigmented breeds. The orientation of the hairs borne by these scars bore no constant relation to that of the fur of the adjacent normal skin; the new hairs sloped outwards from the centres of the scars. Comparison of actual counts showed that the hair densities on the scars did not differ significantly from those on neighbouring normal skin. So far as we have been able to ascertain, guard hairs were not included among the newly formed hairs, which, like those of normal skin, were grouped together in small follicle clusters.

The only striking anatomical imperfection of these new hair follicles was their apparent lack of arectores pili muscles. The hairs were medullated and well-developed sebaceous glands were invariably present.

In the preparation of these experimental wounds particular care was taken to remove all trace of the dermis from the surface of the panniculus, including, of course, any embedded follicle bases. When this fact is taken into consideration, together with the large number of new hairs formed (up to 3,500), it leads unequivocally to the conclusion that the hairs were of new formation and could not possibly have been derived from pre-existing follicle remnants. This conclusion is strongly reinforced by their uniform lack of pigment, which is highly suggestive of an origin from the superficial as opposed to follicular epidermis.

The hairs on these uncontracted wounds persisted throughout the entire period of observation, which rarely fell short of a hundred days and frequently exceeded 150 days. Grafting experiments provided further evidence as to the permanence and stability of the new 'skin'. For when small full-thickness grafts were removed from it and transplanted elsewhere on an animal's body, they invariably healed in satisfactorily and regenerated new hairs of the original type.

The new hair-bearing skin was chronically œdematous and slightly inflamed, enlarged blood vessels being particularly prominent in sections; its thickness was about twice that of normal skin; it had a somewhat soft, cheesy consistency when incised, lacking the toughness characteristic of normal skin, and its collagen fibres were mainly disposed in a horizontal plane as is usual in scar tissue.

That the phenomenon of hair neogenesis has escaped notice for so long is probably attributable to the high proportion of wounds which undergo complete contracture and the fact that, even in rabbits whose wounds fail to contract completely, hairs do not normally appear on the scars for many weeks. It may be added that the great majority of previous wound-healing studies have been based on undressed wounds, in which contracture normally takes place much more rapidly and completely, as we have shown[3]. Here the final conditions are most unfavourable for the formation of new hairs. In all the experiments reported on here, the wounds were maintained under dressings at least until they were completely epithelialized and the epithelium was firmly united to its bed and sufficiently robust to withstand the trauma of everyday life. In no animals were the dressings left off before the thirtieth day.

The first unequivocal evidence of the occurrence of hair neogenesis in adult rabbits was presented by Breedis[4], who realized the necessary experimental conditions when he mechanically inhibited the contracture of full-thickness cutaneous wounds by the insertion of appropriately shaped metal splints. Our own findings are in complete accord with his.

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Muscular Dystrophy of Beef Cattle and Unsaturated Fats

THE enzootic muscular dystrophy of suckling beef cattle in the north of Scotland[1] can be prevented by administration of α-tocopherol[2]. Analyses of rations which consist mainly of turnips and straw show them to be deficient in tocopherol, and this dietary lack is reflected in extremely low concentrations of tocopherol in the blood serum, colostrum and milk of the cow, and in the blood serum and the tissues of her calf[3]. The quantity of tocopherol necessary for the prevention of the disease in the suckling calf is, however, much higher (twice) than that required by experimental calves given artificial rations simulating milk. Since unsaturated dietary fats such as lard[4] and especially cod-liver oil[5] (a particularly rich source of polyethenoid fatty acids) lead to a gross exacerbation in the incidence and severity of muscular dystrophy and to considerable increases in tocopherol requirement, it was thought that the nature of the dietary fat ingested by the calves in the north of Scotland might be a further factor, in addition to a low tocopherol intake, accounting for the incidence of the disease. This hypothesis was supported by the finding that it was not possible to produce muscular dystrophy experimentally in calves when they were given rations low in tocopherol content but free of fat[6].

Table 1. TOCOPHEROL CONTENT OF COWS' SERUM AND MILK AND ANALYSIS OF MILK FATS

Diet (excluding straw)	Mean tocopherol content of blood serum of cows (μgm./100 ml.)	Mean tocopherol content of milk fat (mgm./gm.)	Iodine value of milk fat	Unsaturated acids in milk fat (mol. per cent)			
				C_{10}–C_{14}	Oleic	C_{18} di- and tri-enoic	As C_{20}–C_{22}
Silage	299	38	41·0	5·2	28·7	1·3	2·3
Silage plus turnips	293	22	36·0	4·6	22·6	1·7	1·9
Turnips	117	4	36·6	7·4	21·0	1·5	0·9
Turnips	94	5	30·4	7·4	16·0	1·5	0·6

The composition of the mixed fatty acids derived from the milk fat of groups of cows in the north of Scotland given rations of turnips and straw was determined by ester-fractionation and compared with that of similar cows in the area given rations containing grass silage. In the latter group the incidence of dystrophy in the offspring is rare. The concentration of polyethenoid fatty acids in the serum lipids of the calves of the cows in the two above groups was also determined according to Wiese and Hansen[7]. Salient information on the composition of the milk fats is given in Table 1.

The low tocopherol content of the blood serum and milk of cows given rations of turnips and straw was not, however, associated with a greater degree of unsaturation of the milk fats; on the contrary, the fats contained less of the unsaturated fatty acids in the C_{20}–C_{22} series and less oleic acid than the milk fats of the cows given silage. There was a corresponding increase in the concentration of saturated acids in the C_4–C_{16} series, especially in respect of palmitic acid.

The concentrations of polyethenoid fatty acids in the blood serum lipids of the calves of cows given turnips and straw were lower if anything than in the serum lipids of calves from cows given silage, as shown in Table 2.

Table 2. PROPORTION OF POLYETHENOID ACIDS IN BLOOD SERUM LIPIDS OF SUCKLING CALVES

Unsaturated acids	Proportion (wt. per cent) of acids in serum lipids of calves, the dams of which were fed on	
	Silage	Turnips and straw
Tetraenoic	3·42	3·45
Trienoic	3·95	3·25
Dienoic	10·23	7·63

There was no indication that abnormal amounts of polyethenoid acids were present in the blood serum lipids of susceptible calves. Experiments with seventy-five calves showed that daily supplements of 20 mgm. α-tocopherol per calf led to slight reductions in the concentration of the unsaturated acids in the blood serum lipids. For calves receiving the unsupplemented ration, the average concentrations (weight per cent) of tetraenoic, trienoic and dienoic acids in the serum lipids were 3·8, 3·7 and 9·1 respectively, and for calves receiving the supplemented ration 3·2, 3·5 and 8·4 respectively. These differences, though they suggest that tocopherol reduces the concentration of polyethenoid acids in the serum lipids, were not statistically significant.

As already mentioned, the importance of dietary sources of unsaturated fat in determining tocopherol requirements in experimental calves is now well established[4-6]. The present work shows that in enzootic muscular dystrophy, the milk fat which the calves receive is less unsaturated than that received by calves which do not usually develop the disease. The fat is, however, grossly deficient in tocopherol content, and this is clearly a more important consideration than the presence of abnormally large amounts of unsaturated fatty acids in accounting for the incidence of dystrophy. The sporadic incidence of the disease, its correlation with muscular exercise and the relatively high tocopherol intakes necessary for complete prevention remain to be explained.

Detailed accounts of this work will be published elsewhere.

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Avidity of the Water-soluble Components of Herbage for Added Cupric Ions

DURING work to investigate the availability of organic complexes of copper to the copper-deficient rat, it was found possible to demonstrate the existence of stable copper complexes formed by adding copper-64 ions to the water-soluble components of herbage.

On filter-paper chromatograms developed with phenol/water, a number of complexes of copper with amino- and hydroxy-acids have been shown to have R_F values in the range 0·08–0·98, whereas the R_F of the free cupric ion in this solvent has not been found to exceed 0·06. It is apparent that this technique can provide a useful indication of whether or not the copper in a biological fluid is present as the free ion.

To investigate the effect of adding cupric ions to the water-soluble components of herbage, 2 gm. of freeze-dried grass was extracted with 20 ml. water at 37° C. for 14 hr. After centrifuging at 25,000 *g* for 30 min., 15 ml. of the supernatant was concentrated to 1 ml.

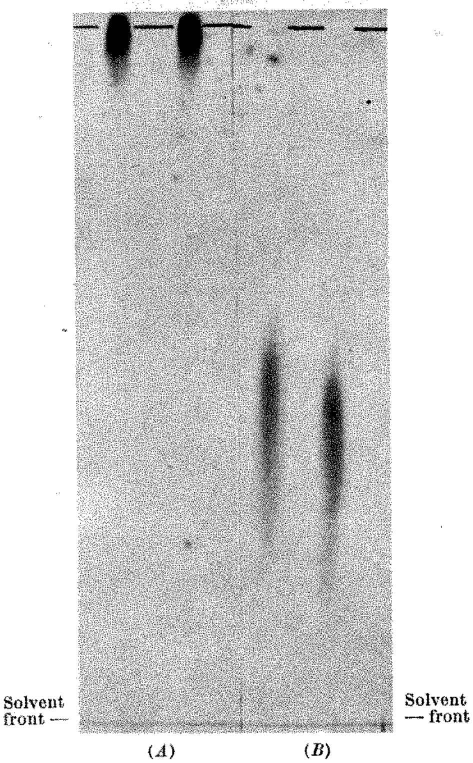

Fig. 1. Autoradiograph of copper-64 chromatograms: (*A*) copper-64 applied to chromatograms as free cupric ion; (*B*) copper-64 applied after combining with water-soluble components of herbage

by freeze-drying and 2·5 μgm. copper-64 + carrier (as copper nitrate) was added. This preparation was applied to Whatman No. 1 filter paper as spots containing 0·012 ml. liquid and the chromatogram then developed with phenol/water as (descending) solvent. Chromatograms containing an equivalent quantity of the untreated cupric ion were developed by the same procedure. Autoradiograph prints of the dried chromatograms on Ilford 'Industrial G' X-ray film were obtained by 24 hr. exposure (Fig. 1).

The absence of a radiation response in the R_F range 0·0–0·06 of the herbage-extract chromatogram indicates that all the added cupric ions have combined to form complexes stable at the solvent pH (4·4) despite the fact that, by this procedure, the copper content of the original extract was increased by two and a half times. The copper complex thus formed has a faint blue-green fluorescence under ultra-violet light, and gives a weak positive response with ninhydrin in butanol.

It is emphasized that, in order to produce a satisfactory autoradiograph, the above chromatograms are overloaded. By the use of more sensitive radiometric scanning methods[1,2], it should be possible to overcome this difficulty.

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Field Resistance to Potato Blight (*Phytophthora infestans*)

Two types of resistance of potatoes to blight (*Phytophthora infestans*) have been distinguished—'true resistance' by virtue of hypersensitivity (suprasensitivity) and 'field resistance'[1]. True resistance is not found in the old varieties of European cultivated potato; but it has been bred for on an extensive scale for more than thirty years using the wild Mexican potato, *Solanum demissum*, as the source of genes for the hypersensitive reaction. It appears now that this hypersensitive type of resistance by itself is of limited value, because new physiological races of blight can arise very rapidly to attack clones carrying as many as four different major genes for hypersensitive reactions[2], and because *S. demissum* itself is attacked by blight in Mexico[3]. In contrast, field resistance, which is found in certain varieties of European cultivated potatoes and in other potato species, may be equally effective against all physiological races of blight.

The nature of field resistance was investigated by Müller and Haigh[1] and by Müller[4]. They claimed that susceptible and field-resistant varieties differed in their "probability of becoming infected per unit area of leaf", and they obtained a measure of this probability of becoming infected by spraying the upper surface of small disks of potato leaflets with a weak zoospore suspension and counting the number of disks on which sporangiophores were produced some days after spraying (susceptible and field-resistant varieties showed no differences if the under-surface of the disks were sprayed). Using two varieties, Arran Pilot (very susceptible) and Ackersegen (field resistant), we also were able to demonstrate a small but significant difference between the two varieties in the percentage of disks on which sporangiophores were produced. On the other hand, we were able to show that the disks of Ackersegen on which no sporangiophores were found did contain hyphæ of blight which could be made to produce sporangiophores by placing them on the cut surfaces of potato tubers. It thus appears that the leaflet-disk method measures "probability of producing sporangiophores per unit area of leaf" rather than "probability of becoming infected per unit area of leaf". The disk method also does not appear to be very sensitive, since it was found[1,4] that King Edward and Majestic had similar values for percentage becoming infected, whereas in field observations[5] it has been found that blight on Majestic frequently reaches the 75 per cent stage a week or a fortnight later than it does on King Edward.

Schaper[6] has suggested that field resistance is due to a longer incubation period for the fungus and a lower production of spores by the fungus when it grows on a resistant potato. This we have confirmed for Ackersegen, on which, using either detached leaflets or leaflet disks sprayed with a weak zoospore suspension, sporangiophores are produced one day later than on Arran Pilot, and the number of sporangia

Table 1

Date of inoculation	Date on which sporangia counted	Relative number of sporangia	
		Arran Pilot	Ackersegen
1/10	5/10	46·35	0·00
	6/10	89·60	6·25
	7/10	92·00	25·00
	8/10	102·95	28·15

produced is very much smaller. Details of one experiment are given in Table 1.

It would thus appear that, while susceptible and field-resistant potato varieties may differ in several characters, two of the most important differences, both of which may be due to a relatively slow growth of the fungus in the leaflets of field-resistant varieties, are the length of the incubation period of the fungus and the number of spores produced.

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Aphelenchoides sp. destroying Mushroom Mycelium

Damage to mushroom mycelium, by eelworms, leading to diminished crops or crop failures has been known for about fifty years[1]. The eelworms responsible for the damage have been reported as *Ditylenchus* sp. by Lambert, Steiner and Drechsler[2] and by Bovien[3], as *Ditylenchus destructor* by Seinhorst and Bels[4] and as a new species of *Ditylenchus* by Cairns[5]. Cairns[6] has also stated that species of *Aphelenchoides* feed upon, injure and destroy mushroom hyphæ.

Populations of *Aphelenchoides* sp. have frequently been encountered in samples of compost from poorly cropping mushroom beds.

Early this year at Wye, bottles of sterile compost already spawned with mushroom mycelium were inoculated with a mixed population of *Aphelenchoides* sp. and *Panagrolaimus* sp. At the end of four or five weeks the mycelium in the inoculated bottles had largely disappeared, and the population of eelworms had greatly increased. Some of the material was sent to Rothamsted. There one set of pots each containing 300 gm. of compost was inoculated, at the same time as spawning, with fifteen hand-picked specimens of *Aphelenchoides* and another set with fifteen similar specimens of *Panagrolaimus*. A further set of pots constituted a control. Cropping began four weeks later, and continued up to the eleventh week in the control pots and those inoculated with *Panagrolaimus*. In the pots inoculated with *Aphelenchoides* cropping ceased at the end of the sixth week. Examination of the compost showed the reason for these differences. Mycelium was present and undamaged in the control and *Panagrolaimus* series; but in the *Aphelenchoides* series it had largely disappeared. From an original inoculum of fifteen specimens of *Aphelenchoides* there were approximately 3,000,000 present at the end of six weeks. On the other hand, there were only 72,000 *Panagrolaimus*.

The identity of the *Aphelenchoides* is still under investigation. It is not true *Aph. parietinus*, as recently redescribed by Franklin[7]; both sexes are present and there are distinct morphological differences which clearly separate it from this species, although it is similar in many respects.

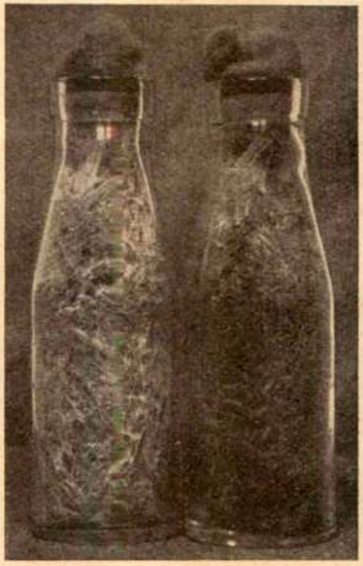

Fig. 1. Mushroom mycelium on compost after eight weeks: left, control; right, inoculated with *Aphelenchoides* sp.

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Control of Seasonal Variation in the Egg Production of Hens

The discovery that artificial light will improve winter egg production by hens is said to have been made about a hundred years ago by Spanish farmers[1]. It was later established in a number of laboratories that it will prevent moulting in pullets brought into lay in the autumn. Little progress has been made in defining the light stimulus except for some experiments on the effect of breaking the night[2]. More than twenty years ago it was suggested on the basis of field records that the seasonal change in day-length as opposed to the absolute day-length was mainly responsible for the seasonal fluctuations of egg yield[3]. This suggestion has never been followed up.

I have tried to examine the effect of the change in day-length in late summer and early autumn on the production of pullets already in lay. Two groups, each of twenty-one Brown Leghorns from an inbred line, were reared from the age of eight weeks, the first in a $23\frac{1}{2}$-hr. and the second in a 12-hr. day-length in artificial light. The birds were kept in

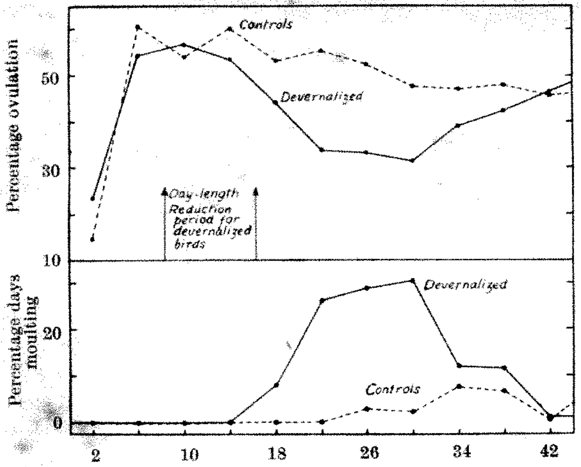

Fig. 1. Ovulation and moulting of survivors of the control group (twenty birds) and the 'devernalized' group (seventeen birds) plotted in periods of 28 days. Moulting days were those on which an appreciable number of feathers were cast, not days on which feathers were growing

batteries from this age, but previously had been in a pen. About two months after the birds had come into lay the day-length of the first group was gradually reduced to 12 hr. over a period of eight weeks and then maintained at this level. This procedure is hereafter called 'devernalization'. In this way the seasonal reduction in day-length in late summer and early autumn was simulated in an exaggerated way. Because the pullets had been in lay for some time before 'devernalization', they represented early hatched birds, which a farmer might expect to moult in the autumn. The day-length for the second group was maintained throughout at 12 hr., an absolute day-length at which good production is normally maintained.

Fig. 1 shows that the production of the 'devernalized' group fell very considerably after the day-length was reduced; it did not recover for some months, and was accompanied by moulting as in farming practice. Its cause cannot be a low absolute day-length, because the 'devernalized' group at no time had a shorter day than the controls. It is unlikely that there was a subclinical infection in the 'devernalized' group, because a fortnight after the end of the treatment the birds of the two groups were mixed. It seems, therefore, that a downward change in day-length can reduce egg production and cause moulting.

From the age of eight weeks up to the end of 'devernalization', the birds had been kept in an environmental temperature of 64° F. A fortnight later, half of each group were exposed to an artificial thermal autumn and winter lasting five months. The temperature during the coldest three weeks averaged 36° F. In agreement with most earlier work on housed birds, discussed by me[4], this had no appreciable effect on production.

A second 'devernalization', after the birds had been in lay for about a year, was successful. Production nearly ceased and moulting was heavy. Controls maintained a reasonable rate of lay.

It is thought that if late summer and autumn 'devernalization' is prevented, and the birds are kept on the intensive system, hatching in Britain could be profitably carried out at any time of the year, so that the supply and price of eggs could be fairly steady, as indeed they are already in the lower latitude of the United States. My experiments are purely fundamental and do not, therefore, indicate the most economic method of controlling 'devernalization'. However, field trials carried out by Temperton[5] suggest that the practical methods of control may be simpler than those used here.

Recent experiments at this Centre[6] show that a short absolute day-length can inhibit production as well as a reduction in day-length; however, when autumn and winter lighting are used, the absolute day-length is never short enough to reduce production in practice.

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Eophila oculata at Verulamium: a Roman Earthworm Population?

DURING the excavation of Roman remains lying beneath a car park near the Verulamium Museum, St. Albans, in the summer of 1955 some eighteen living earthworms were found among layers of blackened organic material between eight and fifteen feet below ground-level.

The worms were identified as *Eophila oculata* (Hoff.), a species fairly widely distributed in Britain and Europe. (The specimens were kindly examined by Dr. A. J. Cain, who wrote: "I think there is no real doubt that the worms are *Eophila oculata* (Hoffmeister 1845). Only one or two have traces of the clitellum and tubercula pubertatis, and the latter are slightly atypical in extending over segments 28–30 instead of 29–30 as usually described. Unfortunately none of the apparently most mature show even traces of the spermathecae and seminal vesicles on dissection, so the diagnosis cannot be confirmed. In the extent of the clitellum and the presence of a genital cushion on 11, and one or two other features they agree well with *oculata*.") This worm does not occur in agricultural soils but inhabits aquatic or semi-aquatic places such as the mud at the bottom of ponds, rivers and ditches and the wet soil of their banks. It has been found in wells[1], in clayey soil under rotting sedge at Wicken Fen[2], and among material dredged from the bottom of Lough Mask, Eire, at a depth of between 100 and 150 ft.[3].

The present record is unusually interesting as the worms were found in the remains of a ditch which was filled in during the first century A.D., and then sealed over by the floors of successive buildings erected between the first and fourth centuries A.D. The varying floor surfaces included tile, gravel, mortar and beaten earth, and were in a fair state of preservation. They formed a compact layer from eight to fifteen feet thick which clearly had not been disturbed since Roman times.

The ditch represented the first disturbance of the site by man and may have been a stage in the construction of a defensive ditch which was not completed. It contained, in its lower part, a water-logged black material, and in its upper part, where the worms were found, soil mixed with separate layers of partially decomposed, blackened vegetation among which brushwood, holly leaves, bracken, grass and various types of seeds were recognizable. Domestic refuse including oyster shells, pottery and scraps of leather; many identifiable fly puparia and other insect parts were also found.

Excavation began in April, but had only reached a depth of 2 ft. by July. The rate of working then increased and the ditch was entered by the end of the month. The first worms were found shortly afterwards. They were in well-developed burrows and evidently had not been introduced during the digging. The nearest likely source of this species of worm is the River Ver, 250 yards away; but as the excavation was carried out during a period of drought (total rainfall July and August, 1·06 in.) it is unlikely that they invaded the exposed ditch across the dry partly built-up area in between. No worms or burrows were found between the ditch and the lowest Roman floor and it is also unlikely that the worms would have penetrated the compacted layers, 8–15 ft. thick, above it. They might, however, have migrated along the ditch horizontally if it connected with the river. The full extent of the ditch is not known, but it almost certainly does not connect with the river as the exposed portion curves away from it and lies ten feet above it.

There remains the possibility that the worms entered the ditch in Roman times before it was filled in, and have continued to breed there ever since. This explanation is supported by the presence in the ditch of seeds of *Carex* spp., typically plants of marshy situations, which suggests that the site provided a suitable habitat for *E. oculata* during the Roman period.

Worms and burrows occurred both among the partly decomposed vegetation and in the surrounding clay. Deposits of 'vivianite' (hydrated ferrous phosphate), a substance laid down under reducing conditions, were found among the organic materials, and this, together with the well-preserved state of the vegetation itself, suggests locally anaerobic conditions. The surrounding soil may, however, have been slightly better aerated and, if so, worms in the vegetation could perhaps have obtained some air from this source through their burrows.

A number of other sites from which *E. oculata* has been recorded, for example, the black mud beneath the River Thames and the bottom of Lough Mask, similarly suggest conditions of poor aeration, and the ability of the species to exploit these habitats implies a capacity for absorbing oxygen at very low tensions.

This may be facilitated partly by its relatively large surface/volume ratio—although up to 75 mm. long, it is only 1–2 mm. in diameter. Only two other species in the British Lumbricidae, *Bimastus icenorum* (Pickford)[2] and *Allolobophora minima* Muldal[4], are similarly proportioned (diameters about 1 mm. and 1–1·5 mm. respectively) and both appear to have been found in the same type of habitat as *E. oculata*. *B. icenorum* and *E. oculata* were both collected by Pickford from "clayey soil under rotting sedge" at Wicken, and a specimen of *A. minima* was found by Muldal among preserved *E. oculata* collected by Friend from the Thames and Nottinghamshire. *B. icenorum* has been recorded only once but both *A. minima* and *E. oculata* have been taken from normally aerated sites. All three species seem to have in common at least some habitats and a body form providing an exceptionally high proportion of respiratory surface. It is tempting to speculate whether they may not also share an ability to live in habitats closed to other Lumbricidae under conditions of very restricted oxygen supply.

We are indebted to Mr. John Lunn, director of the excavation and of the Verulamium Museum, for directing our attention to this problem and for supplying us with archæological details of the site, and to Dr. A. J. Cain for identifying the worms and for his comments on the manuscript.

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An Arctic Lichen, *Siphula ceratites*, in Scotland

I DISCOVERED a large colony of the arctic lichen *Siphula ceratites* (Wg.) Fr. in April 1955 on the Coulin Forest of Wester Ross (lat. 57° 32′ N., long. 5° 22′ W.). The species is circumpolar, markedly disjunct and predominantly coastal in its distribution[1]. It has been recorded from western and northern Norway, Swedish and Finnish Lappmark, the Petsamo area, Novaya Zemlaya, Siberia, Japan, the Aleutian Islands, the Bering Strait region and the Himalaya but not hitherto from the British Isles.

The altitudinal range of these stations is from near sea-level in south-west Norway to 15,000 ft. (4,570 m.) in the Himalaya, the usual habitat being open plant communities of wet, stony or peaty ground. In Ross-shire the lichen is abundant over some 200 acres (80 hectares) of this type of terrain at an altitude of 1,500–1,800 ft. (458–549 m.) O.D. and is apparently extending its range (Fig. 1).

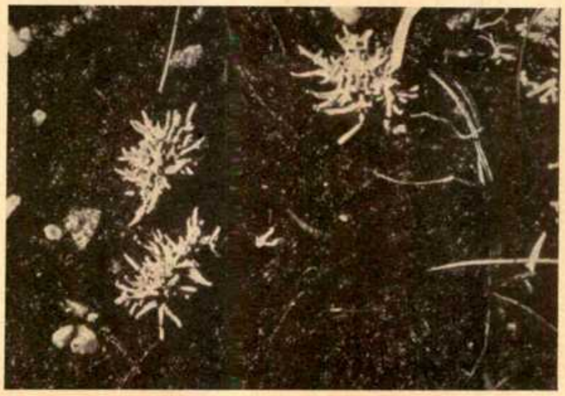

Fig. 1. *Siphula ceratites* on bare peat at 1,800 ft. O.D., Ross-shire, Scotland

Voucher specimens have been deposited in the herbaria of the Royal Botanic Garden, Edinburgh, and the Nature Conservancy, Edinburgh.

I am indebted to Dr. E. Dahl, of Vollebekk, Norway, for identifying the Scottish material.

A detailed account of the Ross-shire locality of *S. ceratites* will be published elsewhere.

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Effect of Environment upon the Growth and Development of Raspberry Canes

THE red raspberry (*Rubus idaeus* L.) has a perennial root system; but the shoots ('canes') are normally biennial, elongating in the first season and fruiting and dying in the second. Replacement canes may arise directly from roots, as root suckers, or from dormant buds at about ground-level on fruiting canes. This sequence of growth and development appears to be largely governed by, and in response to, various environmental factors, primarily those of light and temperature. The effects of these factors are being studied by growing plants under controlled conditions in which length of day, light-intensity and temperature can be varied independently.

Fluorescent lighting has been used, giving about 450 ft.-candles at the plant apices. Plants have been grown in three different constant temperatures, at each of which batches of plants were exposed to 9-hr. and 14-hr. day-lengths respectively. As a result of this work, some of the main effects of environment can now be discerned.

It is convenient to define three major phases of growth and development, namely: (1) the initiation of buds upon raspberry roots and their subsequent elongation to the soil surface; (2) the growth of the vegetative shoot in its first year; and (3) the production of flowers, mainly on lateral shoots, followed by fruit development and death of the cane, in the second year. Phase 1 has been discussed elsewhere[1], and is still under investigation. Phases 2 and 3 are discussed below.

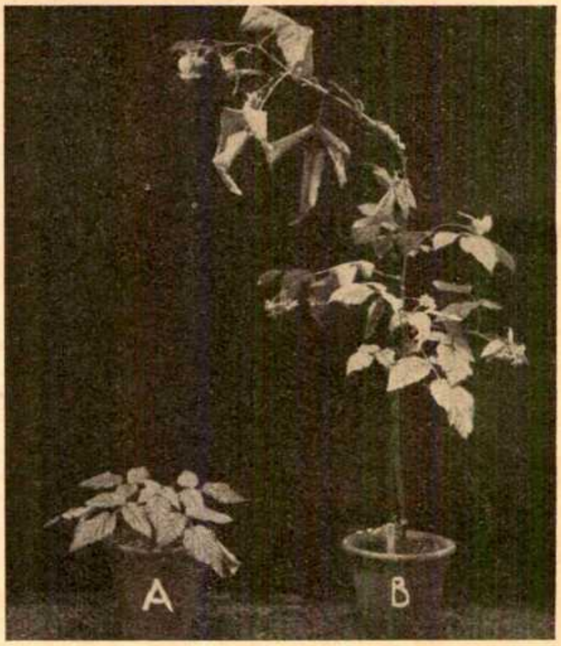

Fig. 2. Plants *A* and *B* were the same age when photographed on December 10, 1955. Plant *A* was grown at 50° F. in a length of day of 9 hr. Plant *B* was grown for 12 weeks at 60° F., 14 hr. length of day, then 'cool-treated' for six weeks at 50° F., 9 hr. length of day, then cold-treated for six weeks at 36° F., 0 light, and thereafter returned to a warm glasshouse where it formed tip and lateral fruit

In phase 2, two distinct forms of growth have been produced, some shoots elongating rapidly whereas others elongated very little, producing compact rosettes of leaves. At 70° F., with a length of day of either 14 or 9 hr., all shoots grew quickly, showing no tendency to form rosettes. In marked contrast, at 50° F. rosettes were formed in both day-lengths. At an intermediate temperature of 60° F., shoots with a 14-hr. length of day elongated, slowly at first but ultimately at a greater rate than those in a comparable length of day at 70° F., whereas plants grown at 60° F. with a 9-hr. length of day formed large rosettes near soil-level and did not elongate. These habits of growth are illustrated in Fig. 1.

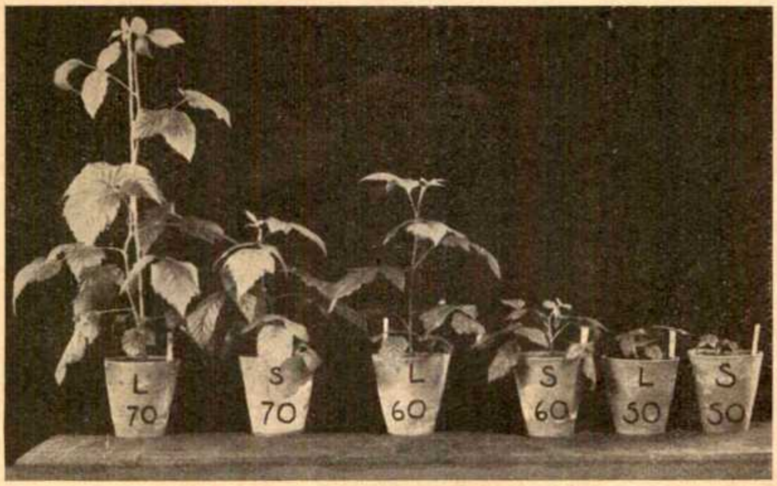

Fig. 1. Raspberry plants propagated from root cuttings on November 3, 1954, and photographed on March 1, 1955, after growing in six different environments. *L*, length of day of 14 hr.; *S*, 9 hr.; 70, 60 and 50 are constant temperatures in degrees Fahrenheit

It is of particular interest to note the interaction of temperature and photoperiod. At temperatures of about 60° F., elongation appears to depend upon length of day, whereas at lower temperatures rosettes form, and at higher temperatures shoots elongate, irrespective of the length of day.

Response to the environment is not confined to the young shoot or to growth near ground-level. Strongly elongating shoots, up to five feet or more in length, can be induced to form terminal rosettes of leaves either by giving lower temperatures or shorter days. Conversely, a shoot which has formed a terminal rosette can be induced to elongate again if the length of day is increased or the temperature raised.

When grown at sufficiently high temperatures, in heated glasshouses, raspberry canes have continued to elongate for considerable periods and have attained lengths of more than twelve feet without showing any tendency to go dormant, even in low light-intensities and short days of winter.

Phase 3, flowering and fruiting, can be initiated by exposing plants with elongated canes to a period of low temperatures, between 35° F. and 40° F. for periods up to six weeks. With the varieties Lloyd George and Malling Promise, a short period of a few days at low temperatures resulted in the production of a terminal flowering shoot when the plants were returned to higher temperatures. On the other hand, exposure of equally mature canes to longer periods of low temperature resulted in an increasing proportion of the lateral buds growing out to form mixed fruiting laterals (Fig. 2).

During exposure to low temperatures, canes become dormant and the leaves fall. It is not necessary for plants to be exposed to light during this period. When plants have been returned to the conditions of higher temperatures and light of a glasshouse and laterals have begun to develop, length of day seems to have little influence upon further growth of the laterals and flower and fruit formation.

Exposure of the canes to a period of short days and a temperature of 50° F. before giving them the low temperature of 35–40° F. materially influences the effectiveness of the latter treatment.

The age of the cane, as measured by the number of nodes produced, is also an important factor in flower initiation and development. Young canes with fewer than twelve nodes have so far failed to flower in response to any treatment applied.

The work is continuing and will be described in greater detail elsewhere. Permission to use the photograph in Fig. 1 is gratefully acknowledged to Mr. B. Cox of *The Grower*.

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Seasonal Sweating

PALMAR sweating increases in young women when their environmental temperature is artificially raised[1], and it is therefore reasonable to suppose that palmar sweating is related directly to environmental temperature and will vary with it in the different seasons of the year. As a preliminary test of the supposition, five women aged 18–20 years were observed for a month in summer and a month in winter, menstrual months being chosen in preference to calendar months to eliminate luteal effects[2]. The menstrual cycles chosen to represent summer and winter were those which began in August and in February.

Sweating was assessed by the number of active glands in an area of skin 4 mm. square immediately distal to the central whorl of the right middle finger[3]. Three hundred counts were made under basal conditions, 156 in summer and 144 in winter, and the mean counts were found to be 60·0 and 100·1 respectively, the standard error being 7·4. Therefore basal palmar sweating in the five women investigated was suppressed in summer to a degree which, from the statistical point of view, is abundantly significant[4]. Body temperatures of the women were taken at the same time and the average found to be 0·3 deg. F. higher in the summer month than in the winter month.

The suppression of basal palmar sweating in summer cannot be a thermoregulatory phenomenon, particularly in view of the raised body temperature in the women under observation, nor, unless winter is regarded as a time of shock, can it be explained as a recovery phase from shock. But subcutaneous injection of 25 mgm. of adrenocorticotrophic hormone suppresses palmar sweating (unpublished results), and there is considerable indirect evidence that an increase in suprarenal cortical activity acts in the same way[5]. Therefore, if suprarenal cortical activity is increased in summer, the paradoxical suppression of basal palmar sweating would be explained. Increased suprarenal cortical activity would also explain various other summer phenomena of unknown etiology—for example, neutrophilia[6], increased resistance to bacterial infection[7] and low death-rate from respiratory infection[8].

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Reaction between Formic Acid and Nitrogen Dioxide

DURING a study of a series of compounds of general formula $R'R''CO$ with nitrogen dioxide, we have investigated the reaction of formic acid with nitrogen dioxide. The reaction was carried out using a cylindrical 'Pyrex' glass reaction vessel (volume ~ 158 c.c., surface area ~ 167 cm.^{2}) and was followed by measurement of the increase of total pressure, and photometric estimation of nitrogen dioxide. Analyses of the final products were carried out as required using standard techniques described previously[1]. Initial pressures of 0–100 mm. each reactant were used, most of the experiments being carried out at 220° C. Under these conditions, nitrogen dioxide is very little associated[2] or dissociated[3], and formic acid is almost completely present as the monomer[4].

The reaction proceeds quite readily at 220° C. according to the overall equation:

$$HCO_2H + NO_3 = H_2O + CO_2 + NO$$

In agreement with this equation, the increase of pressure at any given time was found to be equal to the pressure of nitrogen dioxide which had been used. The pressure increase – time curves are, however, unexpectedly linear for a considerable portion of reaction at 220° C., although the slope of the linear portion is proportional to the first power of the initial pressure of each reactant. It appears, therefore, that the initial overall second-order rate is in some way maintained, indicating the possibility of autocatalysis.

This is supported by the fact that added nitric oxide was found to increase the rate of reaction, whereas additions of water and of nitrogen had very little effect.

For a given mixture of formic acid and nitrogen dioxide, it was observed that the rate was increased in proportion to the amount of nitric oxide added (see Table 1).

Table 1

$p_i NO_2$ = 24·0 mm. $p_i HCO_2H$ = 30·0 mm.	T = 220·0° C.
pNO added (mm.)	Initial rate × 10^3 (mm./sec)
0·0	0·92
9·2	1·30
21·1	1·98
39·9	2·34
56·5	2 63
72·3	2·99
151·6	5 10

Experiments were then carried out using different mixtures of formic acid, nitrogen dioxide and nitric oxide. These show that the rate of reaction can be expressed by an equation of the form

$$\frac{d(\Delta P)}{dt} = \frac{-d(NO_2)}{dt} = k_1(HCO_2H)(NO_2)\left\{1 + \frac{k_2(NO)}{k_1}\right\}$$

$$\text{At } 220^\circ\text{ C.,}\ \left.\begin{aligned} k_1 &= 3{\cdot}78 \times 10^{-1}\ \text{l. mole}^{-1}\ \text{sec.}^{-1} \\ k_2 &= 3{\cdot}56 \times 10^{+2}\ \text{l.}^2\ \text{mole}^{-2}\ \text{sec.}^{-1} \end{aligned}\right\}\ \text{average values}$$

The reaction was found to be largely influenced by surface. Experiments using a reaction vessel packed with 'Pyrex' glass tubing which increased the surface/volume ratio by a factor of nine produced approximately a nine-fold increase in rate. The velocity constants quoted above should therefore be related to the dimensions of the reaction vessel used.

Further experiments on this reaction are being carried out and it is hoped to publish full details at a later date. The present observations, however, are in agreement with those concerning the reactions of a number of compounds of general formula $R'R''$CO with nitrogen dioxide (Table 2). It appears that the presence of an easily removable hydrogen atom (that is, an aldehyde group) facilitates reaction. This does not necessarily imply that hydrogen abstraction occurs and is equally consistent with an initial addition reaction as proposed for the formaldehyde/nitrogen dioxide reaction by Pollard and Wyatt[1] and more recently extended by Walsh[5].

Table 2

R'	R''	Reaction of $R'R''$CO with NO_2		Ref
		Temperature range (° C.)	Comments	
H	H	118–184	Homogeneous reaction < 160° C. E = 15 kc./m. > 160° C. E = 19 kc./m.	1
CH_3	H	110–180	Homogeneous reaction E = 15·2 kc /m.	6
OH	H	210–260	Heterogeneous reaction	This work
CH_3O	H	250	Slow reaction probably heterogeneous	
CCl_3	H	146	Slow reaction	6
CH_3	OH	150	No detectable reaction	6
CH_3	CH_3	146	Very slow reaction	6

Formic acid and methyl formate (which has been briefly studied at 250° C.) differ from the other compounds of this series in the heterogeneity of their reactions with nitrogen dioxide.

The effect of nitric oxide upon the former may well be due to the occurrence of a surface reaction (a possibility is the formation of dinitrogen trioxide), and this would explain why nitric oxide does not increase the rate of, for example, the acetaldehyde/nitrogen dioxide reaction.

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[2] Verhock, F. H., and Daniels, F., *J. Amer. Chem. Soc.*, **53**, 1250 (1931).
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[4] Coolidge, A., *J. Amer. Chem. Soc.*, **52**, 1874 (1930).
[5] Walsh, A. D , *Fuel*, **33**, 243 (1954).
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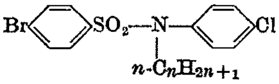
Substituted Benzenesulphonanilides as Synergists for DDT

A SERIES of 4-bromobenzenesulphon-4′-chloroanilides of type (I) have been synthesized and tested for synergistic activity with DDT against DDT-resistant house-flies.



n = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12

(I)

The test subjects were of a strain '*M*' of *Musca domestica vicina* Macq. moderately resistant to DDT, which had originated in 1949 from flies caught in Rosh-Pina, Israel. The potential synergists were tested together with DDT by topical application of benzene solutions (0·175 µl. solution per fly, containing 0·175 µgm. of DDT and 0·0175 µgm. of a potential synergist). Mortality was observed 6 hr. after application. When DDT by itself was applied topically in benzene solution, *LD*25 was 1·3 µgm., *LD*50 was 5·7 µgm. and *LD*75 was 20·1 µgm. per fly. The activity of the potential synergists in the form of residual deposits was tested by a modification of the method of Mer and Davidovici[1]. House-flies were individually induced to walk for 90 sec. first over a glass surface carrying a residual deposit of 10 µgm./cm.^{2} of a potential synergist, and afterwards for the same time over a similar surface carrying 100 µgm./cm.^{2} of p,p'-DDT, at 24–25° C. Knockdown was recorded 3 hr. after contact.

Figs. 1 and 2 represent the biological proportional response (plotted on a probit scale) as a function of increasing alkyl chain-length n of the synergists. The observed proportional response values were analysed statistically by the method for comparing individual means proposed by Tukey[2] and elaborated by Hald[3]. This method permits the classification of means into groups which can be considered as belonging to a statistically homogeneous population of such means. The proportional mortality values observed after topical application formed two

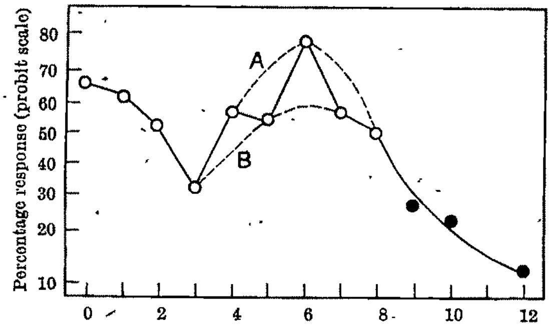


Fig. 1. Percentage knock-down of DDT-resistant house-flies 3 hr. after consecutive contacts for 90 sec. with residual deposits of 10 µgm./cm.^{2} of N-*n*-alkyl-4-bromobenzenesulphon-4′-chloroanilide synergists and of 100 µgm./cm.^{3} of DDT, respectively. Filled circles denote a response not significantly higher than that to DDT alone. *A*, even homologues; *B*, odd homologues

statistically homogeneous groups of responses which were significantly higher than the response to DDT by itself. These groups were {1, 2} and {0, 3, 4, 5, 6, 7, 8}, the figures in brackets denoting *n* of the compounds (I) in each group. The group of compounds {9, 10, 12} showed no significant synergistic activity. The proportional knock-down values observed after short-duration contact of flies with residual deposits[3] formed three statistically homogeneous groups: {6}; {0, 1, 2, 4, 5, 7, 8}; and {3}. The remaining group {9, 10, 12} showed no significant increase of response in comparison to that caused by DDT alone (13 per cent knock-down). The level of significance for all statistical tests was $P = 0{\cdot}05$. The compounds of type (I) showed no insecticidal activity when tested by themselves by the short-contact method.

The curves of biological response versus alkyl length (Figs. 1 and 2) may be divided into three parts: low range ($n = 0$ to $n = 3$), medium range ($n = 4$ to $n = 8$), and high range ($n = 9$ to $n = 12$). In the low range, the response to contact and to topical application showed similarity. In the medium range the response to topical application showed little change, while two additional factors appeared in the contact response curve, namely, maximum response near C_6, and differentiation of the series into separate sub-series of homologues with even-numbered and of those with odd-numbered alkyl radicals. For each sub-series a separate smooth curve for response vs. alkyl chain-length resulted, and therefore the homologous series as a whole formed a zig-zag line. The curves for both sub-series were of similar ω-shape the even homologues caused a higher response than the odd ones. In the high range ($n = 9$ to $n = 12$) the synergistic activity disappeared.

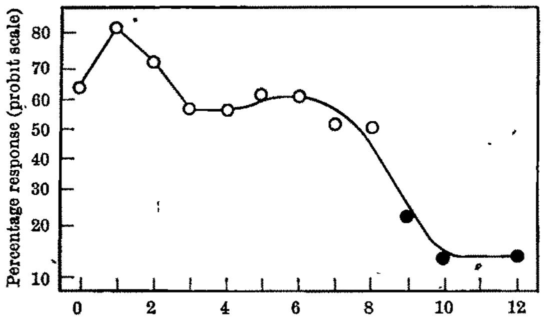


Fig. 2. Percentage mortality of DDT-resistant house-flies 6 hr. after topical application of 0·175 µgm. of DDT + 0·0175 µgm. of N-*n*-alkyl-4-bromobenzenesulphon-4′-chloroanilide synergists in benzene. Filled circles denote a response not significantly higher than that to DDT alone

For comparison several synergists which have been previously reported active when tested by other methods have been subjected to the short-duration contact test described above. 1,1-*Bis*-(*p*-chlorophenyl) ethane, which was reported by March and co-workers[4] to be highly active by topical application, showed no synergistic activity by short contact (10 per cent knock-down), while 4-chlorobenzenesulphon-4′-chloroanilide, reported by Speroni[5] to be active by 24-hr. contact, was also active by short contact (56 per cent knock-down). The N-*iso*-amyl isomer of the compound (I, $n = 5$) was inactive by topical application as well as by the short-contact test.

A detailed discussion of the observed correlation will be published elsewhere. Other synergists are being investigated.

Thanks are due to Prof. E. D. Bergmann for valuable discussions. Statistical analysis was carried out by S. Zacks.

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Kelvin on the Origin of the Earth

A GEOPHYSICAL discussion on the origin of the Earth reported in *Nature* some time ago[1] included an account of his so-called 'pore theory' by Mr. T. Gold. He suggested that an Earth which formed by the agglomeration of solid dust particles would, due to the heating effects of compression and radioactivity, contain a certain fraction of liquid mixed with the solid. A structure of pores or veins of liquid might be set up, and the percolation downwards and upwards of dense and light liquids could account for the formation of the Earth's core and of its atmosphere and oceans, respectively, while various hydraulic actions could explain earthquakes, vulcanism and structural features such as great upheavals.

While looking up a reference in Lord Kelvin's collected works recently, I was interested to observe that nearly one hundred years ago he had considered a similar mechanism in his article "On the Secular Cooling of the Earth"[2]. He suggested that in the process of cooling of a completely or partially liquid globe, portions of solid crust would continually sink until a "close ribbed solid skeleton or frame" had been built up from the bottom of the liquid layer. I quote what follows:

"In the honey-combed solid and liquid mass thus formed, there must be a continual tendency for the liquid, in consequence of its less specific gravity, to work its way up; whether by masses of solid falling from the roofs of vesicles or tunnels, and causing earthquake shocks, or by the roof breaking quite through when very thin, so as to cause two such hollows to unite, or the liquid of any of them to flow out freely over the outer surface of the Earth; or by gradual subsidence of the solid, owing to the thermodynamic melting which portions of it, under intense stress, must experience, according to views recently published by my brother, Professor James Thomson. The results which must follow from this tendency seem sufficiently great and various to account for all that we see at present, and all that we learn from geological investigation, of earthquakes, of upheavals and subsidences of solid, and of eruptions of melted rock."

Lord Kelvin thus seems to have anticipated some of Mr. Gold's ideas, although they, of course, differ as to the origin of the supposed porous structure, and Mr. Gold has given more attention to what such a hypothesis might entail.

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[1] *Nature*, **175**, 575 (1955).

[2] *Trans. Roy. Soc. Edin.*, **23**, 169 (1864); "Mathematical and Physical Papers", **3**, 311.

IT is interesting to know that Lord Kelvin held similar views though for different reasons, and especially that he considers also that a porous structure of the Earth would account for a variety of the phenomena that have occurred on the surface. The views of Chamberlain and Moulton, following their planetesimal hypothesis of the formation of the Earth, are perhaps even more similar to those which I have expressed. This set of ideas seems to me to have been much neglected despite the fact that it is in good accord with modern physical and geophysical knowledge.

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Influence of Expanding Space on the Gravitational Fields surrounding Individual Stars

Einstein and Strauss[1] have found solutions of the gravitational field equations of general relativity

$$G_{\mu\nu} = -k\rho v_\mu v_\nu \qquad (1)$$

$\mu, \nu = 1, 2, 3, 4$, such that (i) outside a spherical boundary $r = R_1$ (R_1 is a constant), the metric is homogeneous and isotropic, the co-ordinates are co-moving ($v_r = 0$, $r = 1, 2, 3$) and the density ρ does not vanish; (ii) inside $r = R_1$, the metric is spherically symmetric and $\rho = 0$, except for a possible singularity at or near the space-origin.

It is shown that the field inside $r = R_1$ is equivalent to the Schwarzschild field. Einstein and Strauss therefore conclude that "the expansion of space has no influence on the structure of the field surrounding an individual star".

However, Pirani[2] has shown that this negative result is obtained only because of the omission of the cosmological term $\lambda g_{\mu\nu}$ from the left-hand side of equation (1). By introducing this term, he has found that expanding space does influence the gravitational field.

Generally, stars are radiating energy. Hence we considered the Einstein–Strauss problem when the singularity at or near the origin is a source of radiation. In that case the space surrounding this singularity is not empty but is traversed by radially flowing radiation for which

$$\begin{aligned} G_{\mu\nu} &= -k\sigma\omega_\mu\omega_\nu \\ \omega_\mu\omega^\mu &= 0 \\ (\omega^\mu)_\nu\omega^\nu &= 0 \end{aligned}$$

σ being the density of flowing radiation[3]. The differential equations for this field can be solved in a manner similar to that employed by Einstein and Strauss in the investigation of the field (ii) mentioned above; but a fundamental difference arises when we try to fit this radiation-field with the pressure-free cosmic field given in (i) above, over a boundary $r = R_1$. The boundary $r = R_1$ now becomes non-static and moves with the velocity of light. The necessary jump conditions to be satisfied at such boundaries are derived by O'Brien and Synge[4]. According to them, if co-ordinates are so chosen that the boundary $r - R_1(t) = 0$ becomes $x^4 = 0$ in the new co-ordinates, then one of the essential conditions is the continuity of $T_k{}^4$ at this boundary ($k = 1, 2, 3, 4$). We have found that if the Einstein–Strauss singularity radiates energy, the components $T_k{}^4$ (evaluated in the appropriate co-ordinate system) are all zero for $r < R_1(t)$, but two of them are definitely non-zero in the cosmic field $r > R_1(t)$. It is therefore not possible to make $T_k{}^4$ continuous across the boundary $r = R_1(t)$. Hence we conclude that if the Einstein–Strauss singularity radiates energy, the field (ii) for $r < R_1(t)$ can never be fitted at the boundary $r = R_1(t)$ to a pressure-free cosmic field (i) with spatially homogeneous non-zero density of matter, irrespective of the vanishing or otherwise of the cosmic 'constant' λ. The jump conditions of O'Brien and Synge allow the fitting of such radiation fields with flat space-time alone, at great distances.

According to Einstein and Strauss, the expanding space of cosmology can be fitted on to a static Schwarzschild field without influencing it. But we have now seen that as soon as the Schwarzschild's singularity begins to radiate energy, the Einstein–Strauss process of fitting the two fields breaks down. We therefore cannot locate a definite (static or non-static) boundary $r = R_1$, such that on one side of it we have expanding space and on the other side a field quite uninfluenced by the surrounding expanding space.

Since all stars are radiating energy, a simple appeal to the jump conditions of O'Brien and Synge leads one to the conclusion that the expansion of space does influence the structure of the fields surrounding individual stars. The exact nature and extent of this influence are now being investigated.

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Nov. 11.

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[2] Pirani, F. A. E., *Proc. Camb. Phil. Soc.*, **50**, Pt. 4, 637 (1954).

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 30

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Efficient Use of Technical Personnel", opened by Sir George H. Nelson, Bart.

Tuesday, May 1

Faraday Society (in the Physical Chemistry Lecture Theatre, Imperial College, London, S.W.7), at 5.15 p.m.—Prof. J. J. Hermans (Leyden): "The Physical Properties of Polymer Solutions"* (Bourke Lecture).

Tuesday, May 1—Wednesday, May 2

Institute of Fuel (at Church House, Westminster, London, S.W.1), at 10 a.m.—Opening Conference of a Special Study of "Domestic Heating in the United Kingdom—Present and Future".*

Wednesday, May 2

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Miss Violet R. Cane: "Some Statistical Problems in Experimental Psychology".

University of London (at Senate House, London, W.C.1), at 5.30 p.m.—Prof. E. C. Wassink (Netherlands): "Morphogenetic Effects of Restricted Spectral Regions of Light in Plants".* (Further Lecture on May 3.)

Society for Analytical Chemistry (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 7 p.m.—Dr. J. H. Hamence: "The Composition of Some Deposits and Muds in Estuaries, Rivers and Lakes".

Wednesday, May 2—Friday, May 4

Institution of Electrical Engineers (at Savoy Place, London, W.C.2)—Convention on "Electrical Equipment of Aircraft".

Thursday, May 3

Faraday Society (in the Large Lecture Theatre, Chemistry Department, The University, Birmingham), at 4.30 p.m.—Prof. J. J. Hermans (Leyden): "Polyelectrolytes"* (Bourke Lecture).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. D. Lowde: "Spin Fluctuation Scattering of Neutrons and the Ferromagnetic State in Iron"; Mr. R. J. Eden: "The Brueckner Theory of Nuclear Structure".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. Rzoska: "Journeying Down the Nile".*

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Prof. N. L. Edson (University of Otago): "The Intermediate Metabolism of Carbohydrate in the Mycobacteria".*

Institute of Refrigeration (joint meeting with the Low Temperature Group of the Physical Society, at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. D. Smith: "The Use of Radioactive Techniques in Refrigeration Engineering".

Institution of Chemical Engineers (at the Royal Institution, Albemarle Street, London, W.1), at 5.30 p.m.—Mr. H. G. Davey: "Some Problems in the Maintenance of Nuclear Reactors".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, May 4

Faraday Society (in the Nicholson Lecture Theatre, Department of Organic Chemistry, The University, Liverpool), at 5 p.m.—Prof. J. J. Hermans (Leyden): "Light Scattering by Solutions"* (Bourke Lecture).

Institution of Mechanical Engineers, Hydraulics Group (at Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. H. P. Hutton: "Three Dimensional Motion in Axial Flow Impellers"; Dr. E. A. Spencer: "The Performance of an Axial Flow Pump".

Institute of Physics, Non-Destructive Testing Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Symposium on "Principles of Penetrant Methods".

Royal Institution (at 21 Albemarle Street, London, W 1), at [illegible] p.m.—Prof. J. Z. Young, F.R.S.: "The Discrimination of Shapes by Animals and Machines".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned.

Chemist (with an honours degree in chemistry or A.R.I.C., or equivalent qualifications, and at least three years experience in the industrial chemistry field) at the Atomic Weapons Research Establishment, Aldermaston, Berks, for duties which will include the control of water-treatment plants, trade waste treatment and radioactive effluent treatment and disposal systems, special laundry for contaminated protective clothing and the decontamination of plant and equipment—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1104/34 (May 2).

Animal Physiologist (with an appropriate honours degree or equivalent qualification) to undertake experimental work with hill sheep—The Secretary, Hill Farming Research Organization, 48 Palmerston Place, Edinburgh 12 (May 5).

Assistant, Grade B (with an honours degree in botany or zoology and able to teach both subjects to the advanced level of the general certificate of education), to teach Biology in the Natural Science Department—The Principal, Derby and District College of Technology, Normanton Road, Derby (May 5).

Deputy Librarian (Chartered Librarian)—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 7).

Lecturer, Grade B (with a good honours degree of a British university, and preferably teaching experience) in Mathematics—Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (May 11).

Assistant Experimental Officer (with a degree in botany or an allied biological science) in the Department of Plant Breeding to assist with cytological studies of horticultural crops—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (May 12).

Head (with high academic qualifications in engineering with industrial, and, preferably, research experience, and capable of directing the teaching and administration of a large and expanding department) of the Department of Civil, Mechanical and Marine Engineering, City College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool (May 12).

Scientific Officer or Senior Scientific Officer (with a first- or second-class honours degree or equivalent in statistics or mathematics, and experience in design and analysis of scientific investigations, and preferably with some knowledge of forestry or other biological subject) at the Forestry Commission Research Station, near Farnham, Surrey, for statistical work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.127/6A (May 12).

Fellow in the Department of Particle Physics to assist in the completion, operation and experimental use of a 10-BeV. proton synchrotron—The Registrar, Australian National University, Box 4, G.P.O., Canberra, A.C.T., Australia (May 14).

Assistant Lecturer in Statistics—The Registrar, The University, Hull (May 15).

Lecturer in Zoology—The Secretary, The University, 38 North Bailey, Durham (May 15).

Lecturer (preferably with a qualification in physical organic chemistry, and an interest in infra-red spectroscopy) in Organic Chemistry, at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 15).

Field Pedologist (with a university honours degree in science or agricultural science, preferably with postgraduate research experience), at the headquarters of the Division of Soils, Commonwealth Scientific and Industrial Research Organization, Adelaide, to undertake surveys and field studies of Australian soils—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 270/129 (May 19).

Lecturer in Technical Mathematics—The Assistant Secretary, The University, Edinburgh (May 19).

Lecturer (preferably with a veterinary qualification) in the Department of Veterinary Physiology—The Assistant Secretary, The University, Edinburgh (May 19).

Lecturer (preferably with some knowledge of microwave techniques) in Electrical Engineering—The Registrar, The University, Sheffield (May 19).

Research Biochemist in the Regional Pastoral Laboratories, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Armidale, N.S.W., Australia, to conduct a series of investigations into biochemical aspects of the soil–plant–animal relationship with particular reference to sulphur metabolism, as part of a general programme concerned with the utilization and management of native and sown pastures—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 208/83 (May 19).

Electrical Engineer or Physicist (with a first- or second-class honours degree or equivalent in electrical engineering or physics, and preferably with a good physics and electronics background) at an Air Ministry Experimental Establishment in Norfolk, for the development of airborne radio receiving and transmitting equipments and their associated aerial systems operating mainly on centimetric wave-lengths—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.134/6A (May 21).

Research Fellow in the Department of Mathematical Physics—The Registrar, The University, Birmingham 15 (May 22).

Lecturer (Grade II) or Assistant Lecturer (Grade III) in Botany—The Registrar, The University, Birmingham 15 (May 26).

Research Fellows (3) (with a good honours degree in physics, mechanical or chemical engineering) in the Department of Textile Industries—The Registrar, The University, Leeds 2 (May 28).

Lecturer (with special experience in virus diseases) in Microbiology—The Secretary, Queen's University, Belfast (May 30).

Assistant Lecturer in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (May 31).

Astronomer Royal for Scotland and Professor of Astronomy in the University of Edinburgh—The Private Secretary to the Secretary of State, St. Andrew's House, Edinburgh 1 (May 31).

Botanist (Assistant Experimental Officer grade) for developmental and anatomical studies of fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (May 31).

Lecturer in Industrial Metallurgy—The Registrar, The University, Birmingham (June 1).

Steetley Research Fellow (graduate, or student graduating this year, of any British university), for research in refractories technology—The Registrar, The University, Sheffield (June 12).

Senior Lecturer (specialized in some branch of pure mathematics, applied mathematics, or mathematical statistics) in Mathematics, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 15).

Assistant Chemist (with a degree in chemistry or agricultural chemistry or A.R.I.C.), for analytical work on crops and soils; and a Horticulturalist or Chemist (with a degree in horticulture or chemistry), for glasshouse work on soils and crop nutrition—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 103.

Assistant Conservators of Forests in the Local Civil Service, Gold Coast Government—The Secretary for Recruitment, Gold Coast Office, 13 Belgrave Square, London, S.W.1.

Assistant, Grade A, to teach Pure and Applied Mathematics—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant or Associate Professor in the Department of Physics—J. H. L. Johnstone, Department of Physics, Dalhousie University, Halifax, N.S., Canada.

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, and postgraduate research experience), to assist in the study of certain physico-chemical properties of mucin—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/3.

Chemists, Grade III (with an honours degree in chemistry or chemical engineering, or A.R.I.C. or A.M.I.Chem.E., or equivalent qualifications) with the Ministry of Supply at Chorley, Lancs, to assist in process study, chemical engineering, design and experimental work on new process plant of unusual nature—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.238/6A.

Lecturer in Agriculture, and an Assistant Lecturer in Dairying—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon.

Lecturer or Assistant Professor in the Department of Mathematics, Joint Faculty of Arts and Science at Dalhousie and King's Universities—Dean of Arts and Science, Dalhousie University, Halifax, Nova Scotia.

Lecturer (with good graduate qualifications in physics, with industrial and/or teaching experience, and preferably research experience) in the Department of Physics, City College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

Lecturers (2) (with research interest in applied mathematics or statistics) in Mathematics—The Secretary, Royal Technical College, Glasgow.

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Physicist (graduate, with a knowledge of mass spectrometry and its associated vacuum techniques, and modern electronic circuitry) in the Biophysics Department of the Postgraduate Medical School (University of London), to continue the development and application of a mass spectrometer for rapid and continuous analyses of gas blends in respiratory research—The Dean, Postgraduate Medical School of London, Ducane Road, London, W.12.

Research Scholars (with graduate or equivalent qualifications) in the Department of Chemistry, Colour Chemistry and Dyeing and/or other Departments—The Principal, Technical College, Queen Street South, Huddersfield.

Scientific Officer (Entomologist) to work on insecticides derived from plants; and Experimental Officers (male or female, with a knowledge of zoology, and preferably chemistry), one for histological and one for ecological work on the action of insecticides—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

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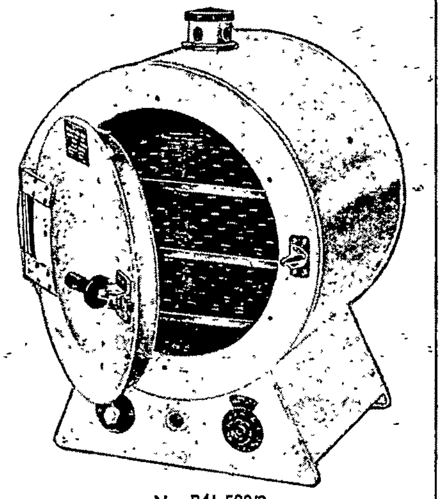

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A Course of six Almroth Wright Lectures has been arranged for the Summer Session, 1956. These Lectures will be given on the following dates in the Lecture Theatre of this Institute at 5 p m Tuesday, May 8, Professor L Pillemer (Western Reserve University, Cleveland, Ohio, U S A), "The Nature of the Properdin System"; Tuesday, May 15, Dr. W E. van Heyningen (Sir William Dunn School of Pathology, University of Oxford), "Recent Trends in Research on Bacterial Toxins"; Tuesday, May 22, Professor F W. Rogers Brambell (Department of Zoology, University College of North Wales, Bangor), "Transmission of Passive Immunity"; Tuesday, May 29, Dr R. E O. Williams (Central Public Health Laboratory, Colindale, N W 9), "The Numbers and Significance of Bacteria in Air", Tuesday, June 5, Professor C. H Stuart-Harris (University Department of Medicine, Sheffield), "Recent Studies in Acute Respiratory Disease"; Tuesday, June 12, Professor R. Hare (Bacteriology Department, St. Thomas's Hospital), "The Transmission of Infections of the Respiratory Tract"

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JAMES HENDERSON,
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ROBT T. HUTCHESON,
Secretary of the University Court

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STANLEY DUMBELL
Registrar.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer in Mathematics. Candidates should have special qualifications in applied mathematics an interest in fluid dynamics will be an advantage. Salary scale £650 to £1,350 per annum with membership of F S S.U. and Children's Allowance Scheme Initial salary according to qualifications and experience.

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THERE WILL BE A VACANCY IN THE Department of Mathematics in the Joint Faculty of Arts and Science at Dalhousie and King's Universities this September The position will be that of Lecturer (salary $3,000 to $4,000) or Assistant Professor ($4,000 to $5,000) depending on qualifications There is a good possibility of the position being permanent after two years. The work will probably involve teaching three undergraduate classes and one advanced class, three times each week from late September to late April.—Further information can be obtained from and all applications should be made to Dean of Arts and Science, Dalhousie University, Halifax, Nova Scotia.

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G. L. BARNES,
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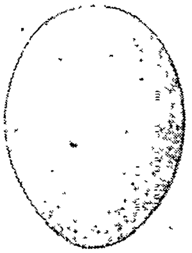

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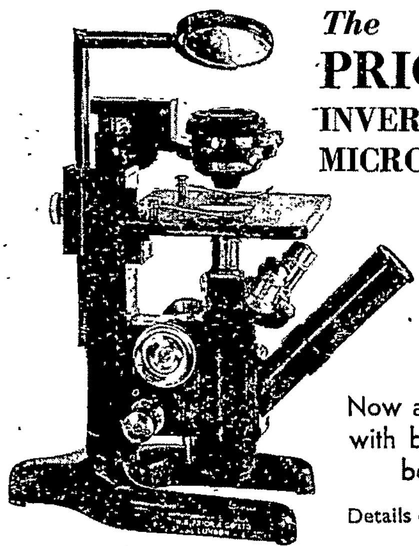

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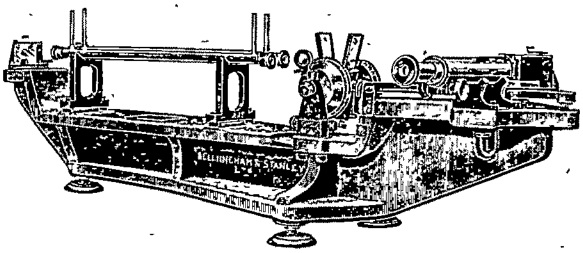

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CONTROL OF GOVERNMENT RESEARCH IN BRITAIN

THE Department of Scientific and Industrial Research Bill*, which received its third reading in the House of Lords on April 17, is the outcome of a report of a committee of inquiry into the organization and functioning of the Department in the light of recent developments in science and industry which he had set up last year under the chairmanship of Sir Harry Jephcott. Besides Sir Hugh Beaver, the present chairman of the Advisory Council for Scientific and Industrial Research, its members included Sir Alexander Todd, chairman of the Advisory Council on Scientific Policy, the Deputy Secretary to the Board of Trade and the Third Secretary to the Treasury. The interim report of this Committee† has been published, but the final report, containing detailed suggestions regarding the internal organization of the Department, is not to be published.

The Committee's investigations led it to the firm conclusion that the organization of an ordinary government department is unsuited to the research activities of the Department of Scientific and Industrial Research, and that, under the present organization, the central direction of the scientific effort at the various research stations, taken as a whole, is inevitably inadequate to secure the most effective use of resources in the national interest. Allocations of man-power and money are determined by headquarters, but headquarters does not and cannot exercise an effective supervision over priorities in the programmes or even the balance between them. Much is started, but not enough is stopped and, as a result, many of the programmes have become too diffuse or too uneven in quality.

The latest report of the Department (see *Nature*, April 28, p. 821) shows that the Advisory Council is well aware both of the importance of discontinuing programmes and also of dropping work which the Department is only able to pursue on a trivial scale compared with what is being done elsewhere. Neither the Advisory Council, in commenting on this point, nor the Jephcott Committee points out, however, that the decision when to discontinue a programme is the most difficult that confronts a director of research. It is, in fact, difficult even for those engaged in the research to judge how near to success or how far from it a programme may be at a particular moment; and from that point of view it is almost impossible for those not in direct contact with an investigation to make a sound decision whether to continue or to stop the work.

The imminence or not of success is not the only consideration. Factors quite unrelated to the programme itself may make the success of the investigation a matter of far less interest to the country than when it was started, while new and more urgent matters demanding investigation may have arisen. It should not be assumed that even the director of a particular research station, however authoritative and distinguished in his own field, is necessarily aware of all such changing circumstances, and the Jephcott Committee may well have over-estimated the part of organization when it lays the whole responsibility for the present position on organization. The Committee recognizes rightly that no one scientist, however distinguished, in the capacity of secretary, could be expected to exercise a tighter control. Ministerial control, it emphasizes, is rightly and necessarily light; but it appears to attach too much importance to the fact that the Advisory Council is only advisory and, though it can have general influence, does not control the programmes.

The Jephcott Committee believes that the better direction of the Department's research activities which is needed can only be obtained effectively by introducing into the chain of responsibility, as high as may be, a number of distinguished scientists and industrialists whose professional authority will be recognized by all concerned, and particularly by the directors. Accordingly, its principal recommendation is that, in place of the Advisory Council, there should be created an executive council on the model of the Medical Research Council and the Agricultural Research Council. The Committee suggests that it will be easier to get men of the high quality required to give the time and attention that will be needed if they have a full responsibility to the Minister for the Department's activities and are not merely asked for advice.

The chairman of the proposed Council would not have powers of his own; decisions would be decisions of the Council. Its members would be part-time and not Civil servants, though it is anticipated that at the start the chairman would have to give a great deal of his time to the task. The secretary would be the chief executive of the Council and responsible for the conduct and activities of the staff of the Department. The Council, it is suggested, should not be too large and it would act largely through committees, recommendations regarding which were reserved for the second report. These committees would examine the programmes of the stations with the directors; and the Council would approve the programmes of the committees, confining itself normally to general questions of policy and the balance of activities within the Department, apart from points to which the relevant committee directs its attention or on which the relevant committee and the director are not agreed. While, as already indicated, the Committee does not consider a Vote-accounting department staffed by Civil servants to be the right organization for a research agency, it makes no recommendation on this point, and it is equally silent on the quinquennial principle, in spite of its bearing on the effectiveness of research as well as on the discontinuance of projects.

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* Department of Scientific and Industrial Research Bill (H.L.). Pp ii+4. (London: H.M. Stationery Office, 1956.) 6*d*. net.

† Department of Scientific and Industrial Research. Report of a Committee of Enquiry. Pp. 4. (Cmd. 9734.) (London: H.M. Stationery Office, 1956.) 4*d* net.

The Bill now before Parliament is based on the principal recommendation of the Jephcott Committee and proposes to place the Department of Scientific and Industrial Research under a research council, the members of which will be appointed by the Lord President of the Council after consultation with the President of the Royal Society. The research council will be required to comply with directions given by the Committee of the Privy Council of Scientific and Industrial Research. Lord Salisbury said that, though the appointment of the members of the research council and of its secretary would be in the hands of the Lord President of the Council, he was sure that the Lord President would continue in the future, as in the past, to consult the Royal Society before making the latter appointment. He also added that he understood that the Royal Society was in agreement with the proposals in the Bill, and that it was the Government's intention to retain the present relation between the Royal Society and the National Physical Laboratory, subject to discussion with the Royal Society of any changes of detail in these arrangements which may seem necessary from time to time.

Neither in the interim report of the Jephcott Committee nor in Lord Salisbury's speech in introducing the Bill was any evidence advanced in support of the view that an executive council would be more effective than an advisory council in directing the work of the Department, or in securing the discontinuance of programmes no longer of public expediency where the relevant director had failed to stop the work. Lord Salisbury, moreover, emphasized that there was nothing radically wrong with the present Department, which has done and is doing extremely valuable work, and he paid a warm tribute to the work of Sir Ben Lockspeiser as secretary and to those who had served as members of the Advisory Council and its committees, pointing out that it was intended that the future research council should be recruited from the same type of eminent leaders of science and industry as had served in the past on the Advisory Council.

In the debate, Lord Wilmot of Selmeston, while agreeing that a full report of this character could not very well be made public, asked for more information about the contents of the report. He was disturbed that the Jephcott Committee made no recommendation about the organization of the Department, although it did not consider that a Vote-accounting department staffed by Civil servants would be the right organization for a research agency. He also pointed out that the Department of Scientific and Industrial Research is only a fragment of the Government's research effort, and asked for more information about the whole layout of Government expenditure in money and staff and about the Government's use of all scientific man-power. Asking how much was being spent by the Government on scientific research generally, he suggested that, before the Committee stage of the Bill, the Government should provide a comprehensive statement showing the total expenditure on scientific research and its broad distribution. Without information of this character, he pointed out, we cannot judge whether we are making the best use of our scientific man-power.

Referring to the request for information as to Government expenditure on research, Lord Salisbury reminded Lord Wilmot of the annual reports of the Advisory Council on Scientific Policy. While, however, the eighth report of that Council summarized in an appendix Government expenditure on civil research and gave some details of the scientific staff working under the research councils, it does not meet a number of points on which Lord Wilmot asked for information. No account is taken of expenditure by the Atomic Energy Authority, the Ministry of Supply and the Admiralty; the nationalized industries are likewise not covered, nor are we given any information as to expenditure on private research contracts, for example, by the public departments to aircraft firms or about research projects in other industries financed by the Government under the heading of development and research. Nor is there any estimate as to the proportion of £34 million that the University Grants Committee distributes to the universities and university colleges which is expended on research.

Without such information, however, it is impossible to judge the soundness of the criticism of the administration of the Department of Scientific and Industrial Research made by the Jephcott Committee, or the appropriateness of the place the Department holds in the national organization for research. All that can be said is that no evidence is forthcoming in either the Department's last annual report or in the interim report of the Committee to substantiate those criticisms, or to justify the belief that an executive council is likely to be more effective than an advisory body in securing the wise expenditure of the Department's vote. In the House of Lords debate, Lord Wilmot asked some of the right questions; but neither Parliament nor the world of science or technology has yet been given the information essential for a sound judgment as to the validity of the Committee's criticisms or the effectiveness of the administrative changes proposed.

At the Committee stage on April 17, Lord Cherwell expressed anxiety that the new council might not give enough attention to scientific research, and particularly to its support at the universities. Lord Salisbury affirmed that there is no intention of withdrawing such support or of limiting the powers of the Department to encourage and support scientific research in the universities. While agreeing to consider further Lord Cherwell's points, he said that under Sub-section (4) of Clause 1 the Department would possess powers to make grants for postgraduate instruction in science and technology, which it did not previously enjoy. At the third reading, on April 19, Lord Cherwell agreed that the amended clause made it abundantly clear that scientific research in the universities as well as industrial research will be supported.

Little was said in the House of Lords about the second main purpose of the Bill, to which effect is given in Clause 3. This, as Lord Salisbury explained, arose out of a technical point raised by the Public Accounts Committee, and, while it means no change in the present arrangements for the Parliamentary control of the finances of the Department of Scientific and Industrial Research, provides that the Department's expenditure shall be met out of monies provided by Parliament. There is, however, no reference to making grants on a quinquennial system, and this aspect should be probed rather more fully in the House of Commons than was done in the House of Lords. It is unsound to insist on retaining close Parliamentary control if, in fact, that tends to lead to waste of resources of either finance or of man-power.

The most surprising aspect of the whole situation is that the Bill should have been introduced without any reference to the Advisory Council on Scientific Policy. There was no suggestion in the last annual report from that Council that any change in the administration of the Department of Scientific and Industrial Research was contemplated or required. Indeed, the reference in that report to the discontinuance of seaweed research suggests that the existing structure provides for the discontinuance of broad lines of research when appropriate, even if not necessarily to the full extent that is desirable. It may well be time for the whole structure and organization of the Department of Scientific and Industrial Research to be reviewed; but that can only usefully be done if the organization of the research effort in Britain as a whole is also considered. Such a review will necessarily include the place of the Advisory Council on Scientific Policy and the position of the Lord President of the Council in the co-ordination and administration of the country's research effort in defence as well as in civil affairs. Now that the matter has been raised, men of science as well as Parliament should insist on being given the information essential for sound criticism and reasoned judgment as to the proposals before Parliament and all their implications.

EPIGENETICS

Principles of Embryology

By Prof. C. H. Waddington. Pp. x+510. (London: George Allen and Unwin, Ltd., 1956.) 45s. net.

In his first chapter, Prof. Waddington suggests 'Epigenetics' as "perhaps the most satisfactory expression" to denote the analytical study of development. In spite of this, he has stuck to 'Embryology' in his title, though he makes it plain that no line can properly be drawn between embryonic and post-embryonic development, between early and late stages of ontogeny. However, a good title provides a banner under which a new scientific movement can advance (witness 'gene' and 'genetics' in the study of heredity). Accordingly, *I* am going to have the courage of *his* convictions: I shall use 'Epigenetics' as meaning the science of developmental process in general, and hope that others will do the same.

Though separate aspects of epigenetics have been treated in various recent books, including the huge composite work, "Analysis of Development", edited by Willier, Weiss and Hamburger, the "Principles of Embryology" is, so far as I know, the first comprehensive and unitary work on the subject since 1934, when de Beer and I published "The Elements of Experimental Embryology".

Knowing by experience the immense amount of labour, both compilatory and critical, that is involved in any such enterprise, my first and agreeable duty, on behalf of all general biologists, is to thank Prof. Waddington for having undertaken the task, and to congratulate him on the result.

Part 1 is entitled "The Facts of Development". It gives a descriptive-analytical treatment of early development in some selected groups of animals (with a natural emphasis on vertebrates, but including summaries of echinoderm, chordate and insect epigenetics) and chapters on growth and regeneration. Throughout, the treatment is centred around the general concepts which are emerging from analysis on the epigenetic level, such as organizer action, induction, evocation, competence, individuation, gradient-fields, and canalized epigenetic pathways.

Part 2 deals with "The Fundamental Mechanisms of Development". Most of it is concerned with a new angle of approach—a general analysis of the relations between genetics and epigenetics, between genes and their effects. Waddington attacks the problem from both ends, on one hand working upwards to trace the biochemical and other effects of particular genes or gene-complexes, on the other digging down from phenotypic effects in an attempt to uncover their genetic basis. This leads on, via phenocopies, to the subject of developmental reactivity, to which (and to its evolutionary implications) the author has made so original a contribution. There is no one else now alive who is equipped both as a geneticist and an embryologist to undertake this task: in the result he has taken an important step forward in epigenetic theory, and is charting a large new area for further research.

I will say no more about the work's positive achievements, beyond the fact that it will clearly be indispensable not only for embryologists and *Entwicklungsmechaniker*, but also for all general biologists. My critical comments, indeed, are a tribute to its value in stimulating trains of thought, some of which I hope may be useful in suggesting improvements in the further editions that I am sure will be speedily called for.

My most general comment is that, though Waddington has done so much to link epigenetics with genetics, he has not proceeded to make the further link with evolution. This in my view can only be done by recognizing the pseudo-teleological, or as I would prefer to say, the *telic* character of all evolutionary processes and resultants. By telic I mean that, thanks to the operation of natural selection, such processes can only be adequately specified in terms of final states or ends as well as of origins or beginnings, of biological utility or function as well as of underlying mechanism or mode of operation. Thus, though analysis of epigenetic process in terms of physico-chemical factors is essential, it will never be sufficient, and knowledge of origin needs to be supplemented by knowledge of final fate (for example, in the axial skeleton). Recognition of this makes many facts of epigenetics more comprehensible (as well as often indicating further lines of research)—for example, the evolution of dominance, the greater stability of wild-type as against mutant characters, and (what Waddington rightly stresses) the canalization of developmental processes into a limited number of "epigenetic paths", each showing considerable powers of self-regulation or homeostasis. The limits of such paths or patterns of process must have been set by rigorous selection; for a process which led to an abnormal or imperfect organ or tissue, or still more to one intermediate between two different kinds of organ or tissue, would be promptly selected out of existence. That such telic pathways must have been built up by selection during evolutionary time is demonstrated by their frequent destruction by hybridization. Wide crosses in *Antirrhinum* lead to many abnormal organs, in *Nicotiana* to tumorous growths, and in some fish crosses to malignant melanomas. In the course of genetic recombination, the telic patterns have been taken to pieces.

Such an approach would, I think, have made a difference to Waddington's discussion of 'competence'. For him competence is "a state of unstable equilibrium", and competent tissues are those which are balanced on a knife-edge between two or more alternative and distinct modes of differentiation: for example, early ectoderm can form either epidermis or neural tissue according to the evocatory stimuli which act on it. To begin with, it would appear that such tissues should be called bicompetent (or multicompetent) and that 'competence' should be generalized so as to include also unicompetence or the capacity to proceed only along one epigenetic pathway. Furthermore, the metaphor of unstable equilibrium is unsatisfactory: bicompetence is best assimilated to those numerous epigenetic phenomena where a switch-mechanism is operative. In such cases, alternative causes or stimuli switch development into alternative pathways, each of which has been sharply delimited or homœostasized (stabilized) by past selection. As with a railway switch, there need be no instability, whether on the single pathway before reaching the switch, or on either of the alternative tracks along which the process may continue.

It is indeed rather surprising that Waddington has not paid more attention to switch-mechanisms such as alternative sex-determination and mimetic polymorphism. In these the relation between genetics and epigenetics, as well as the telic need for sharply defined alternative pathways, is particularly evident: neither intersexes nor inaccurate mimics are of any biological utility, though both can be produced by genetic manipulation of the switch-mechanism.

A chapter devoted to metamorphosis, especially in amphibia, would have been well worth including, primarily as an example of hormone-dependent processes in development. It could also have illustrated the important point that, in a developmental reaction, variations in the capacities (or competence) of the reacting tissues may be more important than those in the properties of the evocating agent. Thus in amphibian metamorphosis the limbs and tail react to thyroxin quite differently in Anura and in Urodela, while in Perennibranchiates no tissues are competent to react to thyroxin at all. In addition, of course, the supply of thyroxin may be quantitatively altered, even to abolition as in some Perennibranchiates, or its time-relations changed, as in the neotenous axolotl. The comparison of anuran and urodele metamorphosis illuminates the evolution and epigenetics of specialized larval forms, and the effects of temperature have a general importance for endocrinology.

A chapter on sexual bicompetence, if space had permitted, would also have been valuable. In metamorphosis, two alternative end-states succeed each other in time: in sexual differentiation, they are contemporaneous. Furthermore, in insects there is only a single (genetic) switch-mechanism for the development of sex-limited characters: in vertebrates, a primary genetic switch leads on towards a later endocrine switch-mechanism.

In some cases the switch is operated environmentally, for example, in the sex-determination of *Bonellia* and in the differentiation of the alternative types of leaf (aerial and aquatic) in *Ranunculus aquatilis*.

A subject which would have repaid further analysis is reconstitution after cellular dissociation, as in sponges (where the morphogenetic effects of cellular orientation and migration are well exemplified). Another is the morphogenetic effect of mechanical stress, as evidenced by the fine structure of bone and by Weiss's beautiful experiments on the response of fibroblasts to tension. Yet another is that of dedifferentiation followed by resorption, which brings out clearly the existence of a physiological balance between organ-systems: thus in unfavourable conditions the larval tissues of an *Echinus* larva start to dedifferentiate, and are finally resorbed and utilized by the *Echinus* rudiment, which accomplishes a premature metamorphosis. Resorption may also be initiated by radical degeneration of tissue instead of by a mere tilting of physiological balance. Such tissues exhibit a specific competence for 'degeneration-proneness' in response to particular evocators: the best-analysed case is that of the resorption of tadpole skin in contact with degenerating gills. The analysis of tail-resorption in anuran metamorphosis deserves further investigation, as does the fact that whenever ectoderm and endoderm become apposed in early vertebrate development, perforation occurs (resulting in the formation of mouth, gill-clefts and anus).

More might have been made of the three different types of cellular dedifferentiation. We have first what Waddington calls true dedifferentiation, or one might say dedetermination, in which cells lose their determination and revert to a pluripotent state, as in some regenerative blastemas. Then there is hypoplastic dedifferentiation, the loss of visible differentiation only, which accompanies rapid multiplication, as in tissue culture or in tumours*; and finally there is anabiotic dedifferentiation, or passage into a resistant and inactive state, as in protozoan cysts or the cold-resistant cells found in some deep-frozen tumour tissues. Perhaps more attention might have been given to the determination of polarity, notably to the rare but interesting cases in which primary (antero-posterior) polarity is determined environmentally, as in *Fucus* eggs. In general, plants might have been drawn on to a considerably greater extent for illustrative examples.

In the valuable discussion of developmental gradient-fields, more stress might have been laid on their *Gestalt* character, notably the fact that their pattern is only deformable as a whole. Thus even when a large local change occurs in a growth-gradient, as when one sex evolves an unusually large organ (chela, abdomen, or the like) it affects the growth-rate of neighbouring organs in an orderly (though as yet quite unexplained) way: similarly in regenerating flatworms, depressants alter the size and form of the morphogenetic gradient-field as a whole. Curiously enough, no mention is made of the continuous gradients revealed by the growth of molluscan shells or of localized areas of excessive proliferation (as in rhinoceros horns), or of the change from positive to negative allometry, with consequent deformation of the whole growth-gradient, during evolution as in the antlers of roe-deer, or during ontogeny as in the limbs of ungulates.

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* *Anaplastic* would be a better term, but unfortunately anaplasia has been pre-empted by oncologists to denote total loss of histological differentiation, and usually with the implication of regression to an embryonic pluripotent state.

There is no mention of Witschi's demonstration that moderate delay of fertilization in Anura deviates the sex-determining mechanism, while greater delay upsets the growth-balance and leads to tumorous proliferation. Indeed, the chapter on growth could profitably have included a section on abnormal and cancerous growth.

I realize that reasons of space must have precluded the inclusion of many of these subjects. However, I hope that in any future revision the size and scope of the work will be enlarged to permit their inclusion.

The discussion of embryonic induction is, as one would expect, both thorough and illuminating. But it left me wondering whether it, or at least its terminology, was not somewhat bedevilled by the history of the subject. Should not the term 'organizer' now be dropped? Again, should not 'evocation' and 'competence' be assimilated to comparable phenomena in other stages of developmental physiology? Is there, for example, any essential difference between the 'induction' of neural tissue by the evocator of the blastopore lip and the 'modulation' of the basal layer of the epidermis into mucous epithelium by vitamin A, or the development of the sexual apparatus of the two sexes under the influence of the appropriate sex-hormones? Here, as in many other places, epigenetics is entering new domains. For example, the facts concerning viruses, plasmagenes, and transduction (admirably though rather briefly discussed by Waddington), together with the proof recently given by Medawar and his associates that many tissues are constantly discharging nucleoprotein particles into the circulation, are opening up wholly new vistas of genetic and epigenetic interaction.

Let me conclude by again expressing my gratitude to Prof. Waddington for this valuable and stimulating book, and my hope that he will in the not too distant future supersede it by a new and even more comprehensive work on the "Principles of Epigenetics".

JULIAN HUXLEY

PRIMEVAL MICROBES

Biochemistry of Autotrophic Bacteria

By Dr. Howard Lees. Pp. viii + 112. (London: Butterworths Scientific Publications, 1955.) 21*s*.

THE autotrophic bacteria may be considered as survivors of the first living organisms to appear on Earth; like the green plants they assimilate carbon dioxide, but they show great variation in the mechanism of assimilation, which perhaps indicates that they are trial pieces in the evolution of more efficient and successful types of metabolism than they themselves possess. Some use light as a source of energy; others, lacking pigment, use the oxidation of a specific inorganic compound. Other species oxidize organic compounds for energy, but cannot assimilate them; and finally there are species which normally are heterotrophic, but can carry out certain autotrophic reactions.

The autotrophic bacteria, however, are important not merely as picturesque survivors, or for studies in comparative biochemistry. They have great practical importance. Without the nitrates made by autotrophic nitrifying bacteria, farming would be impossible; and other autotrophs produce sulphur, and purify the air by assimilating carbon monoxide. On the debit side are the activities of species which cause stone and concrete to decay, corrode buried iron pipes, and produce hydrogen sulphide in standing water, and even sometimes in the sea.

Dr. Howard Lees has now written a short book on the biochemistry of these bacteria, in which most of the available knowledge is collected from very scattered sources. It covers the field very well, and the varieties of metabolism are lucidly explained. He is more interested in the philosophical than the practical aspects of the subject, and writes on evolution with far more conviction than on ecology. There are some faults of style, notably a fondness for words like 'overall' and 'subsume'. Careless proof-reading must account for the appearance of 'oxidized' in one place where 'reduced' is obviously meant, for the curious double plural 'flagellæ' which has crept in on p. 35, and for the explanation of the Calvin cycle in the appendix, which is a year out of date though the diagram is contemporary.

JANE MEIKLEJOHN

AUXINS AND PLANT GROWTH

Auxins and Plant Growth

By Prof. A. Carl Leopold. Pp. xi + 354. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 37*s*. 6*d*. net.

AS the title indicates, this book is concerned only with auxins, namely, β-indolylacetic acid and the many compounds (natural and synthetic) which are related to it chemically and which exert the same remarkable growth-controlling actions in green plants. Prof. A. C. Leopold introduces the reader to his book by expressing alarm at the widespread lack of knowledge of the fundamentals of auxin physiology among research workers concerned with the uses of these compounds in agriculture, and the book is intended to alleviate this unfortunate state of affairs. Prof. Leopold has attacked the problem with vigour and has succeeded in laying before the reader the auxin situation in all its puzzling complexity.

The book falls naturally into two parts. The first half (eight chapters) deals with the fundamentals of the action of auxins and includes their chemical nature, occurrence, metabolism and biochemical mechanisms, the whole being preceded by a clear, if somewhat limited, historical introduction. A chapter on extraction and measurement techniques should form a useful basis for practical exercises by the student. Two chapters are devoted to physiological, anatomical and developmental effects, and a balanced, though restricted, picture emerges of the many parts natural auxin may play in plants. The second half (ten chapters) is concerned with auxins in agriculture and deals in a logical and comprehensive way with the many uses to which these remarkable compounds have been put. As one would expect from the title, no attention is given to the host of 'growth-regulators' not related to auxins, except the few (for example, maleic hydrazide, ethylene, etc.) that are suspected of interfering with natural auxin action. The main aspects dealt with in detail are rooting, flower and fruit production, dormancy and storage, and weed-killers. A miscellany of 'incidental' uses is also included. Much fundamental physiology has, of necessity, been introduced into these chapters on practical applications, and this has led to repetitions and overlaps with sections in the first half. It is a pity that, in a book intending to bring practice into closer contact with theory, such a divorce should have been thought necessary.

The book is illustrated with a great profusion of simple graphs re-drawn from original research articles. The majority are well and aptly chosen and serve, as indeed should all scientific illustrations, to clarify the text and avoid much tedious description. Here and there, however, the author's enthusiasm gets a little out of hand, and figures of such simplicity appear that it is difficult to see what purpose they serve. Fig. 68, in which three graphs are drawn through six 'arbitrary' points, is perhaps the worst example. I find the literary style occasionally a little disconcerting; for example, the obscurity of the sentence: "Enzymology readily recognizes the inhibition of reactions by compounds of slightly different properties from those of true substrates" (p. 165).

The book ends with a guess at the future and a warning of the dangers of promoting technology at the expense of fundamental research. The warning is indeed timely, and it is to be hoped, therefore, that Prof. Leopold's book will be widely read. The format and binding are excellent. There is an extensive bibliography of some eight hundred references, the majority of which are from American journals.

L. J. AUDUS

PREPARING ENZYMES

Methods in Enzymology

Edited by Sidney P. Colowick and Nathan O. Kaplan. Vol. 1: Preparation and Assay of Enzymes. Pp. xxv+835. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 18 dollars.

THOSE actively engaged in the field of enzymology have long felt the need for an authoritative text-book dealing with the isolation and assay of enzymes. The theory and kinetics of enzyme action have been the subject of many recent books and symposia, but a work which gives adequate practical details for the preparation of many common enzymes has not been forthcoming. Such a series is being prepared under the editorship of Drs. S. P. Colowick and N. O. Kaplan, of Johns Hopkins University, and this is the first of four volumes.

In their preface to the series, the editors state that this series should serve as a companion piece for Sumner and Myrbäck's classical work, "The Enzymes", and the present volume gives every indication of this claim being justified. There are more than a hundred and twenty articles contributed by nearly the same number of recognized experts in the enzyme field. The volume is divided into four sections, the first dealing with general preparative procedures. This is eminently readable without being too theoretical in its approach, and should serve as a useful technical basis for the investigation of new enzyme systems. The articles dealing with the variety and applicability of methods of purification are, on the whole, well written and serve to illustrate the advances that have been made in technique during recent years.

The last three sections are concerned with the specific enzymes of carbohydrate metabolism, lipid metabolism and the citric acid cycle. A method for the isolation and assay of each enzyme is given in detail, together with information, where available, concerning optimum conditions, specificity, activators, inhibitors and other data of particular use to the growing number of those who wish to use enzymes as tools in their investigations. The section on carbohydrate-metabolizing enzymes is reasonably well covered, the emphasis, however, being rather on the side of those occurring in animals and micro-organisms. In particular, although plant phosphorylases and amylases are treated at length, other equally well-characterized enzymes concerned in the synthesis and breakdown of starch in higher plants are neglected. Thus some mention was to be expected of the plant branching-enzyme, *Q*-enzyme, which has been obtained in crystalline form. The section on lipid metabolism also has good general coverage, and the section dealing with enzymes of the citric acid cycle is both adequate and up to date. Compared with these two sections, the section on carbohydrate metabolism is rather large and unwieldy and might conveniently have been subdivided.

There is an occasional reference to trade products and equipment by name without further definition and with little reference to working details. In certain cases this has an adverse effect on intelligibility for the non-American reader. Nevertheless, this volume is well worth having in any laboratory where enzymes are studied or used. The system of cross-references and the bibliography, which includes references up to 1953, are adequate and help to ease the burden of searching through the literature.

J. R. TURVEY

DAIRY SCIENCE AND PRACTICE

A Dictionary of Dairying

By Dr. J. G. Davis. Second edition, revised and enlarged. Pp. xxviii+1132+132 plates. (London: Leonard Hill, Ltd., 1955.) 65*s*. net.

THE author of this most useful reference book, a well-known dairying consultant, has evidently been in somewhat of a quandary to find an appropriate title. "Dictionary" is a trifle misleading. Though "Encyclopædia" would probably have been too grandiloquent, the approach of the author is that of an encyclopædist rather than that of a lexicographer. He seems, too, to have been a little diffident in defining what is meant by 'dairying', a word with different connotations for different authorities dealing with the underlying science and its practical application. The precise definition which I had hoped to find is, in fact, not given in the text; on the other hand, if dairying does need an up-to-date definition, then the ground covered by this volume can reasonably be regarded as providing a sufficient one.

It is clear that the author is firmly of the opinion that dairy science and dairying cannot be interrupted by the accident of the farm gate—their scope, in fact, covers everything that happens from (and including) the farm production of milk, through its various types of processing for consumption as liquid milk or its manufacture into dairy products, up to its consumption in one form or another. This is a view with which most of those concerned with dairy science or practice would agree, not least because so many of the problems of milk processing and manufacture are bound up with the efficiency or lack of efficiency of dairy farm management and milking technique.

The scientific disciplines and the technological skills—agricultural, physiological and veterinary, bacteriological and biochemical, engineering and physical—needed to-day to deal with the problems and practice of dairying on both sides of the farm gate cover tremendously wide fields, as is so clearly evident from even a cursory glance at this 1,100-page volume. Nor does the author omit substantial reference to the fact—which is perhaps likely to be forgotten in peace-time—that milk and milk products are still the most valuable, from the point of view of human nutrition, of all our common foodstuffs.

In compiling this work, the author, though himself responsible for large, well-informed and well-written sections of it, has received the contributions of a number of specialists in particular fields. To name two such contributions only, there is an excellent epitome of modern knowledge of milk secretion by A. T. Cowie, and a chapter on legal aspects by A. L. Barton and P. O'Neill which is a model of concise and accurate statement of milk legislation in Britain. But in these two contributions, as in so many others dealing with the changing aspects of dairying, periodical revision is essential, and it is to be hoped that the author will find time to shoulder this heavy task at, say, five-year intervals.

To be without ready access to this excellent compilation is a mistake which few in any consultative, scientific, technological or managerial position in the dairy industry, and which no student of dairy science or practice, can afford to make. H. D. Kay

RECENT ADVANCES IN STEREO-CHEMISTRY

Progress in Stereochemistry
Edited by Dr. W. Klyne. Vol. 1. (Progress Series.) Pp. x+378. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1954.) 50*s.* net.

FIFTY or sixty years ago the study of stereochemistry was almost entirely limited to attempts to discover the orientation of various groups of valency bonds around different atoms by methods analogous to those that had been used for showing that the four valencies of the carbon atoms are directed to the corners of a tetrahedron. However, even at that time, the subject was expanding, as is shown, for example, by Werner's interest in the changes in configuration that occurred at a cobalt atom when certain substitutions of one group by another took place.

Since that time stereochemistry has become important in all branches of chemistry. This is well illustrated by the most interesting book that is under review here, for contained in it are sections concerned with reaction kinetics, spectroscopic properties, the configuration of proteins, enzyme processes, as well as sections which derive more directly from the studies and ideas of Van t'Hoff and Werner.

The book is one in which a number of authors have contributed chapters each dealing with that part in which he is specially expert. As a consequence, the book is a collection of quite separate articles. The first of these, by A. D. Walsh, is concerned with the shapes of simple molecules and contains, besides a valuable discussion, an extremely useful and complete tabulation of data on bond angles. These are now known with increasing precision since microwave spectroscopy has been added to the methods used in their determination. The second chapter, by W. Klyne, who has also edited the book, deals with the conformation of six-membered ring systems and provides a most readable and interesting account of this subject. The long list of references at the end of this chapter shows the great interest that exists in it at the present time. The effect of stereochemical factors in chemical reactions is the subject of the next chapter, which is by P. B. D. de la Mare, a member of the group at University College, London, which has contributed so much to this part of the subject. R. S. Nyholm also deals with the stereochemistry of substitution reactions at complex ions in his chapter on complex compounds. Some relationships between stereochemistry and spectroscopy are examined in Chapter 4. Most of this chapter deals with absorption in the visible and ultra-violet, but there is a considerable section on vibrational infra-red spectra. There are three chapters concerned to a large extent with matters of biochemical interest. One deals with the configurations of large molecules and, in particular, of proteins, and another with the fascinating subject of the stereo-specificity of enzymes. There is also a chapter on the stereochemistry of the hydrogen bond.

The articles included in this book reach in general a very high standard. They will be interesting and useful to the specialist and also to the more general reader. The tables and graphs are well done and the lists of references at the end of each section are extensive and up to date. They add greatly to the value of this publication, which should be most enjoyable and stimulating to chemists at all stages of training and achievement. J. W. Linnett

NEUROCHEMISTRY

Neurochemistry
The Chemical Dynamics of Brain and Nerve. Edited by K. A. C. Elliott, Irvine H. Page and J. H. Quastel. Pp. xii+900. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, 1955.) 140*s.*

AUTHORITATIVE and comprehensive accounts of the chemistry of the nervous system are few and far between. Apart from the original classical work by Thudichum in 1884, the only recent extensive publications have been the books by Page which appeared in 1937 and by McIlwain which appeared in 1955. Consequently the volume under review, compiled by thirty-two authorities on the subject, is indeed welcome.

It begins with an introductory chapter appropriately devoted to Thudichum, the father of the subject. It is unfortunate that in this fairly extensive account of Thudichum's life, much of it spent as a practising physician, no mention is made of the fact that in 1865 he was appointed lecturer in pathological chemistry at St. Thomas's Hospital, although it is noted that seven years previously he had been appointed lecturer in chemistry at Grosvenor Place School of Medicine.

The book covers all aspects of the biochemistry of the nervous system. It includes sections on the chemical constituents of nervous tissue, the mechanism of respiration, glycolysis and oxidation, nerve function, acetyl choline, intracranial fluids, electrolytes, neurotropic drugs, neurotoxins and snake venoms, the toxic effect of oxygen, aspects of narcosis, convulsive conditions, nutritional disorders, the nervous system in arthropods, and concludes with a chapter on the thermodynamics of the message. It will be clear, therefore, that although much of the material is fundamentally biochemical in nature, it also covers a much wider field, and the contributors range from neurologists to mathematicians.

Three main criticisms may be levelled at this book. The first and least important is that inevitably much of the material described in the chapters dealing with metabolism, glycolysis, respiration and oxidation, comes under the heading of general biochemistry and is to be found in any text-book of biochemistry, since the fundamental steps in these processes are not peculiar to the nervous system.

The second criticism is that the book suffers severely from those defects which are inevitable in any work of multiple authorship. It is, in fact, a series of isolated essays dealing with different aspects of the metabolism of the central nervous system but without much thread of continuity to connect them. This lack of continuity is more serious than is the fact that the various authors frequently and not unexpectedly express contradictory points of view. This is inevitable in any work dealing with debatable material discussed by each expert from his own particular angle. It is even stimulating to see the clash of personalities. For example, Nachmansohn in his chapter on "Metabolism and Function in the Nerve Cell" holds to the view that the role of acetyl choline in conduction is essential, whereas this view is strongly contested both by Gerard and by Burgen and MacIntosh.

A third and much more serious criticism is that much of the book is already out of date. The editors explain in the preface that most of the manuscripts were in their hands in 1951 and that some of them have been revised since then. Even so, some advances made in the past two or three years have been omitted. For example, Hyden's important chapter on "Nucleic Acids and Proteins" is up to date as far as 1950 and contains only a few references to work done between 1950 and 1953. Similarly, in Burgen and MacIntosh's masterly chapter, one of the best in the book, on the "Physiological Significance of Acetyl Choline", the section on p. 327 dealing with coenzyme *A* is seriously out of date, although an attempt has been made to modernize it in a footnote on p. 329 which mentions Lipmann's paper in the *Federation Proceedings* of 1953.

But, in spite of these criticisms, the book contains a wealth of valuable material which will not easily be found elsewhere, and it will undoubtedly remain for some time to come an authoritative work in this particular field.

J. N. DAVIDSON

NEUTRON CROSS-SECTIONS

Neutron Cross Sections

Prepared by the United States Atomic Energy Commission. (Selected Reference Material on Atomic Energy.) Pp. viii + 328. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 90*s*.

THE probability that a neutron interacts with the matter through which it is passing interests a surprisingly large number of people. There is the 'pure' interest of the nuclear and solid state physicists, and the 'applied' interest of reactor physicists, metallurgists and engineers. Alongside this there is the indirect interest of all those using radioisotopes and neutron irradiations for research in medical, biological and other fields.

This interest arises, of course, because of the utility of neutron interactions both as a research tool and in the production of power.

The probability of interacting with an atom in a given state is called the total cross-section for that atom, and its value will depend upon the energy of the neutron involved. Very often several types of interaction are possible, and then an attempt is made to divide up the total probability into partial cross-sections for each interaction. Since the development of the nuclear reactor and of powerful neutron sources associated with particle accelerators, a vast number of neutron cross-sections have been measured.

The task of compiling these cross-sections, from the small compilations already published and the original data, was undertaken several years ago by a compilation group of the U.S. Atomic Energy Commission at the Brookhaven National Laboratory. This compilation, *AECU*-2040, has been an invaluable handbook for everybody concerned with neutrons. Now it has been brought up to date and published as part of the selected reference material issued by the U.S. Atomic Energy Commission at the Geneva Conference on the Peaceful Uses of Atomic Energy.

The editors, Drs. D. J. Hughes and J. A. Harvey, are to be congratulated on the production of such a worthy handbook. It includes tables of thermal neutron cross-sections (absorption, activation, scattering and fission) and of resonance parameters, as well as graphs of the cross-sections between 10^{-4} eV. and 100 MeV. and the angular distributions of scattered neutrons. It will be appreciated that with such a mass of material available some kind of explanatory background book is required to be used in conjunction with the compilation. I understand that such a book is in course of preparation. For those not familiar with the interaction giving rise to the reported cross-section, such an adjunct is indispensable. In addition, some background information is often useful for the specialist; for example, the methods used in the compilation for choosing a 'best value'.

The cross-sections as a function of energy are shown on large graphs each covering a factor of 10^4 in energy. But in some cases difficulties of graphical presentation arise due to the complicated nature of the experimental data. Many of these difficulties are overcome by including with one of the large graphs an inset showing an expanded graph of the complex region. However, there are a few cases where the present uniform layout might be dropped altogether in favour of a more detailed presentation. This might include a table of values of cross-sections as a function of neutron energy. Due to the steady improvement of experimental techniques, the number of such cases is likely to increase rapidly, making the task of the compiler even more difficult than it is at present.

An additional piece of information, which might well be included in the tables and graphs, is the method of measurement used. Since many methods are used quite widely, a simple coding system should be possible.

It was a disappointment to find that the supplement to the compilation, which was made available to members of the Geneva Conference, was not attached to the present publication. This supplement included data taken from all sources on the cross-sections of the fissile isotopes, whereas the main compilation covers American sources only. Consequently, the supplement is invaluable to those interested in atomic energy. (The book, including the supplement, is also available in paper covers from the Government Printing Office, Washington, D.C., price 3.50 dollars.)

In conclusion, this well-presented compilation is as essential as its predecessors to everyone working with neutrons, and we all look forward to many future editions coming from the same source.

P. A. EGELSTAFF

THEORETICAL STATISTICS

Introduction to Mathematical Statistics

By Prof. Paul G. Hoel. Second edition. (Wiley Publications in Statistics.) Pp. xi+331. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 40s. net.

THIS is one of the best text-books on theoretical statistics at the undergraduate-level. The first edition was good, but this second edition has been revised, extended and greatly improved. It is very suitable for first-year students with a knowledge of elementary calculus and some general acquaintance with the scope of statistical method. There are numerous exercises, the answers to which can be obtained separately.

Prof. Hoel breaks away from the traditional course of development. An initial chapter on probability introduces the idea of a sample space on p. 4, before frequency distributions or their summarizing measures have been discussed. Models, testing hypotheses and estimation are dealt with in the following chapter. This sounds like putting the cart before the horse and, logically, perhaps it does so; but from the teacher's point of view there is much to be said for it.

The book then swings back more or less on course and deals with frequency distributions, sampling theory, correlation and regression, goodness of fit, the general principles of testing hypotheses, small sample distributions, design of experiments and non-parametric methods. The treatment throughout is fresh and clear. Prof. Hoel has succeeded in teaching the essential ideas without much mathematical complication and, at the same time, in providing enough exercises to enable the student to feel that he has mastered the details of the technique.

A few suggestions for further editions: would the author not consider 'theoretical statistics' a better expression than 'mathematical statistics', and 'distribution-free methods' better than 'non-parametric methods'? Moreover, could he not say something about the manipulative algebra of expectations and about generating functions, two subjects which, in my experience, give the greatest trouble to beginners?

M. G. KENDALL

THEODORE ROOSEVELT AS NATURALIST

Theodore Roosevelt's America

Selections from the Writings of the Oyster Bay Naturalist. Edited by Farida A. Wiley. (American Naturalists Series.) Pp. xxiii+418. (New York: The Devin-Adair Company, 1955.) 5.75 dollars.

THIS book is one of a series devoted to commemorating such famous American naturalists as were citizens of the United States, by publishing selections from their writings. Theodore Roosevelt was a most versatile as well as a most remarkable man, and an intense love of wild Nature was one of his greatest and most lasting interests. His knowledge of natural history was wide, and though he studied natural sciences, including zoology, for four years at Harvard, his defective eyesight compelled him to abandon the idea of making science his life-work. He entered politics instead, but after three years went on a hunting trip into the Bad Lands of the Dakotas to recuperate his health. He was so fascinated with the region, and with the life of the cattlemen, that he bought two ranches where he lived for the next two years as a stockman. Thereafter he returned to politics; but his experiences in North Dakota had left a deep impression on him and, indeed, formed a vivid background to the rest of his life.

Most of this book consists of Roosevelt's own writings about the Bad Lands, and the last two chapters deal with his expedition through tropical Brazil. The introductory matter by several hands entitled "Roosevelt as a Naturalist" on the whole does little service to his memory; but the subsequent chapters from the pen of the great man himself are very different, and at once arouse the reader's interest. There is probably no better account of life on a cattle ranch in the 1880's than Roosevelt's—he writes with sympathy, knowledge and understanding. His style is simple and direct, and gives a most vivid picture of the country with its human and other wild inhabitants. His accounts of the game animals, the birds, and the smaller creatures are first class, and his yarns about his cowboys and about his adventures with 'bad men' and other desperadoes are thrilling. It was a hard strenuous life, and he lived and enjoyed it to the full.

It was in later life that Roosevelt undertook his South American expedition, which turned out to be a laborious and at times a hazardous journey; he was perforce more of a passenger than he would have wished to have been. His account of it is interesting, but it has not the vitality of the chapters on the old days in Dakota when he was in full health and vigour.

A chapter criticizing the Thayers' book on revealing and concealing coloration in the animal kingdom, originally published many years ago, is of little present interest—the Thayers' principle of counter-shading is generally agreed, and all their fantastic nonsense has long ago been forgotten. A short chapter "In Defence of our Natural Heritage" reminds the reader that Roosevelt was one of the great pioneers of conservation, which has made so much progress all over the world since his day.

The book is decorated with most attractive silhouette designs by Ugo Mochi; but it is marred by numerous misprints that ought to have been eliminated by competent proof-reading.

L. HARRISON MATTHEWS

Astronomical Photoelectric Photometry

Edited by Frank Bradshaw Wood. (A Symposium presented on December 31, 1951, at the Philadelphia meeting of the American Association for the Advancement of Science.) Pp. vii+141. (Washington, D.C.: American Association for the Advancement of Science; London: Bailey Bros. and Swinfen, Ltd., 1953.) 33*s*.

In his preface to this publication, consisting of eight papers submitted at a symposium presented on December 31, 1951, at the Philadelphia meeting of the American Association for the Advancement of Science, the editor states that it is the intention of the volume to provide a summary of use to those actively at work in this field and yet provide guidance to astronomers embarking for the first time on a programme of photoelectric observations.

The first paper, on the topic of direct-current techniques, contains a valuable bibliography, the references including most of the important papers from the days of pre-multiplier photometry up to recent years.

The second paper, dealing with alternating-current techniques and sources of error in photoelectric stellar photometry, suffers in its first few pages from a lack of lucidity. The portions dealing with sources of error are the more interesting features of this communication.

Pulse-counting techniques are represented by two papers, one containing a detailed description of the photometer at the Cook observatory and the other the recent developments in Great Britain carried out at Cambridge by Redman and Yates.

A recent photoelectric installation at the Observatoire de Haute Provence is described in two papers by Lallemand and Lenouvel.

A photometer constructed by Walraven combines the advantage of the null method with the excellent properties of the phototube, the arrangement in effect constituting a servomechanism.

The final paper in this attractively produced little book is by Whitford and concerns a consideration of ultimate limits and a critical summary.

A. H. Jarrett

Organic Peroxides

Their Chemistry, Decomposition, and Role in Polymerization. By Arthur V. Tobolsky and Robert B. Mesrobian. Pp. x+198. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1954.) 5.74 dollars.

This excellent little book provides a general account of the chemistry of organic peroxides with special reference to their role in initiating polymerization reactions.

The first of the three sections of the volume gives a systematic and well-documented outline of the chemistry of the various classes of organic peroxides and hydroperoxides. In the second section the manner of decomposition of peroxides under various conditions is discussed. The formation of free radicals and the diagnostic tests which may be used to detect their formation are given special consideration. Other modes of decomposition such as the Haber–Weiss process and heterolytic cleavages are also included. In the final section the kinetics of polymerization of substances of the vinyl type, such as styrene and methyl methacrylate, are described, and the methods used for determining the characteristics of the process are discussed, including the rates of initiation of polymerization and the related catalytic efficiencies of various peroxides.

The physical properties and the explosive nature of known organic peroxides are presented in tabular form as appendixes. Literature references extend to 1953 inclusive, and there are complete subject and author indexes.

This volume will provide a useful introduction to the subject which should be of real value to senior students or research workers.

G. M. Bennett

A Textbook of Sound

Being an Account of the Physics of Vibrations with special reference to Recent Theoretical and Technical Developments. By Dr. A. B. Wood. Third (revised) edition. Pp. xvi+610. (London: G. Bell and Sons, Ltd., 1955.) 42*s*. net.

To treat in one text-book both classical and modern acoustics has now become impossible. Beranek needs more than nine hundred pages to deal with acoustical measurements alone. Electro-acoustics, communication theory, ultrasonics, speech, physiological acoustics, architectural acoustics and musical acoustics each need separate volumes. Dr. A. B. Wood resolves the difficulty by continuing to present a standard treatment of classical acoustics. New diagrams, new references and fifty more pages of letterpress are added to the second edition.

The point of view is still that of classical acoustics, with its emphasis on those features of vibrating systems which can be treated by simple mathematical or experimental techniques, that is, on the steady state. Yet, as soon as speech, music or noise reaches a steady state, it ceases to be speech, music or noise.

Phenomena contrary to the ideas of classical acoustics are apt to be treated with caution. For example, in 1924 Harvey Fletcher, using electric filters, showed that if several of the lowest components of a complex sound were removed, the pitch of the sound was unchanged. Referring to this effect in this 1955 edition, Dr. Wood still writes, "He [Harvey Fletcher] claims to have proved that only the quality and not the pitch . . . is changed". The student would be helped by the addition of a short annotated bibliography of the many excellent books on acoustics published during the past ten years and also by notes on such journals as *Acoustica* and the *Journal of the Acoustical Society of America*, especially as the latter journal publishes in each number a very comprehensive list of references to contemporary papers on acoustics.

W. H. George

Call of the River

By Mabel E. Byrt. Pp. 127+8 plates. (London: Country Life, Ltd., 1955.) 8*s*. 6*d*. net.

The "Call of the River" is a story of wild life, of otters in particular, on waterway and seashore. The tale is well told, the adventures of the otters making good reading in the tradition of that great master of Nature fiction, Ernest Thompson Seton, though unfortunately the standard of accuracy is not quite so high as that of the Canadian writer. Here and there the author slips—for example, the dramatic fight of the otter with the giant conger eel. This is staged in the river, regardless of the conger eel being a marine fish not in the habit of entering fresh water. Yet by and large the book gives a vivid picture of wild life on our English rivers and in particular of that remarkable mammal, the otter. The illustrations are from photographs, and the excellent coloured jacket is from a painting by Michael Lyne.

F. P.

PERKIN AND THE DYESTUFFS INDUSTRY IN BRITAIN

By R. BRIGHTMAN

Recently Division Bibliographer, sometime Chief Librarian of the Dyestuffs Division,
Imperial Chemical Industries, Ltd.

THE centenary of the discovery of mauve may be celebrated variously from the Easter vacation of 1856 when W. H. Perkin, at the age of eighteen, accidentally made the discovery while working in the rough laboratory he had fitted up in his home at "King David's Fort", King David's Lane, Shadwell; from the date of the reply he received, on June 12, 1856, from the firm of Pullar, of Perth, to whom he sent specimens of his dyed silk, reporting the discovery as "decidedly one of the most valuable that has come out for a very long time" (provided it did not make the goods too expensive); or from August 26 of the same year, the date of the first patent application for a synthetic dyestuff. Any of these dates will serve, though the last comes nearest to giving the true measure of Perkin's achievement. None of them, however, fully represents Perkin's claim to remembrance as the founder of the synthetic dyestuffs industry, and the Perkin centenary which really deserves commemoration is not his fortuitous discovery of the dyestuff but the opening of the works which, in June 1857, he began to build for its manufacture at Greenford Green, near Sudbury. Six months later mauve, or aniline purple, was in use at Bethnal Green in the silk dyehouse of Thomas Keith and Sons, which was the first firm to use it on an industrial scale.

The story of this achievement has often been told, not always, however, with full justice to the magnitude of the achievement of a young chemist who had not even seen the inside of a chemical works and whose knowledge was derived entirely from books. Moreover, at that time very limited supplies of benzene were available, as there was little use for it, nor was the fuming nitric acid thought to be essential in making nitrobenzene obtainable commercially, and only in 1854 had Béchamp found that on a laboratory scale nitrobenzene could be reduced to aniline by means of finely divided iron and acetic acid. Without this discovery, as Perkin himself said in his Hofmann Memorial Lecture[1], the coal-tar colour industry could not have been started. The successful manufacture of aniline from nitrobenzene appeared to be so formidable a task that attention was first directed to the possibility of extracting by acid washing the minute quantity of aniline contained in coal-tar, and only after many experiments was this source abandoned as too expensive and yielding too impure a product. Such difficulties might well have deterred a far more experienced man than Perkin, whose venture, moreover, was undertaken in the face of strong discouragement from Hofmann, in whose laboratory at the Royal College of Chemistry Perkin had been working, and whose comment on the desirability of synthesizing quinine (made in the *Reports of the Royal College of Chemistry* for 1849) probably prompted Perkin's experiment, as indeed he admitted in his Hofmann Memorial Lecture. Perkin tells how, in October 1856, following visits to Pullar at Perth and experiments on cotton dyeing and on calico printing, which in the absence of suitable mordants were less encouraging than he had hoped, he sought an interview with Hofmann and told him of the discovery, showing him also the dyed patterns and announcing his intention of leaving the Royal College of Chemistry to undertake its manufacture. Hofmann appeared to be much disturbed and spoke as if Perkin was taking a false step which might ruin his future prospects.

None the less, young Perkin had faith in his results; but there has been little inquiry into the reasons which in 1856 made Perkin so confident of the importance of his discovery and so resolute to embark on its manufacture in the face of powerful discouragement and formidable technical difficulties. Dr. C. J. T. Cronshaw truly remarked in his Jubilee Memorial Lecture to the Society of Chemical Industry: "If a Faery Godmother had given Perkin the chance of choosing the precise moment for his discovery, he could not have selected a more appropriate or auspicious time"[2]. It is hard to believe that a youth of eighteen could fully apprehend the opportunities which the expanding textile industries alone offered to the new colouring matters that were to come out of coal tar in the next two decades, but justice cannot be done to his achievement unless we look a little more closely not merely at the way in which the discovery was made and brought to technical fruition by Perkin himself, but also at the scientific and technical and commercial background of the time.

At the time Perkin made his discovery, he was a research assistant to Hofmann in Hofmann's laboratory at the Royal College of Chemistry, to which Perkin had been promoted in 1854 and where he had completed his first investigation, on anthracene, at the age of seventeen. We may note, in passing, that the crude material for this research was obtained from the tar works of that Bethell whose discovery in 1838 of the value of tar for creosoting timber, coupled with the railway boom, had opened up one of the first considerable markets for coal tar and taken us a step towards the beginning of organic chemical industry. Perkin's object on this occasion was to prepare an amino-compound through the nitro-compound, and although he failed to obtain the latter, he prepared what were later recognized to be anthraquinone and chloro- and bromo-anthraquinones, and gained experience of great value when later he began work on the production of anthracene.

It is worth while looking a little further at the Royal College of Chemistry, which Perkin entered in October 1853, on leaving the City of London School at the age of fifteen, for part of Perkin's fortune consisted in the availability of such an institution for teaching and research in chemistry. True, as Perkin tells us, at the age of twelve or thirteen he had been greatly attracted to chemistry, with its possibilities of making new discoveries, by some chemical experiments shown him by a friend, particularly by the power of crystallization in definite forms possessed by some compounds. He determined, if possible, to become a chemist, and immediately commenced to accumulate bottles of chemicals and to make experiments.

Perkin's father was disappointed at William's choice of a career, as the outlook for chemistry was very poor in those days, but eventually he was allowed to follow his bent and to enter the College founded only eight years earlier. There was at this time, it is true, seldom any desire among students to become chemists, but it is not solely because of Perkin that Mr. W. A. Silvester[3] described the Royal College of Chemistry as the seed plot of the dyestuffs industry; and the circumstances in which the College was founded little more than ten years before Perkin made his discovery deserve attention. It could not well have been created at that time without the support of some strong popular feeling.

In this second quarter of the nineteenth century, organic chemistry was still little known or studied in Great Britain; as Liebig said at the Liverpool meeting of the British Association in 1837, it was only beginning to take root. Moreover, here and elsewhere the idea that chemistry should be taught and learnt in the laboratory was still new. Strommeyer had begun to admit students to his laboratory at Göttingen for practical instruction in chemistry in the first decade of the nineteenth century, but Thomas Thomson, then reader in chemistry in the University of Glasgow, in the next decade opened his laboratory to students[4] and, according to Lord Kelvin, himself in 1834 one of Thomson's students, this became the first laboratory in the world in which was carried out chemical research and the practical instruction of university students in chemistry. There were indeed other chairs of chemistry in Britain—that at Aberdeen was founded in 1793 and one at Cambridge had been created in 1702, while Daubeny had been professor of chemistry at Oxford since 1822.

None the less, the chair and laboratory at Glasgow are to be remembered here first because Thomson and Graham, who came to the Andersonian Institution, Glasgow, as professor of chemistry in 1830, spread the idea that laboratories were necessary in training chemists and, second, for the part which Graham and his students took in founding the Royal College of Chemistry, where Perkin and others who played so conspicuous a part in the development of the early dyestuffs industry were trained. No longer had students of chemistry or physics without independent means to rely for experimental work on such private bodies as the London Institution or the Manchester Royal Institution. For many years those with the means to do so flocked to the famous laboratory which Liebig opened at Giessen in 1826, or, after 1836, to that of Wohler at Göttingen. With the opening of the Royal College of Chemistry in 1845 there was in Great Britain also public provision for the practice of experimental chemistry.

The impulse to scientific and technical education had thus been given when Perkin entered the Royal College of Chemistry: Playfair's report on industrial education on the Continent had been published in 1853 and Herbert Spencer's articles on the need for scientific education began to appear in 1854. We have still to examine, however, the circumstances in which that College was founded. Among Graham's students during the seven years before he went to London as professor of chemistry in the newly founded University College were Lyon Playfair and James Young, both of whom followed Graham to London. Lyon Playfair, after two years as Graham's private assistant in 1839, on Graham's advice went to Giessen to study under Liebig, and there he first met Hofmann, at that time studying mathematics and physics. Playfair's friendship with Liebig led to him acting as conductor and interpreter when in 1842 Liebig made his famous tour of Britain. The immediate effect of this tour was to make chemistry a popular science and to strengthen the hands of those like Graham who were seeking to develop laboratory teaching. The School of Mines, which was opened in Jermyn Street, and King's College, London, as well as University College, gave much attention to laboratory teaching. Following an unsuccessful attempt to found a Davy College of Practical Chemistry within the Royal Institution, the efforts of Sir James Clark, the Queen's physician, and the Prince Consort, led to the founding of a new College of Chemistry, to which A. W. Hofmann was invited as director.

The College opened with temporary laboratories in George Street, Hanover Square, in October 1845, but by October 1846 was installed in new buildings fronting on Oxford Street under the title of the Royal College of Chemistry. When the College, in 1853, was incorporated with the new School of Mines and of Science Applied to the Arts, founded in 1851, Lyon Playfair, professor of chemistry in the latter, retired in favour of Hofmann. In the laboratories of this institution Hofmann, in the two decades 1845–65, laid an enduring mark on technical education in Britain and provided the emergent chemical industry with many of its leaders in the second half of the nineteenth century. His first batch of twenty-six students in 1845 included E. C. Nicholson, F. A. Abel, Warren de la Rue, G. Simpson and C. W. Bloxam, the second batch C. B. Mansfield, F. Field and George Merck, while among Hofmann's assistants besides students such as E. C. Nicholson, J. Spiller and W. H. Perkin himself were H. Medlock, Peter Griess and C. A. Martius. C. Simpson, like W. Spiller, E. Nicholson and G. Maule, were all partners at some time or other in Simpson, Maule and Nicholson or Brooke, Simpson and Spiller. H. T. Lowe, another student of 1848, was works manager to the former firm, F. Field, chemist to the same firm, and J. Spiller, consulting chemist. Among students preceding Perkin there were also W. Odling, W. Crooks, G. D. Liveing, while after him came W. A. Tilden and, just as Hofmann left for Berlin, W. Thorp and H. E. Armstrong.

These names alone give some measure of the influence of Hofmann and his students upon the chemical thought and industry of the time, but the picture is still incomplete. Not only did young Perkin enter the doors of the Royal College of Chemistry in the first flush of the development of practical laboratory work in Britain and when the impulse which the Great Exhibition of 1851 had given to technical education was still felt; he entered an institution where teaching and research were proceeding side by side under an inspiring leader who was rapidly writing new chapters in organic chemistry. The way was being prepared for the age of organic synthesis, and young Perkin's enthusiasm for research is better understood when we recall the exciting developments of the time as Laurent converted Dumas's theory into a real theory of substitution, Wurtz, Hofmann, Williamson and Odling elaborated the theory of types, Frankland, working on radicals, introduced the doctrine of valency, and in 1858 Kekulé and Couper independently and simultaneously advanced a satisfactory theory of molecular constitution resting on the quadrivalency of carbon and the capacity of carbon atoms to form chains, and that this theory in 1865 led Kekulé to his hexagonal structure for benzene.

"England is not the land of science", wrote Liebig to Berzelius in 1837; but although it is true that nowhere in the country was there for decades to come any school of organic chemistry comparable with that which Baeyer established at Munich, many of the important contributions of the period 1840–70 came from chemists working in Britain who might be seen at the regular meetings of the Chemical Society or the Royal Society, the journals of which provided the means of publication for Hofmann as well as for Perkin himself and others like Griess. Moreover, in the relatively small circle of chemists (even in 1856 the Chemical Society had only 256 Fellows) in which these developments took place, many were known to each other and moved as easily from London to Giessen or Gottingen or Heidelberg as from Glasgow to London or Manchester or Liverpool or Edinburgh.

The Chemical Society had only been founded in 1841 and its *Journal* did not appear regularly until 1848, but by the time Perkin entered the Royal College of Chemistry it had won its place as a medium of communication, not least for the work which Hofmann and his school were carrying out on the ammonium bases and the compounds of coal tar. The importance of this early work of Hofmann, Mansfield, Medlock and Nicholson on benzene, toluene, aniline, toluidine and alkylanilines, and especially the development by Mansfield of the technique of fractional distillation, is not easily overstressed. Without it Perkin could scarcely have attempted the manufacture of mauve and other dyestuffs for which those compounds were required.

Perhaps young Perkin was also fortunate, therefore, that in entering the one real school of organic chemistry in Britain at the time, he entered one which arose out of technology. Although Hofmann's first research at Giessen had been upon the nature of coal tar, and his paper describing this work, entitled "A Chemical Investigation of the Organic Bases contained in Coal-Tar Naphtha", was published in the *Philosophical Magazine* in 1844, coal tar was still largely a waste product and something of a nuisance when Hofmann came to London. Apart from the developing use of creosote for preserving timber, it was still frequently mixed with ashes and used to heat the retorts of the gasworks or the stills in which young Read Holliday was distilling ammonia from the ammoniacal liquor of the gasworks.

Garden had isolated naphthalene from coal tar in 1819, but it was for some time regarded as doubtful whether naphthalene existed as such in the tar or was a product of its decomposition. Mansfield, in his paper on coal tar in the *Journal of the Chemical Society* in 1847, remarking on the deposition from the tar of the London gas works of naphthalene as granular crystalline masses, called 'salts' by the workmen, states that it was thrown away as useless or burned for lamp-black, although priced at 4–5*s.* an ounce in chemical catalogues. Faraday discovered benzene in oil gas residues and described it to the Royal Society in June 1825 and suspected its presence in coal tar, and in 1832 Dumas and Laurent discovered anthracene in residues from the distillation of coal. Two years later Runge indicated the potentialities of coal tar for the organic chemist, isolating carbolic acid, or phenol, pyrrole, kyanol or aniline and leucol or quinoline, none of which he analysed; and besides noting the blue coloration developed on oxidation of aniline with bleaching powder, he also described an aniline black, emeraldine as well as rosolic acid, while according to B. Anft[6] he had discovered purpurin in 1822 and obtained a Prussian patent in 1823.

These hints, however, were not taken until first Hofmann began to investigate aniline and quinoline, and then Perkin tried to oxidize aniline. Runge appears to have had some real appreciation of the possibilities, but was frustrated by E. E. Cochius, the business manager of the Oranienburg Chemical Works, where Runge was employed, from developing them and left the firm in 1852. Thus it was that practically all the aniline used by Hofmann in his numerous inquiries until Perkin's discovery stimulated its manufacture was obtained by distilling indigo with potash.

At the meeting of the British Association in Manchester in 1842, Leigh produced evidence of the presence of benzene in naphtha; and this was confirmed by Hofmann in 1845, who had already, in 1843, in a joint paper with Dumas, shown that aniline could be obtained from phenol through ammonium phenoxide. Hofmann now induced Mansfield to investigate the liquid hydrocarbons of coal tar. Mansfield succeeded in obtaining pure benzene and toluene sufficiently pure for Hofmann and Muspratt to prepare toluidine from it, while Hofmann described ethylaniline, diethylaniline, and methylaniline in the *Journal of the Chemical Society* before Perkin entered the Royal College of Chemistry.

None the less, when aniline was required for the manufacture of mauve, several inquiries were necessary before a supplier of benzene could be found. Perkin's first supplies came from Miller and Co., of Glasgow, at 5*s.* per gallon; but this benzene was crude, very variable in quality and required redistillation. Nitrobenzene had only lately been made in small quantities as 'essence de myrbane' for scenting soap and had never been made in iron vessels. Unable to obtain commercially nitric acid which was sufficiently strong for the nitration, Perkin used a mixture of sodium nitrate and sulphuric acid. The method succeeded on a small scale, but many precautions were necessary when working with larger quantities. In the early stages, the nitration was carried out in large glass 'boltheads'. Cast iron stills with mechanical stirring gear were not introduced for some time after the manufacture of mauve commenced, and this improvement is attributed to E. C. Nicholson at the Lockfields works of Simpson, Maule and Nicholson.

Perkin himself made large quantities of nitrobenzene in this way and deserves full credit for overcoming on his own the immense difficulties that confronted him. None the less, an infant chemical industry was already developing, of which the firm of Simpson, Maule and Nicholson, established at Lockfields in 1853 as manufacturers of fine chemicals, was only one representative. Although the firm failed to obtain the desired licence from Perkin and Sons for the manufacture of mauve, Simpson, Maule and Nicholson sought to manufacture nitrobenzene for use by Perkin and Sons, and eventually did so cheaply enough to make it worth while for Perkin to discontinue the manufacture of nitrobenzene, and later of aniline also. Originally, at Lockfields as at

Greenford Green, the nitrobenzene was reduced in iron vessels with removable still-heads which were only placed in position when the reaction showed signs of starting, and a water-hose was played on the still if the reaction became too violent. It was soon found that the cheaper hydrochloric acid could replace acetic acid, and by degrees Simpson, Maule and Nicholson became manufacturers of dyestuffs. Beginning with a product, roseine, which David Price had obtained and patented in 1859, they followed this with the manufacture of magenta, which they were the first British firm to make by the arsenic process of Medlock and Nicholson. In 1860 they built the Atlas works at Hackney Wick, and on Nicholson's retirement in 1868 the firm became Brooke, Simpson and Spiller.

Perkin, however, had given the impulse, and the manufacture of magenta (the formation of which was first observed by Natanson in 1856, about the same time that Perkin discovered mauve) was attended by nothing like the difficulties which beset Perkin. Moreover, while Perkin had first, or at least simultaneously, to work out the preparation of his intermediates, his rivals largely worked from intermediates to dyestuffs, Ivan Levinstein at Blackley a little later being possibly the exception. Thus, the improvements in the manufacture of phenol for which Dr. Crace-Calvert, who had succeeded Lyon Playfair as professor of chemistry at the Manchester Royal Institution, and C. Lowe had introduced from 1857, had prepared the way both for the manufacture of picric acid, which had come into use as a dyestuff about 1851, and of rosolic acid or aurin.

Indeed, Manchester was already the centre of a small synthetic dyestuffs industry when Perkin made his discovery of mauve. Roberts, Dale and Co., for example, had begun the manufacture of inorganic pigments and dyewood extracts at Cornbrook in 1852 and their interest in wallpaper colouring made them quick to exploit every opportunity of meeting the demands of an expanding market. Besides picric acid, Roberts, Dale and Co. introduced some of the first basic and azo dyestuffs, notably aniline yellow and Manchester brown, and they had in their service for a time such chemists as Caro, Martius and Leonhardt, while Peter Griess was a consultant. According to J. B. Cohen, at one time the firm bought from Perkin and Sons the mauve residues, specially purified them, and sold the product to calico printers, who used it as a pigment, fixing it on the fibre with albumen. In Manchester also was centred the manufacture of murexide, the derivative of alloxan, the use of which in dyeing wool had been described by Schlumberger in September 1853, and which was freely marketed for dyeing silk and wool in 1856.

There are two features about the existence of this infant dyestuffs industry in Manchester which deserve notice. First, while there was a large and expanding market for the new wares in the surrounding counties of Lancashire and Yorkshire, the real impulse to their introduction came from the French dyers, from whom also came much of the demand for an increasingly purer grade of phenol during the decade 1857–66 which stimulated the work of Crace-Calvert and Lowe. It may well also have encouraged Ivan Levinstein to make his venture at Blackley in 1864, and it certainly facilitated Read Holliday's entry into the dyestuffs field; from distilling coal tar and supplying primary materials, he began to make the intermediates, and, commencing with magenta in 1860, then the colours themselves. Read Holliday was also helped by Mansfield, who at the time of his accidental death was working with hydrocarbons supplied by Read Holliday and Sons and had for the last five years of his life been experimenting for them on the utilization of benzene and toluene.

Perkin, however, had not only to make his dyestuff and, at first at least, the nitrobenzene and aniline required for its production. Its purification called for equal resource, and it may be mentioned that he had considerable difficulty in getting perfectly tight joints for the process of extracting the crude oxidation product under pressure with naphtha or strong spirits of salt. Perkin had further to find satisfactory methods of applying the mauve to fabrics and also to induce the dyers to use them. Pullar wrote to him, in the letter of June 12, 1856, already quoted: "This colour is one which has been very much wanted in all classes of goods, and could not be obtained fast on silk, and only at great expense on cotton yarns. I enclose a pattern of the best lilac we have on cotton—it is dyed by only one house in the United Kingdom, but even this is not quite fast and does not stand the tests that yours does, and fades by exposure to air". When, with the assistance of his elder brother, T. D. Perkin, he had prepared a few ounces of mauve, Perkin visited Pullar's and made some experiments on cotton dyeing, only obtaining, however, pale direct shades, not fast to washing, as no suitable mordants for a basic dye were known at that time. Experiments on calico printing were also made at some print works; but printers feared that the dye would be too dear and, although it proved to be one of the most serviceable colours as regards fastness, they were not satisfied because it did not resist bleaching powder like madder purple. Perkin then found that application with casein gave good results, but the printers who tried it were not enthusiastic and even Pullars began to waver. In January 1857, however, on Mr. Pullar's advice, Perkin saw Thomas Keith, a silk dyer of Bethnal Green, and after making a few experiments Keith encouraged Perkin to proceed with the production of mauve.

Thomas Keith and Sons were the first firm to use aniline purple on an industrial scale, and it was in use in their silk dyehouse in December 1857, only six months after the building of the works at Greenford Green was commenced. In dyeing large amounts of silk, however, the great affinity of the dyestuff led to uneven shades, and Perkin himself found that level shades could be obtained by dyeing in a soap bath. He was thus the first to introduce this general method of dyeing in a soap bath, and independently of R. Pullar he also discovered the general method of dyeing basic dyes on cotton mordanted with insoluble inorganic compounds of tannin. This method, in which cotton was steeped in a decoction of sumac or other tannin, then in a solution of sodium stannate (or alum), next in acidified water and finally dyed with aniline purple, was universally employed in preparing cotton for dyeing with basic dyes until the use of tannin and tartar emetic was discovered by John Dale, son of the founder of Roberts, Dale and Co., in 1861 and introduced by Thomas Brooks, of Manchester. Calvert claims, indeed, that he and Lowe succeeded in fixing aniline and orchil colours with tannin and alumina as early as 1858 and that they observed the precipitating action of tannins for coal tar colours in 1856. Others, such as Greatrix of Butterworth and Brookes, were also working with gall-nuts and stannous oxide or alumina, and it is clear that, if Perkin led here, it was not by much.

It was not, however, until the end of 1858, when the French printers had already introduced mauve into their patterns, that British printers began to be interested in the colour. Perkin, however, was not satisfied with the simple method by which mauve was originally used with casein, albumin or glue, followed by steaming, and worked for some time on this problem at the Dalmonach Print Works, Alexandria, Dumbartonshire, where mauve was first used in Britain for printing on the large scale. With Matthew Grey, he devised and patented a process for printing with a lead salt, passing through an alkaline solution of soap, followed by dyeing in a boiling soap bath. This gave good results, but could only be used for a single colour pattern; printers then experimented with tannin and a metallic oxide, which became the most important method until, in 1862, Perkin and A. Schultz discovered and patented a process based on the formation of an insoluble aluminium arsenite of mauve. This process could be used in multicolour patterns, gave brilliant shades fast to washing and was very largely used.

Perkin not only thus largely pioneered the application of the colouring matter, he also originated the dyemaker's practice of supplying the user with technical service. He spent some weeks in Bradford showing the dyers how to dye mixed fabrics of cotton and wool successfully with mauve, and his pioneer work in this direction cleared the way for the later introduction of magenta, Hofmann's violet and other colours also. It was not only in the manufacture of the aniline dyestuffs that Perkin started the ball rolling: he was as much a pioneer in the application of the colours. As H. E. Armstrong remarked: "Almost everything he did was novel, and he was right in nearly everything"[6].

Mauve itself had a comparatively short run, and the range of dyestuffs manufactured at Greenford Green was never extensive. At the International Exhibition in London in 1862, Perkin and Sons staged an exhibit of the varied uses of mauve and displayed a metallic glistening block of the dyestuffs representing the quantity obtainable from 2,000 tons of coal tar and sufficient to print 100 miles of calico. The following year it was used by Thomas de la Rue as an insoluble lake in printing the British sixpenny postage stamp; but within ten years from the outset, use of mauve was very limited and one of its last uses was in printing the 1881 issue of lilac British penny postage stamps which continued in use until the end of Queen Victoria's reign. Perkin's other major achievement—the synthesis and manufacture of alizarin—belongs to the last few years of the firm's existence: the first invoice for the artificial alizarin was dated October 4, 1869, in which year the firm made one ton of paste. In 1870, when they made 40 tons, the firm was still practically the only maker, and in the following three years they made 220 tons, 300 tons and 435 tons of paste with practically no opposition in the home market.

In the preceding ten years, however, Perkin and Sons had manufactured magenta by the mercury nitrate process (quickly discontinued), an ethyl derivative of mauve known as dahlia, for dyeing and calico printing; aniline pink, or safranine, obtained by oxidizing mauve with lead peroxide; the Britannia violets, discovered by Perkin in 1863 and obtained by heating purchased magenta with brominated turpentine in methyl alcohol under pressure; and Perkin's green obtained from these with acetyl chloride (a process which necessitated the manufacture of both phosphorus trichloride and acetyl chloride), used in calico printing in place of the expensive iodine green[7]. The firm also made mixtures of aniline salts, oxidizing agents, and copper compounds for use in producing aniline black.

Thus, Perkin's contribution to the development of the industry is not in the range of dyestuffs which he actually manufactured but in his demonstration of its possibilities and the resource and determination with which he overcame the initial obstacles alike to the manufacture of mauve and to its application in dyeing. To appreciate fully the magnitude of his achievement it is necessary to compare the range of colours available for the dyer's palette when he began his work with that available some five years later, when Hofmann reported as juror on the Chemical Section of the International Exhibition in London, and also to notice the way in which his ideas pervaded the scientific and technical circles of the time. By and large, the dyer used logwood for black and navy shades, indigo for blue, madder for red, yellow berries for yellow, tumeric for brown, cochineal and safflower, indigo and madder being by far the most important, though according to a report written at the time of the Great Exhibition of 1851, which puts the exports of cotton, linen, silk and leather manufactures as more than £45,000,000, imports of cochineal had increased by more than 50 per cent by weight between 1847 and 1850, and by 1851 cochineal and lac dyes had quite superseded kermes. In this report, synthetic dyestuffs are not mentioned, although Guignot showed specimens dyed with picric acid at the Exhibition. Even two years later, J. Napier's "Manual of the Art of Dyeing" contains no mention of picric acid, and yellows on silk were obtained solely with weld, bark and fustic or bark and annotta liquid. Even O'Neill's "A Dictionary of Calico Printing and Dyeing" in 1862 says of picric acid, "This is only lately introduced as a dyeing material for silks and woollens", but he reports that abundance of murexide was coming into the market along with a process of applying it on calico.

Hofmann in this juror's report quotes from an article of August 24, 1862, by M. E. Meunier: "Notwithstanding the enormous price at which the aniline colours have been sold, the new industry has already exercised a most depressing influence on the commerce of cochineal. From 15 francs 50 centimes per kg. the price of cochineal has fallen to 8 francs. Safflower is difficult to dispose of at 25 francs per kg. although two years ago easily sold at 45 francs. The production of picric acid has considerably diminished the importation of yellow dyewoods. Even indigo itself, although still occupying the first rank as a colouring matter, has been thrown somewhat into the shade by the brilliancy of the aniline blues and violets. For dyeing silk, indigo is no longer used. Thus, of three dyeing materials, hitherto considered indestructible elements of the commercial prosperity of tropical countries, we find indigo diminished in its applications, and cochineal and safflower very notably depreciated, solely and exclusively by the work of the chemist".

It did not then perhaps appear as fully as to us to-day how largely that was due to the work of one young chemist, still only twenty-two, but in England at least the natural dyestuffs retained a strong place in the dyeing and printing trades for more than a generation. Not for a decade was Perkin's production of synthetic alizarin to bring about the rapid displacement of madder. and the replacement of natural indigo by the synthetic product waited on the investment of more than £1,000,000 in research and thirty years of sustained endeavour, and added £3,000,000 to the annual turnover of the dyestuffs industry. Griess had made the observation which led him to his great discovery of the diazo compounds before he left Kolbe's laboratory in Marburg, and the note in which he first directed attention to this new reaction of nitrous acid was communicated to the Royal Society on December 8, 1858, by Hofmann, whose assistant he had then become. Aniline yellow came in 1863 and Manchester brown in 1864; but the flood gates were only opened to the azo dyestuffs by Roussin, Witt and Bottiger from 1875, after Perkin had left the industry.

It was in this juror's report that Hofmann made the prophecy: "England will, beyond question, at no distant day, become herself the greatest colour-producing country in the world, nay, by the strangest of revolutions, she may, ere long, send her coal-derived blue to indigo-growing India, her tar-distilled crimson to cochineal-producing Mexico and her fossil substitutes for quercitron and safflower to China, Japan and other countries where these articles are now derived". Even when Perkin left the industry this prophecy was not impossible of fulfilment. Perkin had shown the way: together with Hofmann and Nicholson he had largely made the industry. Hofmann's students and assistants were everywhere. Moreover, the little scientific and technical society of the time was mobile, and competition did not check a real interchange of ideas in opening up a new field in which science and technology advanced side by side.

C. H. Greville Williams, the discoverer in 1859 (1856 is sometimes claimed, but the evidence is doubtful: the discovery was patented in 1859) of quinoline blue, was a chemist with Perkin at Greenford Green during 1863–68 before founding the firm of Williams, Thomas and Dower at Brentford, where Witt a little later made some of the first acid azo dyes. F. Field, who gave his name to Field's yellow, or aminoazobenzene, which he made for Simpson, Maule and Nicholson, by passing nitrous gases from nitric acid and starch into aniline, had been previously professor of chemistry at the London Institution; Crace-Calvert in Manchester had a foot in industry as well as in teaching as professor of chemistry at the Manchester Royal Institution; Lyon Playfair, his predecessor, too, was manager of Thomson's print works at Clitheroe in 1841.

What seems worth noting in this connexion with the founding of the dyestuffs industry is the extent to which, in the meetings of the Royal Society, the Chemical Society or the Manchester Literary and Philosophical Society in the period from 1840, there was to be found a nucleus of members with industrial experience as well as a keen interest in the rapidly advancing science of chemistry. At the meetings of the Chemical Society might be found besides Graham, its first president and one of the only two British chemists for whom, in 1837, Liebig had a good word, Anderson, Lyon Playfair, W. Odling, Williamson, Kolbe, who in 1847 was assisting Playfair in London, Frankland, H. E. Schunck, and, in 1853, Kekulé, then assistant to Stenhouse at the Mint. The Royal Society numbered among its Fellows Edmund Potter, James Thomson, Walter Crum and John Mercer, men of mark in calico-printing, and also to be found in the Manchester Literary and Philosophical Society and in what are known as the Whalley meetings which began about 1843, and although the original number of ten persons was not greatly exceeded, were remarkable for the distinction of their membership.

Less than justice has been done to the influence of the Manchester Literary and Philosophical Society in the mid-Victorian era in fostering the spread of ideas and the interaction of science and technology. Early in its history Thomas and William Henry were well known for their contributions in developing dyeing and calico-printing, and that tradition was carried on in the 'forties and 'fifties by John Dale and by H. E. Schunck, originally a calico printer, who in 1842 characterized the organic colouring matters to the Chemical Society as an "unexplored field" and became one of the earliest workers in it, particularly on indigo and madder, his investigations providing Pincoff and Co., of Manchester, with the basis for the improvements in the manufacture of alizarin and garancin which Hofmann commended at the 1862 Exhibition. Co-worker with Schunck on alizarin at Rochdale until 1850 was James Higgin, another Fellow of the Chemical Society and an authority on calico-printing, who also worked for a time with Dr. Angus Smith and later, in 1857, with John Lightfoot had a patent application for fixing colouring matters with glue or glutinous or aluminous substances. John Mercer himself had retired from his partnership in Fort's calico-printing works at Oakenshaw eight years before Perkin's discovery of mauve, and the versatile James Young had, in 1847, after eight years in Manchester, in which he founded the first chemical section of the Literary and Philosophical Society, been started off by Playfair on the quest which founded the Scottish shale oil industry. Before he left Manchester in 1852, by bringing together in this Chemical Section in informal discussions, usually around the tea table, some thirty works chemists, he widened the opportunities for discussion between industrialists and scientists, then essentially amateurs, already notable in and around Manchester.

It does not detract from the merit of Perkin's real achievements that there is strong evidence that the hint given in Runge's work twenty years earlier was not altogether lost on the chemists of the north, and that if Perkin had not lighted on mauve others in Lancashire would soon have produced aniline red or similar products by oxidizing aniline bases.

In spite, however, of the evidence of the close relations between science and industry at that time, we find H. E. Roscoe, in 1883, more than a quarter of a century later, expressing the hope that "calico-printers ere long will buy dyes from British dye makers". That hiatus suggests that another tendency of the time deserves note in passing, though its full effect on the dyestuffs industry was scarcely felt for another fifty years. While it is true that Hofmann himself returned to Germany in 1865 and that within a few years Caro, Martius, Leonhardt, all of whom had worked in the developing British industry, followed him to build up the industry in Germany after the Franco–Prussian war, there was another movement outward from the Royal College of Chemistry and the British firms. We have already noted the close association of academic life and industry in the person of Playfair himself and Crace-Calvert. There were others also; but, equally important, Hofmann's students and assistants moved out into academic life as well as into industry, and thus there were some places at least where the seed which Playfair and Roscoe later scattered in their campaign for technical education fell on fertile ground.

So, though within ten years of Perkin leaving the industry, drawn by his passion for research, the decline of the industry in Britain was being lamented by Roscoe, Levinstein and others, the seeds of its future expansion were already being scattered. But we are not here concerned with why they lay dormant for over a generation or the reasons which led to the industry languishing to its near extinction, or with its brilliant renaissance in the past forty years, but to commemorate Perkin's achievement, with Hofmann and Nicholson, in founding an industry.

That Perkin was fortunate in his hour and in his times is undeniable, but the chance which placed mauve in his hands was the chance which favours the prepared mind. There was nothing haphazard or half-hearted about the way in which Perkin equipped himself for the career of research on which his mind was set, and, through those sixteen years which he spent in the industry which he, more than anyone else, created, he displayed the same determination, enthusiasm and pioneering spirit that he brought to bear in his laboratory during a long life of research. He could claim, with complete justification in lecturing to the Society of Arts in 1868: "to introduce a new coal tar colour after mauve was a comparatively simple matter. The difficulties of all the raw materials had been overcome as well as the obstacles". It was not his luck but his initiative, his resourcefulness, his persistence and determination that made him the foremost technologist of his day, and the qualities and achievements which constitute Perkin's real claim to remembrance in industry are exactly those which are still needed as Britain faces the social and industrial implications of an age in which coal will no longer form the sole basis of power or of technology.

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[1] *Trans. Chem. Soc.*, 69, 596 (1896); *J. Soc. Dyers Col.*, **54**, 551 (1938).

[2] *Chem. and Indust.*, 515, 547 (1935).

[3] "What Chemistry Owes to Chemical Science", 3rd edit., p. 120.

[4] W. Crum suggests that Thomson opened his laboratory to pupils while still teaching in Edinburgh, 1801–11, *Proc. Phil. Soc. Glasgow*, 252 (1854).

[5] *J. Chem. Educ.*, **32**, 566 (1955).

[6] *Pharm. J.*, **73**, 187 (193[illegible]).

[7] *J. Soc. Dyers Col.*, **24**, 95 (1908).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH*

ANNUAL REPORT FOR 1954–55

Research Associations

DURING the year 1954–55 grants were offered to three new research organizations, bringing the total of those in receipt of grant from the Department of Scientific and Industrial Research to thirty-nine, with six other co-operative industrial research organizations which have not yet reached the status of research associations. Co-operative industrial research for the glass industry has been carried out at the Department of Glass Technology, University of Sheffield, since 1915; but while this Department will continue its long-term fundamental research, the work of more direct industrial interest will be undertaken by the new Association, to which a block grant of £10,000 a year has been offered for the period April 1, 1955–March 31, 1960, conditional on £20,000 being obtained from industry, and with up to an additional £12,000 on a cent-per-cent basis from industry. The Research and Development Committee of the Timber Development Association, which has acquired new premises near High Wycombe, has been offered a block grant of £14,000 a year for the period January 1, 1955–December 31, 1957, conditional on £28,000 coming from industry, with up to a further £4,000 on the cent-per-cent basis.

New terms of grant were offered to eight research associations and research councils during the year. The British Leather Manufacturers Research Association, for the period October 1, 1954–September 30, 1956, will receive a block grant of £16,000 a year, conditional on £32,000 coming from industry, with up to a further £12,000 on a cent-per-cent basis. From October 1, 1956, to September 30, 1959, the block grant will be conditional on the Association receiving £34,000 from industry. A special programme of research on the dyeing and pigment-finishing of leather has been commenced, and trials on goatskins in India through the monsoon indicate that sodium pentachlorophenate is effective in keeping sound skins in a good condition. Long-term investigations of the particle size of chromium complexes in solution indicate that the average size increases with the basicity of chrome tanning liquors. A method has been found by which soft and extensible leather backing can be made to adhere to glacé kid skins, and comprehensive washing trials have shown that while soap is harmless to chamois washing leathers, anionic detergents containing polyphosphates, as well as non-ionic detergents, are liable to cause damage.

The Cutlery Research Council, which for the period January 1, 1952–December 31, 1959, will receive a block grant of £3,000 a year, conditional on £4,000 coming from industry, and up to a further £3,000 on the cent-per-cent basis, continued its long-range project on the properties and heat treatment of cutlery stainless steel. In accordance with the change in emphasis to longer-term work of a more fundamental nature, projects have been initiated on the quality and characteristics of cutlery edges and a study of mechanical polishing processes and the surface finishes they produce. For the period January 1, 1955–December 31, 1959, the block grant to the Parsons and Marine Engineering Turbine Research and Development Association will be increased to £40,000 a year, conditional on £100,000 coming from industry, with up to a further £30,000 on the basis of £75 for each additional £100 from industry. Extensive tests on an experimental high-pressure, high-temperature steam turbine operating at 1100° F. and 1,100 lb./sq. in. are revealing the relative suitability of various materials for use under these conditions. An epicyclic turning gear incorporating a hydraulically operated disk brake for engagement and an automatic overload cut-out has been developed, and great advances made in the design of new bearings which have much lower power losses, greater overload capacity, and the ability to continue running after occurrence of oil failure.

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* Continued from p. 771.

The terms of grant to the British Internal Combustion Engine Research Association for the period April 1, 1954–March 31, 1957, are unchanged, providing a block grant of £15,000 a year conditional on £25,000 being received from industry, with an additional £10,000 on the usual basis. Further confirmation has been obtained of the accuracy of the Bicera method of evaluating crankshaft stiffness, and investigations of the running characteristics of a four-stroke cycle engine fitted with variable-ratio pistons continued, employing turbochargers of conventional type. Work on test rigs continued in order to determine the applicability to larger engines of previous findings in connexion with valve gear noise and a simplified form of pilot injection device, intended primarily for use with a hydro-pneumatically operated injection pump, has been developed.

The Motor Industry Research Association, which has completed its first year in its new laboratories at Lindley, near Nuneaton, will receive a block grant of £30,000 a year, conditional on £80,000 coming from industry, for the period July 1, 1955–June 30, 1960, with up to a further £30,000 on the basis of £75 for each additional £100 from industry. Work proceeded on a study of bending and torsional loads in the crankshafts of a 'square' petrol engine (in which the cylinder-bore and piston stroke are equal) and of a 10-litre, 6-cylinder, 4-stroke, compression-ignition engine. The effect of design features of cast crankshafts on the torsional fatigue strength was studied and also the causes of failure in service of splined axle shafts, and work initiated on torque converters included a critical survey of hydrokinetic, hydrostatic and mechanical converters and experimental investigation of a hydrostatic converter.

For the period October 1, 1956–September 30, 1960, the Linen Industry Research Association will receive a block grant of £15,000 conditional on £30,000 being received from industry, with up to an additional £10,000 on the cent-per-cent basis. In its spinning research, the Association has given priority to the development of a new servo-drafting control mechanism which permits greater regularity of yarn and the spinning of finer counts, and to a modified ring system for wet spinning which gives much greater productivity. Work on the macro-structure of the flax fibre continued and a new method of testing the water-proofness of cover canvas is being developed.

The Research Council of the British Whiting Federation, which has acquired additional premises at the Hall, Welwyn, in order to undertake pilot-plant work, will receive a block grant of £6,000 a year for the period January 1, 1956–September 30, 1959, conditional on £10,000 coming from industry, with up to an additional £2,000 on the cent-per-cent basis. The efficient use of fuel in the drying processes of the industry has been studied in the works of members and numerous recommendations made leading to appreciable economies, while work on hydraulic and air methods of classifying whiting continued. For the period January 1, 1956–December 31, 1958, the Research and Information Committee of the Furniture Development Council, since April 1955 housed under one roof in premises in Holloway, will receive a block grant of £6,000 a year, conditional on £10,000 coming from industry, with up to a further £4,000 on the basis of £80 for each additional £100 from industry. Research on cabinet construction, particularly the structure of cabinets made from wooden frames with thin panels attached, continued, the development of performance tests for domestic furniture has been completed and efforts are being made to develop simple and accurate means of assessing the properties of finishing materials, particularly lacquers.

Of the work of the remaining research associations, only a few points of interest can be mentioned here. The fundamental work of the British Baking Industries Research Association on natural oils in flour and bread indicates that the flour oil fraction considerably affects bread quality and is closely linked with the way in which bread quality is improved by shortenings and other substances. The British Boot, Shoe and Allied Trades Research Association has issued a major report on the comprehensive survey of the feet of more than two thousand adult women which introduces a new way of looking at and analysing foot measurements and may profoundly affect design of the last. The British Cast Iron Research Association has developed a promising technique for sampling molten metal for hydrogen estimation, and the British Ceramic Research Association's study of the health hazards associated with the towing of the edges of plates in the fettling process and the application of correct air-flow principles substantiated by ciné-photography in special lighting have led to the design of an exhaust hood which gives satisfactory control of the dust and is now being widely adopted by the industry. The British Coal Utilization Research Association's work on domestic appliances has shown that the central heating and hot-water supply demands of a house of medium size can be satisfactorily provided by a relatively small boiler of 6–10 sq. ft. heating surface, and in the trials two new systems of automatic control were developed and patented, utilizing the pressure differential available across the circulating pump. The British Coke Research Association has made further studies of the thermal conductivity of the coal charge during carbonization and of the properties of carbon and the process of carbonization. Extensive mill trials are proceeding of a hood and extraction system developed by the British Cotton Industry Research Association for fitting to carding engines, which, by reducing the dust content of the atmosphere by 90 per cent, is believed to reduce the accompanying disease of byssinosis. Further progress is reported of the Shirley Developments, Ltd., the activities of which are now beginning to affect appreciably the rate of application of scientific advances by the industry. The British Electrical and Allied Industries Research Association has installed an automatic equipment for cyclic tests on joints with live steam at a power station, and in experiments on polythene cross-linked by high-energy radiation has discovered a new type of intrinsic breakdown, in which the material fails mechanically under the electrostatic forces present. The British Hat and Allied Feltmakers' Research Association continued its study of damage to wool noils and a comprehensive large-scale study of the carrotting process. The Research Association of British Flour Millers continued to collaborate with the National Institute of Agricultural Botany in the effort to find wheat varieties of improved milling and baking quality, and also its work on the effect of improvers upon the quality of flour. The British

Food Manufacturing Industries Research Association extended its study of the melting and crystallizing behaviour of cocoa butter and of possible alternative fats; and the Fruit and Vegetable Canning and Quick Freezing Research Association continued its work on the effect of conditions of cutting and drying of harvested peas on their texture when canned as processed peas.

Steady progress was made by the British Gelatine and Glue Research Association in fundamental investigations into the structure, properties and mode of formation of gelatin and animal glue; and the Hosiery and Allied Trades' Research Association's investigations on crimped nylon products promise to facilitate a more precise control of their 'handle' and elastic properties. The permanent fireproofing process developed in the British Jute Trade Research Association's Laboratories retains its effectiveness even after immersion in sea water for four to five weeks and also after four months free exposure to atmospheric conditions. Further work by the British Launderers' Research Association has confirmed the effect of traces of impurities in the fibres on the extent of dirt removal produced by detergent solutions. A method recently developed in the British Non-Ferrous Metals Research Association's laboratories allows the fatigue limit of many materials to be determined in a few hours with only one specimen, and the Association has also developed the use of the direct-reading spectrograph, the quantograph, in the analysis of copper and copper alloys. The Research Association of British Paint, Colour and Varnish Manufacturers is using autoradiography to examine the migration of plasticizer from synthetic latex paint films into wooden substrates, and continued a special programme on the adhesion of paint films to their substrates.

The work of the British Paper and Board Industry Research Association is making a material contribution to scientific knowledge of the physical structure of papermaking fibres which it is hoped will lead to improved techniques for developing the physical characteristics in commercial pulp required to produce sheets of paper of satisfactory quality. A main object of the packaging research of the Printing, Packaging and Allied Trades Research Association is to improve the performance of packages so that they provide the maximum protection at the minimum cost. The British Rayon Research Association made further fundamental studies on the frictional properties of individual fibres with particular reference to the effect of diameter. The electromagnetic method of thickness-gauging devised by the British Scientific Instrument Research Association for use on lead-covered power cables has reached the stage of commercial exploitation.

The wide range of the contribution to industrial advance and to national welfare which the Department of Scientific and Industrial Research is making, both directly through its own research stations and indirectly through its support of the research associations and of fundamental research at the universities, is sufficiently illustrated by the foregoing examples. What should be no less apparent is that the real difficulty is to select from the many possible projects those on which public money can be spent to the best advantage. The increased provision made for the work of the Department over the past few years has not, in fact, permitted any real expansion: it has scarcely balanced the mounting costs of research. While the present report does not supply all the information required for a sound judgment, it does indicate the need for some careful consideration of the exact functions of the Department and of its place in the national organization of research when the Bill now before Parliament to change its administrative and financial arrangements is debated.

DETECTION AND DEVELOPMENT OF SCIENTIFIC ABILITY

On March 17, the British Social Biology Council held a conference on "Scientific Ability: its Detection and Development" at the London School of Economics. It was attended by a good number of teachers, representatives of Government departments, members of national organizations of a scientific nature, and representatives of industry. The purpose of the conference was to consider the influences acting on the minds of boys and girls in deciding whether or not to take up science; the ways in which scientific ability may be detected and developed; and the extent to which originality in science is subject to changing conditions. It brought to light three major points.

The first point was that although science is rapidly altering the material fabric of the economic world, and profoundly influencing all aspects of human culture, very little consideration is being given, at research level, to the nature of scientific ability itself and the conditions under which it develops. This is particularly true of Great Britain. Studies made in the past, chiefly in the United States, have little value in predicting scientific talent, since they fail to distinguish promise in this direction from that in other walks of human life, such as commerce, the arts and the professions. There is urgent need for new researches to be undertaken, drawing on the insights provided by recent progress in psychology.

The second point was that while latent intelligence is almost certainly inherited—a point that received no consideration at the conference—it is now fairly generally agreed that the manner in which it manifests itself is subject to influences of a personal and social nature. There does not appear to be any special mental characteristic that is essential for success in science; instead, given equal degrees of intelligence, the difference between the scientist and the artist, the teacher and the man of affairs, can be attributed to the accidents of family upbringing, educational training, and opportunities in the choice of a career. This realization carries with it a supplementary one that in varying degrees, depending on innate intelligence, there is still in the nation a large reservoir of potential scientific ability lying latent—both among boys, and to a still greater extent among girls, among whom its development presents special difficulties.

A third point was that owing to social pressures, tendencies that are recognized as being unfavourable continue in operation, on account of the absence of positive action to resist them. It was, for example, generally agreed that specialization ought not to take place in the schools until a boy or girl has reached the Ordinary level of the General Certificate of Education; but some of those present explained that they were powerless to resist the demands of parents who wanted their children to have the longest possible time in which to prepare for highly competitive examinations. Yet as a measure of attainment, the General Certificate of Education examination itself came in for criticism. At a later stage the same kind of pressures were seen to be exerting a bad effect on work done in polytechnics and similar institutions, the overcrowded syllabus leaving the students no time to pursue their own interests and investigations. These pressures will continue until a concerted effort is made to alter the character of examinations like those for the General Certificate of Education at Ordinary and Advanced level, the First M.B. and for university scholarships, so as to give less weight to the mere accumulation of knowledge that a candidate can carry in his head.

Prof. N. F. Mott opened the proceedings by emphasizing that the function of a university was to give specialized training of a high degree. He felt that in a cultural sense, breadth depended on studying some subject thoroughly and then seeing where it led. But he was aware of the dangers of excessive formalized teaching, and in favour of postponing some of it to courses leading to the Ph.D. degree. He felt compelled to recognize that, under present conditions, a certain amount of specialization at school was unavoidable.

Discussing the nature of scientific ability, Mr. Alec Rodger explained that it took a variety of different forms and that lines of demarcation were indistinct. After reviewing the studies that have been made of this problem, he thought that one might conclude that, in favourable circumstances, any reasonably able person might become a reasonably competent scientist (though he made an exception in the case of high ability amounting to genius); and since it appeared that general ability was convertible, he drew the conclusion that, in the schools, early specialization in any direction should be resisted. He put forward the suggestion that since young children are keen observers, it might be advisable to build up early training in science around some agriculture instead of the traditional chemistry and physics.

Mr. M. A. Brimer, of the National Foundation for Educational Research, also emphasized the unreliable nature of qualities which in the past had been held to be indicative of ability in science. Those that might be of value in the selection of a young scientist might prove of little reliability in assessing the capabilities of a mature research worker. Throughout the country there was no uniformity in the selection test at 11+ years of age, on the results of which children were transferred to grammar schools. The same was true of the test at 13+ years, upon which allocations were made to technical schools. He criticized the General Certificate of Education examination, which was allowed to take place without any check on its reliability; it covered a narrow range of attainment and had only a restricted scope. Basing his case on the argument that the variety of patterns of experience depended on the size of a school, he was in favour of comprehensive schools, and felt that the new ones to be built should be larger than those now in existence. Mr. Brimer suggested that in the schools guidance should be individual and continuous; he looked forward to this development as an essential part of the educational service, carried out by staff specially trained in psychometrics.

Problems relating to the teaching of girls were considered by Dr. E. M. Delf-Smith. Speaking generally, girls' schools experienced acute difficulties on account of the shortage of scientifically trained teaching staff, inadequate laboratory space and a poor supply of equipment. All this, she thought, constituted a great handicap for the nation, not only in a material sense, of girls being lost to science, but also in that conditions were allowed to continue which fostered an outlook on life that lacked a proper appreciation of the cultural value of science. She recognized that it was easier for girls to win places to universities in arts than in science, and that, as a whole, girls showed greater aptitude for biology than for physics; even so, if full use were made of their latent abilities, they would release men for work in the more technical fields, such as engineering.

For the afternoon session, Prof. R. M. Barrer was in the chair. He referred to the number of first-year men at the universities who appeared to have reached the upper limit of their capacity. They constituted a problem in selection, yet all forms of ability were needed by the nation. For success in science, however, certain personal characteristics were also essential, a point that, in his day, Faraday had appreciated.

Drawing on many years of teaching practice under school conditions, Mr. W. Llowarch, of the University of London Institute of Education, said that the most gifted young scientists that had passed through his hands had not fitted into any normal pattern of training; they had demanded individual attention. Yet a considerable proportion of them had elected to take up engineering although they had shown promise of being capable, after suitable training, of undertaking fundamental research. Teaching practice in the schools was still preoccupied with the factual and informational aspects of science, leaving too little time for independent inquiry. The good second-class boy, he thought, might have his interest aroused best if the approach were made through engineering or agriculture.

Mr. W. H. Dowdeswell, of Winchester College, said that observation and originality were the sparks that shone most brightly in a young scientist. All children were born experimenters; they rebelled against repetition and loved to pursue inquiries to which there was no known answer. Because of that, there was a wide difference in practical work between experiment and verification. He considered that for some of the most gifted boys, the last one or two terms at school, after the scholarship examination, were extremely valuable, providing the opportunity for ranging widely and pursuing individual lines of investigation. For non-scientists, he made a strong case for a course in general science at a late school stage. For similar, but still stronger, reasons he made a plea for the introduction of courses in Science Greats at the universities.

The discussion produced a convincing statement from Mr. A. J. Peters, of the National Foundation for Educational Research, on the need for more technical training. A survey on which he had been engaged had shown that the supply of pure scientists was comparatively good but that there was a serious shortage of technologists and technicians. Present school courses in chemistry and physics did not appeal to many boys willing and capable of taking up these occupations; and owing to the lack of adequate facilities, thousands of children in secondary modern schools were being lost to British industry. At the grammar school level, too, the lack of suitable equipment for training in applied science was almost universal. In suggesting that considerable scope remained for increasing the supply of young scientists, he was strongly supported by some other speakers, who considered that existing standards of requirements for entrance to industry should be critically examined and courses of training carefully reviewed.

As a whole, however, the discussion served to reveal once more the short range and empirical nature of the terms in which educational matters, and those relating specifically to training in science, are being considered not only by teachers but also by representatives of industry, members of public bodies and by many people at the universities, including a high proportion of scientists. These terms are not adequate for the effective assessment of the problems with which we are faced; still less can they be relied on to produce any satisfactory solution. A wider appreciation of the importance of fundamental research is essential, and with it must be associated a deeper understanding of the part that social forces play in the development and expression of all kinds of human ability. This is the only way in which, at this stage, the supply of scientists can be substantially increased. Only then will science take its true place in the cultural life of the nation.

OBITUARIES

Prof. W. H. Keesom

Prof. W. H. Keesom, whose death occurred in Leyden on March 3, was born on June 21, 1876, the son of a farming family at Texel, which is one of the small islands in the north of Holland. On this island the majority of the habitants make their living by lamb breeding. During many years the father of Prof. Keesom was a well-known figure on the lamb market of Leyden, which he regularly visited to deliver his lambs. His origin from the north established a strong impress on the personality of Keesom. So he was tenacious, but 'silent' and difficult in conversation. Also from his origin the young Keesom was not prepared to become a specialist in physics.. Because of his unusual intelligence, his parents sent him to Alkmaar to study there at the secondary school.

At the age of eighteen, Keesom started to study at the University of Amsterdam. There he followed the courses of van der Waals and van 't Hoff. It was under the influence of those great masters that Keesom's interest for physics appeared.

In 1900 Keesom left the University of Amsterdam and became assistant under Kamerlingh Onnes at the Physical Laboratory of the University of Leyden. There he worked for seventeen years (1900–17), first as assistant and later as conservator, under the direction of Kamerlingh Onnes on the thermodynamic properties of gases and specially of helium. In 1904 he obtained his doctorate under van der Waals at the University of Amsterdam with a thesis entitled "Isotherms of Mixtures of Oxygen and Carbon Dioxide". In 1912 there appeared his famous paper "Die Zustandsgleichung", in the "Encyclopadie der Mathematischen Wissenschaften".

Keesom left Leyden in 1917 to become lecturer and later professor in the University for Veterinary Science in Utrecht. There he developed a laboratory for X-ray analysis of the structure of solidified gases. In 1923 he returned to Leyden as successor to Kamerlingh Onnes, and since 1924 he had, with Prof. W. J. de Haas, directed the Kamerlingh Onnes Laboratory there. From that date the laboratory was divided into two sections (I and II): Keesom undertook the directorship of section I, which was specially devoted to the study of molecular physics; de Haas took for his part the field of magnetism.

After the success obtained by Kamerlingh Onnes in liquefying helium, the remaining programme consisted in making a systematic study of the physical properties of liquid helium. So Keesom started to study, with Wolfke, the dielectric constant of liquid helium. With Clusius, and later with his daughter Annie, he measured the specific heat of liquid helium. It is well known that those measurements led Keesom to the detection of the two phases of liquid helium, helium I and helium II. Just before 1926, Keesom had succeeded in solidifying helium. Also, in his attempts to obtain still lower temperatures, Keesom, together with Gaede, succeeded in 1932 in reaching a temperature of 0·7° K. by pumping off liquid helium. During his systematic study of the specific heat of metals and in particular of superconducting metals, Keesom detected with Dr. Kok the jump in the specific heat of tin.

Apart from his two famous discoveries, namely, the λ-point of liquid helium and the jump in the specific heat of superconducting metals, Keesom and his collaborators carried out a lot of important work in the field of molecular physics. Thus I may mention his systematic work on van der Waals forces by means of measurements on the equation of state, the vapour pressure curve of helium, adsorption of gases, viscosity of gases and liquid helium, the structure of condensed and solidified gases, etc.

To close his scientific career Keesom wrote his book "Helium", which contains essentially a complete report of his life-work on helium in the three states. It is also necessary to mention the important part played by Keesom in the organization of the Institut International du Froid and in the preparation for its international meetings. His various collaborators during those exciting times will remember the way in which he stimulated everybody to write their reports for those meetings. He liked to feel that the outside scientific world should be impressed by the work done at Leyden.

The Second World War stopped Keesom abruptly in his scientific work. As a consequence of the tragic events of those times, Keesom began to suffer from neurasthenia, an illness which had attacked him earlier, after the death of his first wife. He retired from the University of Leyden in 1945.

During recent years, Keesom had recovered intellectually and again found some interest in scientific problems, which he discussed with his son Piet, professor of physics in the University of Purdue, who is continuing the systematic work of his father on the specific heat of metals.

Keesom was known by his collaborators and friends as a severe but kindly director; he was always extremely helpful to young scientists and students.

A. Van Itterbeek

Brigadier J. A. Sinton, V.C., O.B.E., F.R.S.

John Alexander Sinton, who died on March 25, was born in British Columbia, of Ulster parents, on December 2, 1884. He was educated at the Royal Belfast Academical Institution and at The Queen's College, Belfast, where he was an exhibitioner. He graduated M.B., Ch.B., with first-class honours at the Royal University of Ireland in 1908, and after holding house appointments at the Royal Victoria Hospital, Belfast, became Riddell demonstrator in pathology at The Queen's University and clinical pathologist to the Ulster Eye, Throat and Ear Hospital and to the Mater Infirmorum Hospital. In 1911 he took the diploma of tropical medicine at Liverpool, and in the same year entered the Indian Medical Service.

During the First World War, Sinton served as a regimental medical officer in Mesopotamia and was awarded the Victoria Cross for most conspicuous bravery and devotion to duty during an action at Sheikh Sa'ed in 1916. He also received the Russian Order of St. George, and was mentioned in dispatches on four occasions. He was promoted brevet major in 1919 and saw further active service in Afghanistan and Waziristan, being again mentioned twice in dispatches and being appointed O.B.E. in 1921.

On reversion to civil employment in 1921, Sinton entered the Medical Research Department of the Indian Medical Service. He was in charge of the Quinine and Malaria Inquiry at Kasauli during 1921–30 and was director of the Malaria Survey of India from its foundation until 1936. He returned to England in that year, and in 1937 became Manson Fellow of the London School of Hygiene and Tropical Medicine and adviser on malaria to the Ministry of Health. He also carried out researches in the Malaria Laboratory, Horton. On the outbreak of the Second World War he was recalled to duty and, after a brief period in India, became consultant malariologist successively to the East African Forces, the Middle East Forces and the War Office. He finally retired in 1945 with the honorary rank of brigadier and settled down on a country estate at Cookstown in Northern Ireland. He took an active part in public affairs, being a justice of the peace and high sheriff for Tyrone.

Sinton's activities covered a wide field, but were principally concerned with the study of malariology in its various aspects. His researches on the chemotherapy of the disease were of outstanding importance and he also published a number of papers on its immunology, parasitology, laboratory and survey techniques and sociological effects. Among his other interests was the study of cutaneous leishmaniasis, on which he published several articles. He was also the author of a series of thirty-six papers on Indian species of *Phlebotomus*, on which he was a leading authority.

Sinton was elected a Fellow of the Royal Society in 1946 and received a number of other honours. He was awarded the Arnott Memorial Medal of the Irish Medical Schools and Graduates Association in 1917; the Chalmers Memorial Medal of the Royal Society of Tropical Medicine and Hygiene in 1928; the Bisset-Hawkins Medal of the Royal College of Physicians of London in 1944; the Robert Campbell Memorial Medal of the Ulster Medical Society in 1946; the Mary Kingsley Medal of the Liverpool School of Tropical Medicine in 1949; and the Manson Medal of the Royal Society of Tropical Medicine and Hygiene in 1956, an award which was announced only a few days before his death.

Sinton was a man of boundless energy, high moral rectitude and outstanding personal charm. He never spared himself in any of his endeavours and was a source of inspiration to all who came in contact with him. He was buried with full military honours near his home in County Tyrone.

G. Covell

Dr. A. G. Lowndes

Ashley Gordon Lowndes, who died on March 15 at Falmouth after an attack of pneumonia, has left his mark on science in several ways. His passion for investigation produced some valuable researches and, perhaps even more important, it generated in others a love of the subject and a rigour of method that have been the basis of many successful investigations. He went to sea in the Merchant Navy at the age of thirteen, until he was twenty-six, when the curate of a church in Portsmouth, where Lowndes was taking a Sunday School, recognized his brilliance as a teacher. The curate's father was the headmaster of Ardingley and he took Lowndes on to his staff. From there he went to Cambridge, where he was one of J. T. Saunders's first pupils and obtained a 'double first' and a 'swimming blue'. He joined the analytical staff of Nobel Industries as a chemist, and there his ideas led to several successful new processes.

The next phase of Lowndes's career was that Norwood took him to Marlborough as biology master, and it was here that he did his best work, both as teacher and investigator. He drove his pupils hard but gave them a real opportunity to see the fascination of living things and the possibility of exact investigation of them. It must be more than an accident that so many of them have proved to be successful investigators and teachers. His simple belief in scientific and moral principles, single-minded love of the subject and directness of statement, provided a compelling appeal to boys and an excellent basis for life.

Lowndes became interested at this time in Crustacea, and his series of papers on them are probably his best scientific work. He quickly mastered the systematics of the Entomostraca and contributed substantially to knowledge of freshwater copepods and ostracods. He would probably have been wise to concentrate on systematics, but it was characteristic of him to want to do more. By breeding experiments he showed that the superficially similar *Leptocyclops speratus* and *agilis* are unable to cross, although the various races of the latter do so freely. He then embarked on a study of locomotion and feeding, first in *Chirocephalus*, then in calanoids. He used elegant photographic techniques and obtained results that seemed to him unambiguous. But as he entered these experimental fields his aggressiveness led him into controversies of a type that often seemed unhappy; but were perhaps necessary for him. They became still more marked as he attacked more complicated problems, such as the mechanism of flagellar movement and the density of aquatic organisms. In such matters he usually had much of right on his side, but his simple approach sometimes let him down. The value of his work was recognized by the award of the Cambridge Sc.D.

He gave up his career at Marlborough to undertake research in a leper colony in West Africa, where he stayed for eighteen months. When asked why he had left he replied, "Well, it is obvious why the natives get leprosy and I told the authorities so, but they wouldn't listen to me. Since we have stopped them eating each other the only protein they get is an occasional snake".

After this he taught in a number of schools, though never with quite the same success as at Marlborough. He declared that of all the nine headmasters he had served under none could hold a candle to Norwood. He continued investigations on various biological and geological subjects, receiving much hospitality from the Marine Biological Association at Plymouth.

Lowndes carried always something of the sea about him, in his rolling gait, his simple directness and sharpness of observation. His influence will be felt by his pupils for more than one generation, and his contributions to knowledge of Crustacea may last even longer than that.

J. Z. Young

NEWS and VIEWS

Directorship of the British Scientific Instrument Research Association :

Mr. A. J. Philpot, C.B.E.

Mr. A. J. Philpot will retire in June from the directorship of the British Scientific Instrument Research Association, a post which he has held since 1937. Mr. Philpot had a distinguished academic career at King's College, London, and later, after active service in the First World War, at Cambridge in the Cavendish Laboratory under Lord Rutherford. In 1920 he joined the staff of the British Scientific Instrument Research Association soon after its foundation as the first of the co-operative industrial research associations to be established. As senior physicist of the Association he accomplished a large amount of experimental work, the results being recorded in publications and twenty-one research reports on subjects as varied as X-ray tubes, the stability of glasses, luminous compounds, thermometer liquids and the deposition by volatilization of reflecting surfaces on glass. In 1937 Mr. Philpot was appointed director of research and secretary of the Association, in succession to Dr. Harry Moore, and soon his responsibilities were greatly enlarged by the Second World War. In 1943 he was appointed chairman of the new Inter-Service Optical Instrument Committee which did vital co-ordinating work. Though the laboratories of the Association, in Russell Square, London, were damaged by a bomb, many firms new to instrument manufacture were helped to master the problems of design and production, and the end of the War found the Association with a greatly increased membership but quite inadequate laboratory space. New premises were found on the outskirts of London, new departments were established and new staff engaged, and Mr. Philpot found himself director of an organization which had multiplied its size by five in a couple of years. At the same time, he undertook new duties, being for a number of years director of the Scientific Instrument Manufacturers' Association, the trade association of the industry. Mr. Philpot has played an active part in the affairs of scientific societies concerned with physics and instruments, and has been vice-president and treasurer of the Physical Society, vice-president of the Institute of Physics, and vice-president of the Society of Instrument Technology.

Dr. J. Thomson

Dr. J. Thomson, who will succeed Mr. Philpot, is a graduate of the University of Glasgow, being awarded the Kelvin Medal of the University in 1932 for research in mathematical and experimental physics. He lectured in physics at the Universities of Reading and Glasgow until the end of 1939, when he joined the Admiralty Signal School at Portsmouth. During the Second World War he was engaged in research on microwave devices, and his work included service with a Royal Marine Commando Unit throughout the German campaign. After the War he was appointed professor of physics and electrical engineering in the Royal Naval College, Greenwich, and later he became the deputy director of physical research (C.V.D.) at the Admiralty with responsibility for research and development in the field of electronic valves on behalf of the three Armed Services. Last year he also undertook the editorship of the new *Journal of Electronics*. His published work includes three books and many research papers.

Presidency of the Society of Glass Technology :

Dr. J. H. Partridge

At the annual general meeting of the Society of Glass Technology, held in Sheffield on April 25, Dr. J. H. Partridge was elected president, in succession to Sir Graham Cunningham, who has retired after serving for two years. Dr. Partridge graduated in metallurgy from the University of Birmingham in 1924, and four years later joined the Research Laboratories of the General Electric Co., Ltd. ; he is now head of the Company's Glass, Refractories and Ceramics Department. He has published more than thirty papers on studies relating to metals, glass and refractories and is the author of "Refractory Blocks for Glass Tank Furnaces" (1933) and "Glass-to-Metal Seals" (1947). Dr. Partridge has been a vice-president of the Society of Glass Technology and was honorary general secretary during 1946–49.

New Foreign Members of the Royal Society

The following have been elected foreign members of the Royal Society : Kai Ulric Linderstrøm-Lang (Copenhagen), distinguished for his contribution to protein chemistry and for his pioneer development of ultra micro-techniques for the biochemical study of the localization of enzymes in tissue cells ; Hans Pettersson (Göteborg), distinguished for his researches in oceanography ; Robert Burns Woodward (Cambridge, U.S.A.), distinguished for his investigations in organic chemistry, especially on the synthesis of important natural products such as quinine, cortisone and antibiotics ; Fritz Zernike (Groningen), distinguished for his researches in phase-contrast microscopy.

Royal Society Delegation to Moscow

AT the invitation of the Academy of Sciences of the U.S.S.R., the Royal Society is sending a delegation to Moscow under the auspices of the Soviet Relations Committee of the British Council. The delegation will leave on May 18 and will spend a fortnight in the U.S.S.R. visiting scientific institutions. Lord Adrian, the immediate past-president of the Royal Society, will lead the delegation, and other members are: Lady Adrian; Dr. H. G. Thornton, foreign secretary of the Royal Society and head of the Department of Soil Microbiology at Rothamsted Experimental Station; Miss M. L. Cartwright, mistress of Girton College, Cambridge; Prof. J. H. Gaddum, professor of pharmacology in the University of Edinburgh; Prof. J. M. Robertson, professor of chemistry and head of the Chemical Laboratories of the University of Glasgow; Prof. M. Stacey, professor of chemistry in the University of Birmingham; and Dr. D. C. Martin, assistant secretary of the Royal Society.

Merck Institute for Therapeutic Research

THE facilities and staff of the Merck Institute for Therapeutic Research have been approximately doubled recently by the incorporation of several research groups at West Point, Pa., which were formerly part of the Sharp and Dohme Division of Merck and Co., Inc. There is now a staff of more than three hundred, sixty-five of whom hold M.D. or Ph.D. degrees. The Merck Institute, which was founded in 1933, is a separately incorporated organization of Merck and Co., Inc., its function being to investigate the biological properties of new drugs and chemicals and to conduct fundamental research in the medical and veterinary sciences. Besides its laboratories at Rahway, N.J., and West Point, Pa., it also has Branchburg Farm, a two-hundred acre experimental farm at North Branch, N.J. Dr. L. Earle Arnow, formerly vice-president and director of research of the Sharp and Dohme Division, has been appointed executive director of the Merck Institute and will direct all the activities of the various branches of the Institute. Dr. Hans Molitor, director of the Institute since its founding in 1933, has been elected chairman of the board of trustees of the Institute in succession to George W. Merck, and at the same time has been appointed director of scientific relations of the Merck Sharp and Dohme Research Laboratories, with the responsibility for the development of relations with investigators in the United States and abroad. Other appointments in the Institute are as follows: Dr. Harry J. Robinson, formerly associate director, to be director of the Rahway unit; and Dr. Karl H. Beyer, formerly head of pharmacological research at Sharp and Dohme, to be director of the West Point unit.

Statistics of Scientific Workers and Technologists in Britain

IN reply to a question in the House of Commons on April 18, the Secretary of State for Air said that about 7,500 graduate scientists and technologists of equivalent standing are employed in a civilian capacity in defence establishments in Britain, and about 3,000 men with such qualifications are doing National Service. The number of officers and men in all three Armed Services with scientific qualifications of this standard is not readily available. In reply to a further question on April 19, the Financial Secretary to the Treasury, Mr. H. Brooke, stated that it is not possible to give an estimate of the proportion of science graduates who, on leaving college, take up work in defence and civilian organizations, respectively. The only information is derived from returns by university authorities, which are not comprehensive and do not distinguish between work in defence organizations and in civilian organizations. Asked for an assurance that no part of the proposed £100 million savings in government expenditure would be made at the expense of technological education, Mr. Brooke said that the Government attaches the highest importance to increasing the numbers of scientific and technological graduates from the universities.

In a written answer on April 13, the Chancellor of the Exchequer gave the number of university students taking first degrees and diplomas in pure science during 1954–55 as 5,304. Of these, 2,226 were pass degrees and diplomas, and 558 general honours degrees; honours degrees in mathematics were 504; in biological sciences, 380; chemistry, 917; physics, 597; and in geology and related sciences, 122. For technology, the figures were: pass degrees and diplomas, 1,912; honours degrees in civil engineering and building, 215; chemical technology, 123; mechanical and aeronautical engineering, 191; electrical engineering and electronics, 158; mining, 52; metallurgical engineering and metallurgy, 114; general engineering, 364; other technologies, 36; and architecture, 56.

National Reference Library Plans

THE Chancellor of the Exchequer was questioned again in the House of Commons on April 24 about the funds he proposed to make available for the establishment of a National Reference Library of Science and a Lending Library. Mr. Macmillan said in reply that he is making £2,500 available during the current year for the purchase and binding of scientific periodicals as a beginning to the Lending Library, and that £10,350 has been included in the estimates for the purchase of books and periodicals for the Patent Office Library. This Library will eventually form the basis for the National Reference Library, but Mr. Macmillan declined to add anything to Mr. Bevin's statement on November 1 as regards capital expenditure. The proposals of the Advisory Council on Scientific Policy are still being considered. In a written answer on April 20, the cost of the new National Library in Bloomsbury was estimated as about £10 million.

Scientific Research in British Universities, 1954–55

THE Department of Scientific and Industrial Research has prepared a volume, "Scientific Research in British Universities, 1954–55", which provides brief notes indicating the scientific research in progress in British universities and university colleges during the academic year 1954–55 (pp. 572. London: H.M.S.O., 1955; 12*s.* 6*d.* net or 2.25 dollars). The material has been collected by the British Council from the heads of departments of the university institutions concerned and is issued by the Department of Scientific and Industrial Research with the agreement of the Agricultural and Medical Research Councils. Entries are limited to permanent members of the staff normally engaged in supervising research.

As in previous issues, entries are arranged alphabetically first by universities, and then under the university by departments. There are a name list and an alphabetical subject index to research programmes. Although some major institutions have supplied no information, this is a formidable volume running to nearly six hundred pages.

Nuclear Engineering

The Temple Press is to be congratulated on the high quality of the first number of its new publication, *Nuclear Engineering* (1, No. 1; April 1956; 3*s.* 6*d.* per copy, annual subscription 42*s.*). This journal should appeal not only to qualified engineers engaged in the design of nuclear reactors, but also to those interested in the uses of radioactive isotopes, or in the instrumentation associated with these two topics. Of the fourteen articles, five give details of particular reactors, one outlines the Central Electricity Authority's plans for the generation of electrical power by nuclear fuel, two deal with the production, transport and disposal of radioactive isotopes, and one with instrumentation. The remaining articles discuss the training of nuclear engineers, the Harwell Reactor School, the structure of the United Kingdom Atomic Energy Authority and the development of glandless pumps. The final article is "An Introduction to Nuclear Energy". An interesting section of this journal, and one which will be a regular feature, includes editorial comments, news items, both from home and from abroad, of interest to those connected with nuclear engineering, trade events and developments, and personalia. There are also abstracts of technical papers and a section dealing with processes and equipment, both of which should assist many who find difficulty in keeping abreast of the very rapid development of this field. Advertisements from nearly one hundred advertisers show the very large part that industry is now playing in the development of nuclear energy in Britain. Finally, the Temple Press shows its awareness of the necessity for training nuclear engineers to a high standard by its announcement of a postgraduate scholarship, tenable at any British university, for studies directed towards the engineering aspects of nuclear energy.

New Form of *Science Abstracts*

COMMENCING with the January issues (Vol. 59), both *Physics Abstracts* and *Electrical Engineering Abstracts*, Sections *A* and *B*, respectively, of *Science Abstracts*, appear in a completely new form. The page size has been increased to 11 in. × 8½ in., and the text is printed by photolithography from typewritten material, the whole of the typing and mounting being done in the office of *Science Abstracts*. The adoption of this new method has long been contemplated, not only because of the increasing cost of good letterpress printing, but also because it is technically better suited to the production of a periodical like *Science Abstracts* than the orthodox methods of printing. The abstracts are typed and corrected for press, arranged in order for the monthly issue and the papers made-up by pasting the abstracts into position. Once the pages have been photographed, no further proof-reading is necessary. Fresh items can be included up to a very late stage in the process. This method, which is not possible with ordinary metal-type printing, saves considerable time, and it is hoped, also, that there will eventually be considerable advantage in the publication of the annual indexes, by the development of new methods of assembling and reproducing the entries. Though the new form cannot equal the standard of good letterpress printing, by the use of semi-automatic electric typewriters a high standard of appearance, clarity and legibility is achieved. The increased page-size allows a longer line to be used. Apart from the increased page size and the new method of printing, no other change has been made in the preparation of the abstracts, and the contents, classification and indexing follow the accustomed pattern. Each abstract is given its appropriate Universal Decimal Classification number and headed by the English title of the article, the authors' names and the location of the article, together with a statement of the language, if foreign. The length of the article is also indicated.

Daedalus: a Journal of the American Academy of Arts and Sciences

THE journal which in the future will appear under the title of *Daedalus* (86, No. 1; 1955) is, in fact, the continuation of the *Proceedings of the American Academy of Arts and Sciences*, the volume serial numbers of the *Proceedings* being continued. The charter of incorporation granted to the American Academy of Arts and Sciences by the Massachusetts Legislature in 1780 summarized the purpose of the Academy as being "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people". The new *Daedalus* does not aim at popularization, but it hopes to attract the interest of all classes of scholars. In the experimental stages, it will appear at irregular intervals, with not less than two issues in each calendar year, but eventually it is hoped that regular quarterly numbers may become possible. The present number includes articles on Daedalus; a catalogue of *H* (II) Regions in the Milky Way; physical problems of photosynthesis; Count Rumford on photosynthesis; publishing the papers of great men; and art as the function of an audience.

Centre International d'Epistémologie génétique

As a result of a grant from the Rockefeller Foundation, the Centre International d'Epistémologie génétique was recently established in the Faculty of Science, University of Geneva, under the direction of Prof. Jean Piaget. The Centre, which was opened on October 1, 1955, is an interdisciplinary one, and is closely asssociated with the Department of Psychology, University of Geneva. It consists of a team of research workers (from the logico-mathematical, natural and psychological sciences) interested in the experimental and theoretical study of developmental behaviour. Its members are L. Apostel (logic and axiomatization in behavioural science), B. Inhelder (child development), B. Mandelbrot (language, decision theory and information theory), W. Mays (logical machines and cybernetic models), A. Morf (research on mental development of logical reasoning), J. Piaget (genetic psychology) and J. Rutschmann (genetical evolution of perception and physiological mechanisms). The general topic of study for the present year is the relation between logical structures and the behaviour and thought of the subject in his development. A guest symposium on this topic will be held in July next, when the first publication of the Centre will also appear. Inquiries and correspondence should be addressed to the acting secretary, Mlle. S. Taponier, Centre International d'Epistémologie génétique, Geneva 14.

Science Museum Classified Lists of Historical Events

A VALUABLE new series of inexpensive pamphlets, under the general title of "Classified Lists of Historical Events", has been issued by the Science Museum, London, the first being on "Mechanical and Electrical Engineering, including Energy Conversion, Transmission and Storage; Atomic Energy; Pumping, Blowing and Compressing Machinery; Explosives and Ordnance", compiled by G. F. Westcott (pp. 40. London: H.M.S.O., 1955; 2*s*. net). The lists contain the dates of the principal scientific discoveries and their authors, from the earliest times to the present day. The references are naturally very much fuller for the past hundred years than for earlier ones. The compiler has had to contend with a most difficult problem of selection and classification, and it would be only too easy to disagree with the items chosen for mention or omission in a particular list. It is satisfactory that experimental and development work is not allowed to take entire precedence over analytical and theoretical work, and it is also good to see that, for the most part, the events noted are the successful applications rather than the suggestions that never came to commercial fruition. The compiler requests ideas for improvement, and one such suggestion is that two indexes should be added: a name index and a subject index, giving against each entry the dates on which the person or object is mentioned. This would be a great asset to the use of these lists; it would not be too formidable to compile, and would not require alteration in subsequent editions.

New Germanium Phototransistor

THE introduction by Mullard, Ltd., of a germanium phototransistor, type *OCP*71, which is similar in form to a conventional low-power junction transistor, opens up new possibilities for compact, inexpensive, light-operated devices. The phototransistor is sufficiently sensitive to operate a relay of normal type directly. It is of the *p–n–p* alloy type, and for most applications the base is left floating so that only two connexions to the phototransistor are required. The dark current at 25° C. is less than 300 μamp., while the light current, for a sensitive area of 7 sq. mm., can be of the order of 4 m.amp. The spectral response ranges from the visible into the infra-red region, with a peak at 1·55μ and a cut-off at 2μ. The phototransistor is not suitable for use above 40° C., and the optical cut-off frequency (that is, the maximum frequency of response when the light source is chopped or otherwise interrupted) is in the region of 3 kc./s. The overall size, including the glass envelope, is 15 mm., and its small size, together with its low voltage operation and other characteristics, make it particularly suitable for tape and punched-card reading in addition to most industrial control applications such as photoelectric counters, speed measurement, liquid-level controls, edge detection in paper-making and textiles, etc., and burglar alarms.

Oil in the Karroo Series, South Africa

COMMERCIAL oil developments in the Union of South Africa have often been mooted in the past, especially in the Karroo rocks; but it has hitherto proved to be misguided optimism. Memoir 45 of the Geological Survey (pp. 130. Pretoria: Department of Mines, 1953; 10*s*.), which has only recently been received, gives results of a comprehensive field-examination of oil possibilities in this series. The conclusion is reached that results rule out the areas mapped as likely sources of petroleum. The main evidence of possible occurrence of oil in southern Karroo is the presence of 'pseudocoal', a solid product apparently derived from hydrocarbon distillation at a temperature not more than 400° C., found in joints and veins in sediments. But pseudocoal is as elusive a surface indication as crude oil is itself in the Union. When it is categorically stated that "it is hoped that the present description of the results obtained by the State will discourage future waste of private money and energy that could be diverted to more profitable uses", then it would appear that the swan-song of Karroo oil has at long last been realized.

Latex of Apocynaceae

A COMPREHENSIVE study has been made by J. van Die of some aspects of latex-particle formation in species of the order Apocynaceae (*Ann. Bogorienses*, 2, 1, 1–214; 1955). The latex-coagulate, comprising all the particulate matter in a latex, has been analysed in some forty species of about twenty-five genera. Like latex-coagulates in general, these latices have been found to contain only a few types of compounds, these being closely related chemogenetically, such as the polyisoprene hydrocarbons (rubber and gutta), triterpenes and fatty acids, which all appear to be built up enzymically from acetate carbon via acetoacetate. Little is known about the origin of cinnamic acid, which is found occasionally in latex-coagulates. Since the particles may represent some 40–90 per cent of the constituents of dry latex, it is inferred that their formation is quantitatively one of the most important functions of the latex cell. The composition of the coagulate varies little from one part of a plant to another, and this is also true for the average degree of polymerization of the polyisoprene. Only *cis*-polyisoprene (rubber) has been found in the plants examined. The acetone-soluble substances of the latex-coagulates have been analysed by column chromatography. They consist in all cases of triterpenyl esters and triterpenols. Digitonin-precipitable compounds were never found, so that phytosterols form less than 1–2 per cent of the unsaponifiable substances present. From the analyses it is concluded that acetate carbon is the precursor of the particles. They are built up by the particle-forming centres into polyisoprene, triterpenols and fatty acids. In some cases, latex-particle compositions can serve as an indication of the systematic relationships of species and forms which are difficult to distinguish morphologically (for example, *Plumiera*), but, generally speaking, they cannot be used for tracing connexions between individual genera.

National Research Council, Canada: Members

THE following have been appointed new members of the National Research Council, Canada, for three years from April 1: Prof. I. McT. Cowan, professor and head of the Department of Zoology, University of British Columbia, Vancouver; Prof. J. H. L. Johnstone, head of the Department of Physics and dean of the Faculty of Graduate Studies, Dalhousie University, Halifax; Prof. R. B. Miller, professor of zoology in the University of Alberta, Edmonton; and Prof. B. W. Sargent, professor and head of the Department of Physics, Queen's University, Kingston. Two other members have been reappointed for a further term of three years: Prof. R. F. Farquharson, professor and head of the Department of Medicine, University of Toronto; and Dr. David L. Thomson, vice-principal of McGill University, Montreal.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: J. Cook (chief field officer, Federation of Malaya), director of agriculture, Sarawak; V. E. Gale (senior agricultural officer, Western Region, Nigeria), principal agricultural officer, Western Region, Nigeria; J. R. G. Hadland (principal cocoa officer, Western Region, Nigeria), assistant director (cocoa), Western Region, Nigeria; J. O. Torto (food production commissioner, Gold Coast), deputy director of agriculture, Gold Coast; H. Vine (senior specialist officer, Federation of Nigeria), principal research officer (soils), Western Region, Nigeria; D. F. Davidson (senior assistant conservator of forests, Cyprus), conservator of forests, Cyprus; J. A. D. Jackson (assistant conservator of forests, Northern Region, Nigeria), senior assistant conservator of forests, Northern Region, Nigeria; J. C. K. Mashall and F. S. Walker (conservators of forests, grade B, Federation of Malaya), conservators of forests, grade A, Federation of Malaya); H. G. Burks (metallurgist, Tanganyika), chief research officer, Geological Survey, Tanganyika; A. R. Melville (senior research officer, Kenya), chief research officer, Agricultural Department, Kenya; J. M. Waterston (research adviser, Federation of Nigeria), director of agricultural research, Federation of Nigeria; M. J. Fitzpatrick (veterinary investigation officer, Northern Region, Nigeria), principal veterinary officer (research), Northern Region, Nigeria; R. D. Fotheringham (livestock officer, Northern Rhodesia), dairy and poultry officer, Northern Rhodesia; E. P. Rice (assistant director of veterinary services, Kenya), deputy director of veterinary services, Kenya; A. Angus, plant pathologist, Northern Rhodesia; M. Bigger, entomologist, Tanganyika; R. A. Fitton, agricultural officer, Gold Coast; W. A. Hope, specialist assistant, Northern Region, Nigeria; S. B. Boaler, assistant conservator of forests, Somaliland Protectorate; G. H. Brister, assistant conservator of forests, Kenya; S. H. Inchbold-Stevens, assistant conservator of forests, Trinidad; U. L. S. Murthy, assistant conservator of forests, Sarawak; E. J. G. Swellengrebel and A. T. Vink, assistant conservators of forests, British Guiana; W. W. Bishop, pleistocene geologist, Uganda; R. Bradshaw, specialist adviser (petrologist/geologist), British Guiana; J. Brazell, director, East African Meteorological Department, East Africa High Commission; J. F. McCloy, senior scientific officer, East African Industrial Research Organization; E. B. Halpin, veterinary officer, Northern Region, Nigeria.

Announcements

PROF. D. KEILIN, lately Quick professor of biology and director of the Molteno Institute, University of Cambridge, has received the degree of doctor of medicine *honoris causa* of the State University of Utrecht, on the occasion of the 320th anniversary celebrations of the University.

DR. R. N. BRACEWELL, formerly of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Australia, has joined the Radio Propagation Laboratory of Stanford University, California, as associate professor of electrical engineering; with support from the United States Air Force Office of Scientific Research, he is planning to obtain daily spectroheliograms at 9 cm. wave-length using a Mills cross-aerial with a cone of reception of 10^{-6} stereradians.

THE fourth meeting of the General Fisheries Council for the Mediterranean will be held in Istanbul, during September 17–22. The member countries of the Council are Egypt France, Great Britain, Greece, Israel, Italy, Monaco, Spain, Tunisia, Turkey and Yugoslavia, but other countries and international organizations can send observers. Those who wish to submit papers should write before May 15 to the Secretary, General Fisheries Council of the Mediterranean, Food and Agriculture Organization, Viale delle Terme di Caracalla, Rome.

THE Institute of Physics, in conjunction with the British Nuclear Energy Conference, has arranged a conference on "The Physics of Nuclear Reactors", to be held in London during July 3–6. The proceedings of the conference will be published as a supplement to the *British Journal of Applied Physics*. An allotment of places (without payment of conference fee) has been made to members of the other constituent bodies of the British Nuclear Energy Conference, namely, the Institutions of Civil, Mechanical, Electrical and Chemical Engineers. Application forms for the conference and further information can be obtained from the Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

As part of the summer programme of the Massachusetts Institute of Technology, arranged by Prof. Ernest H. Huntress, director of the Institute's Summer Session, a number of short courses will be held by the various Departments as follows: June 18–29, modern food technology; June 25–July 6, aerodynamic heating of aircraft structures in high-speed flight; August 6–17, orbital and satellite vehicles in space flight; August 13–17, analogue-digital conversion techniques; August 20–31, tropical hurricanes; August 20–31, modern communication theory; August 20–31, molecular engineering. Application forms for these courses and further information can be obtained from the Summer Session Office, Room 7-103, Massachusetts Institute of Technology, Cambridge 39, Mass.

THE French National School for Geographical Sciences will hold a course during June 4–July 13 on the theory and practice of aerial photogrammetry. The course, like those of previous years, is designed for non-French students wanting to familiarize themselves with instruments and methods currently used in France. Lectures will be delivered in French, with explanations in English and Spanish for those not fluent in the French language. The fee for the course is 20,000 francs. Application should be made by May 15 to the Director, École National des Sciences Géographiques, 2 Avenue Pasteur, Saint-Mandé (Seine), from whom further information can be obtained.

THE proceedings of a symposium on cell secretion which took place in March 1955 at the Institute of Biology of the University of Minas Gerais, S. Paulo, have now been published. The volume has been edited by G. Schreiber, and inquiries for it should be sent to him at the Instituto de Biologia, Faculdade de Filosofia, Universidade de Minas Gerais, Belo Horizonte, Brazil.

NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C.

REPORT FOR 1954–55

THE fifth annual report of the National Science Foundation, Washington, D.C.*, covering the year ended June 30, 1955, includes a brief review of the operation of the Foundation during its first quinquennium, but otherwise follows the pattern of the fourth report. The report of the director, Dr. A. T. Waterman, is in two parts: the first discusses some current aspects of American science, such as the loyalty and security considerations which determine the Foundation's grants for non-classified scientific research; the forthcoming International Geophysical Year, synthetic rubber research and development and the indirect costs of research supported by Federal grant or contract at educational institutions; the second reviews the work of the Foundation itself during the year. A foreword by Chester I. Barnard emphasizes the importance of leadership by the Federal Government not only in the financial sphere, but also in developing an adequate supply of scientists if science is to make its full contribution to the public welfare. Such leadership rather than direction is the Government's function, and the need for co-ordination can be met best by fostering the collection of facts regarding all aspects of the scientific situation and facilitating communication between scientists and scientific institutions. Appendixes occupying almost half the report list the personnel of the Foundation's Board and its advisory panels and committees, the basic research grants and fellowships awarded during the year, publications of the Foundation and the financial report.

During the year ended June 30, 1955, the Foundation made 588 grants, totalling 7,857,395 dollars, to 184 institutions for the support of basic research in the natural sciences. Of these, 275 (totalling 3,542,495 dollars) were in the biological and medical sciences and 313 in the mathematical, physical and engineering sciences. During the period 1952–55 the Foundation has made 1,232 grants totalling 14,316,140 dollars in support of basic research in the natural sciences, and the present report stresses the special efforts of the Foundation to foster co-operative research with nuclear emulsions (for which purpose a second conference was sponsored at De Pauw University on March 30, 1955), research on the solid state, on high-speed computation and in geochemistry. Grants have been made for the assistance of biological field stations, and a limited programme of support of the social sciences was approved in August 1954. The programme is being administered within the framework of the Foundation's three scientific divisions, using the criteria of science (that is, the identification, within the social disciplines, of those areas characterized by the application of the methods and logic of science), national interest, convergence of the natural sciences and social sciences, and basic research. The Foundation has also established a continuing programme for providing funds to medical schools for research stipends to medical students.

In March 1955 the Foundation announced the award of 715 fellowships and 70 post-doctoral fellowships for advanced study in the natural sciences for the year 1955–56. Of these, 225 were in the biological sciences, 183 in chemistry, 108 in engineering, 31 in the terrestrial sciences, 63 in mathematics and 175 in physics and astronomy. A research programme on techniques for fellowship selection over the past three years has led to some modifications and simplifications in the methods used in selecting. Three further conferences on the role of physics in engineering education were held during the year under review, dealing with mechanics, with thermodynamics and with electricity and magnetism. The Foundation continued to sponsor a series of summer institutes for science teachers and instituted a survey of the educational and vocational attitudes of high-school leavers in an attempt to discover why talented youths often fail to continue education. The survey was able to arrive at an estimate of the numbers of those who wished to proceed to college but would be prevented from doing so.

The Foundation is also extending its interest in the exchange of scientific information and is urging scientific societies to seek some permanent solution of their publishing difficulties and to undertake studies that will lead to a clearer understanding of the facts and problems of scientific publication. The Foundation is supporting the publication by the Science Division of the Library of Congress of comprehensive lists of United States and Russian scientific serial publications as well as a list of the world's biological serial publications, and also a study in the Technical Information Division of the Library of Congress to determine the extent to which information first available in unclassified government reports is afterwards published. Funds have been provided for bringing up to date the indexes for *Biological Abstracts* and for a thorough study of biological abstracting, and the Foundation is also attempting to promote fundamental research on methods of organizing information and on the feasibility of translation by machines. Continuing support was given to the translation and publication of an English edition of the Russian *Journal of Experimental and Theoretical Physics* and to the Scientific Translations Centre of the Library of Congress, and 132 scientists were given grants enabling them to attend twenty-nine different international scientific meetings.

Including those already noted, the National Science Foundation sponsored, alone or jointly with other bodies, twenty-one conferences convened during the year to examine special areas of science, chiefly where adequate support was not available from industrial or other sources. They included an international symposium on problems relating to arid lands, sponsored jointly with the American Association for the Advancement of Science, the United Nations Educational, Scientific and Cultural Organization, and the University of New Mexico; conferences on the crust of the Earth, the anomalous magnetization of rocks, man's role in changing the face of the Earth, the cosmic distance scale, and on genetic, psychological and hormonal factors in the regulation of patterns of sexual behaviour in mammals; mathematical tables; research in the history, philosophy and sociology of science, the mechanics of sediment transport, radiocarbon dating, the evolution of behaviour, the theory of numbers, mathematical statistics and probability, problems of nuclear structure, molecular quantum mechanics and high-energy nuclear physics; the twentieth Cold Spring Harbor Symposium on Quantitative Biology, at which special emphasis was given on population genetics; and the fourteenth Growth Symposium of the Society for the Study of Development and Growth. Some 137 scientists from the United States and abroad were assisted to attend the Garden Research Conferences.

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* National Science Foundation. Fifth Annual Report for the Fiscal Year ending June 30, 1955. Pp. 159 + ix plates. (Washington, D.C.: Government Printing Office, 1955.) 50 cents.

Appropriations for services and equipment for the International Geophysical Year totalled 1,914,957 dollars, and during the next fiscal year the Foundation plans to make a full evaluation of current basic research activities on synthetic rubber, the average annual expenditure on contract research, which at universities and other institutions during the quinquennium ending June 30, 1955, exceeded 1,118,000 dollars and at the government laboratory at Akron 1,094,000 dollars. The Foundation assumed responsibility on July 1, 1955, for administering the Federal programme for basic research on synthetic rubber. At the request of the Bureau of the Budget the Foundation has also given special attention to the indirect costs of research supported by Federal grant or contract at educational institutions and has recommended procedure for reimbursing such indirect costs where requested. Adoption of the policy is estimated to involve an additional cost to the Federal Government of not more than 8 million dollars, or 2·3 per cent of the present Federal expenditure on research in such institutions. As regards the loyalty and security considerations in making grants for non-classified scientific research, Dr. Waterman affirms that the Foundation will not knowingly support anyone who is, by admission or conviction, disloyal to the United States; its grants will be made on the judgment of outstanding scientists in his field and of persons possessing personal knowledge of his competence and integrity.

RESEARCH IN SEMICONDUCTORS

SYMPOSIUM AT OTTAWA

A SYMPOSIUM on semiconductors took place during February 13–14 at the National Research Council Laboratories, Ottawa, at the invitation of the Low Temperature and Solid State Physics Group of the Division of Pure Physics; the arrangements followed the lines of the symposium on melting reported in *Nature* of January 7. The chairmen were Dr. D. K. C. MacDonald and Dr. W. B. Lewis.

When opening the meeting, Dr. MacDonald said that the subject of semiconductors was chosen because of widespread interest throughout Canadian universities and laboratories. The Low Temperature and Solid State Physics Group is specifically interested in bulk properties, and is investigating magnetic susceptibility and the thermal and electrical conductivities, as well as the occurrence of semiconductivity in intermetallic compounds; but the scope of the meeting in general would be much wider. Later, Dr. Lewis said that quite apart from the revolution it has effected in electronics, research in semiconductors may well provide a basis for a new statistical treatment of processes whereby energy is stored and dispersed. In nuclear reactors, energy is produced initially in a very intense form, and dispersed under conditions far from thermal equilibrium. The processes of dispersal and degradation of this energy, until it emerges as heat, seem to require a statistical approach which would be essentially different from the traditional equilibrium theories of thermodynamics and thermal fluctuations, and yet would to some extent take their place.

In the first of two papers, R. E. Burgess (University of British Columbia) outlined the theory of statistical fluctuations of both the spatial and temporal distributions of electrons among the energy-bands and -levels in a semiconductor; these give rise to 'patch' effects and noise, respectively, and the theory can be compared with experiment. In his second paper, mathematical analysis of the characteristics of germanium point-contact diodes (showing voltage turnover) was shown to lead to severe restrictions on conjectural models: possible mechanisms were discussed, and in particular a model due originally to Gunn appeared to be consistent with these restrictions.

W. B. Pearson (National Research Council, Ottawa) described briefly the concept of the semiconducting valence bond, which has proved fruitful both in accounting for known semiconductors and in predicting new ones, and went on to discuss further aspects of bonding in semiconductors. G. F. Bolling and J. W. Rutter (University of Toronto) showed how both the grain structure and the distribution of impurities in solid germanium are affected by the way in which it is formed from the melt. This is important both for obtaining distributions required for electronic devices and for knowing how to avoid the formation of undesirable substructures in the solid. J. Sharma (National Research Council, Ottawa) described an experimental frequency analysis of the glow peaks obtained at different temperatures from luminescent alkali halides. The luminescence is caused by colour centres, and a provisional model was put forward to account for the spectra caused by different types of centre. Two chemists, D. M. J. Compton and T. C. Waddington (National Research Council, Ottawa), described experiments on the organic semiconductor anthracene, with various kinds of electrode, various impurities and under various conditions of illumination. Among properties measured have been the electrical conductivity, Hall effect and distribution of space-charge. Marked differences in behaviour from typical inorganic semiconductors require correspondingly different explanations.

Other papers were given by J. H. Simpson (National Research Council, Ottawa) on the calculation of the ground-state of an *F*-centre; by J. Rolfe (National Research Council, Ottawa) on the design of high-frequency transistors; by Z. Szepesi (Canadian Marconi Co.) on the similarity in electrical characteristics between condensed layers and single crystals of cadmium sulphide; by F. T. Hedgcock (National Research Council, Ottawa) on the magnetic properties of very dilute germanium alloys down to 8° K.; by R. P. Singh (National Research Council, Ottawa) on the functions developed by Wannier for use in the theory of a perturbed lattice; and by A. O. Barut (University of Montreal) on the conditions needed for a rigorous quantum statistical derivation of thermodynamics.

An informal report of the proceedings is being prepared, similar to that produced for the previous symposium on melting and diffusion.

T. H. K. Barron

TAYLOR, TAYLOR AND HOBSON, LTD., LEICESTER

SEVENTIETH ANNIVERSARY

THE firm of Taylor, Taylor and Hobson, Ltd., which has long enjoyed an international reputation in the field of photographic and engineering optics and in precision testing and gauging, celebrated the seventieth anniversary of its founding on April 12 by inviting some ninety guests, representing government departments, research and trade associations, learned bodies, and suppliers to and customers of the firm, to attend a lunch at the Grand Hotel, Leicester, and to visit its works to view an exhibition representative of its range of products and to see demonstrated the processes of their manufacture, assembly and testing. At the luncheon, Mr. Mark H. Taylor, the managing director, gave a brief account of the history and work of the firm, some personalities associated with it and its relations with its customers. Other speakers were Mr. H. P. Potts, president of the Machine Tool Trades Association, Mr. A. J. Philpot, director of the British Scientific Instrument Research Association, and Sir William Palmer, vice-chairman of Rank Precision Industries, Ltd., of which organization Taylor, Taylor and Hobson, Ltd., is now a constituent company.

The visit to the works was designed to give a cross-section of the manifold activities of the firm at the present time, which afford a fine example of the ramifications that can result quite logically from developments of an initially limited field of activity. The firm was started in 1886 when the brothers T. S. and W. Taylor, both products of the Finsbury Technical College (now the Northampton Polytechnic, London), set up in business in Leicester; the former had been apprenticed to R. and J. Beck, Ltd., and the latter trained as an electrical engineer, and they described themselves as "Engineers and Manufacturers of Optical, Electrical and Scientific Instruments". Their principal activity was the making of high-quality lenses of conventional type. Shortly afterwards they were joined by W. S. Hobson, who concerned himself principally with sales.

For the first few years it would seem that little more was achieved than a reputation for fine workmanship (an interesting exhibit was what is presumed to be the first balance sheet showing each of the two brothers as having assets of approximately £240 after the first year of trading), and it was the securing in 1893 of the sole rights of manufacture of the famous Cooke photographic lens which really launched the firm on its successful course. It placed the company (it became a private limited company in 1901) in the forefront of the photographic optical industry, and this, of course, has been one of its most important activities ever since. Photography in the 1890's meant little more than portrait and landscape photography and a limited number of specialized processes; but the present century has seen many highly specialized needs created, and Taylor, Taylor and Hobson have played a leading part in meeting many of them. Cinematography called for large-aperture short-focus lenses of very high quality. Sound films demanded even faster lenses, as noisy arc-lamps had to be replaced by the photographically less satisfactory incandescent lamps, and the company's 'Speed Panchro' *F*/2 lens already developed by it met this need immediately. The 'Technicolor' process, requiring simultaneous registration of three colours by one lens, made further new demands which were successfully met by the company, while wide-screen cinematography, with its horizontal compression of the photographic image, the proper proportions being restored in the process of projection, called for anamorphic lenses and resulted in the company's 'Varamorph' attachment to cope with the different amounts of distortion used in the various wide-screen processes. Aerial reconnaissance photography and television in turn also presented their own peculiar problems, the former giving rise to the Taylor, Taylor and Hobson 'Aviar' lens (developed during the First World War) and the latter to the 'Varital' variable-focus lens which permits of rapid change from 'close-up' to 'distance' without change of intensity over a fixed focal plane. Examples of most of these products were exhibited at the company's works. In connexion with these purely optical developments, it does not seem unfair to single out for special mention the part played by Mr. Arthur Warmisham, director of research for the company during 1922–55, who retired last year after forty-three years of service.

This represents only one side of the company's activities. Very early on, the necessity for replacing the tedious hand-engraving of the necessary data on lens-mounts by something more efficient led to the development by W. Taylor of the now world-famous Taylor, Taylor and Hobson engraving machine and brought the company into the field of machine tool manufacture. Irritation at the lack of standardization and non-interchangeability of parts led him to a close examination of the standards and means of precise measurements of screw threads and to the devising of methods of making screw threads accurate to prescribed limits. This resulted in the development of the thread chasing lathe and the enunciation of the 'Taylor principle': "For a limit gauging system to be effective the 'go' gauge should measure the elements concurrently, while the 'not-go' gauge should measure them independently". It is a pleasing tribute to W. Taylor's abilities that he was elected to the Royal Society in 1934.

The precision needed in the manufacture of optical products necessitated precision methods for testing and gave rise to another important activity, namely, the design and production of instruments for precision testing and gauging, which have found application not merely in optical workshops but also in engineering generally. Many examples of these were exhibited by the company. They fall mainly into two categories, optical and electro-mechanical. Among the former may be mentioned the Taylor Hobson turbine-blade projector and turbine-blade-edge microscope for viewing sections of turbine blades and examining their leading and trailing edges; and also the micro-alignment telescope, now extensively used in the aircraft industry and elsewhere for the alignment over large distances of salient points, lines and planes. In the second category there are notably the 'Talysurf' instrument for the measurement of surface finish and the 'Talyrond' for measurement of errors in surfaces of nominally circular section. These depend on the surface inequalities being transmitted by a diamond stylus to a self-inductance to cause modulations of a high-frequency carrier, the results being recorded on a moving tape or sheet. Also on view were samples showing a fairly new activity of the company, namely, the production by the Bridgeman process of large single crystals of the alkali halides for the manufacture of windows, prisms, etc., for infra-red equipment. Potassium bromide crystals up to nine inches in diameter were shown.

A small historical section was of great interest. It ranged from some early examples of brass-mounted, hand-engraved lenses to articles produced for the War Office during the two World Wars, and included a resplendent 'magic lantern' of the polished mahogany, lacquered brass era; an early model of the engraving machine (treadle operated); and a series of moulds for producing pits on the surfaces of golf balls resulting from W. Taylor's investigations into the conditions needed to produce a straight flight of the ball.

This account gives only a very rough survey of the wide range of equipment and processes shown by the company on this anniversary, but it gives some idea of its achievements in the fields it has set out to serve. It is interesting to note that the direction of the company is now, after seventy years, in the hands of only the second generation, for the present managing director, Mr. Mark H. Taylor, is the son of the original T. S. Taylor.

MUSCLE CONTRACTION IN AN INSECT

A Technique for recording Muscle Contractions in an Insect on a Kymograph

MANY insect muscles are capable of very fast contractions, but it appears that very little work is performed by these contractions. This situation causes some characteristic difficulties in recording them on a kymograph. These difficulties have now been overcome in the case of the muscles of the coxo-trochanteral joint in *Periplaneta americana.* The method devised may prove to be applicable elsewhere.

It was proposed to study the muscles of the coxo-trochanteral joint, which are situated in the coxa (and partly in the pre-coxa). They either stretch or bend the leg at this joint, thus levating or depressing the femur, the latter being nearly immovably connected with the trochanter. Therefore, each movement of the femur may be regarded as a reliable indicator of the activity of the corresponding muscles in the coxa. The recording of these movements on a kymograph, however, is not a simple question.

The first difficulty is to attach a sufficiently light but stiff writing lever to the femur. Its weight should preferably be of the order of that of the femur, tibia, pre-tarsus and tarsus together, amounting to about 7 mgm. Finally, a special writer, weighing about 11 mgm., was designed. It could be inserted into the remaining half of the femur after the other half (including the distal parts of the leg) had been cut away. Thus a solid 'artificial leg' is formed, which very soon sticks to the inner wall of the chitinous 'tube' as a result of drying hæmolymph and tissues.

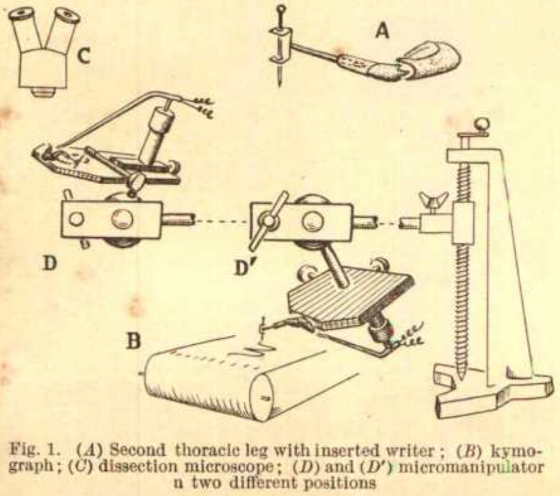
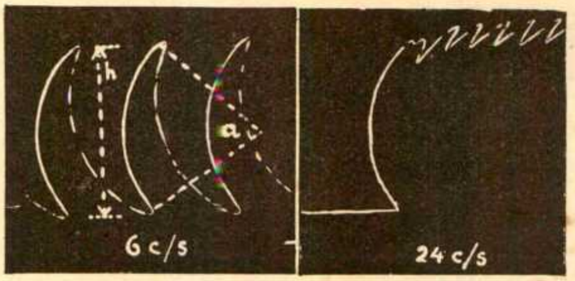


Fig. 1. (*A*) Second thoracic leg with inserted writer; (*B*) kymograph; (*C*) dissection microscope; (*D*) and (*D′*) micromanipulator in two different positions



A *B*

Fig. 2. Myograms of muscle 136 + 137. (*A*) Three separate twitches at 6 cycles/sec.; (*B*) twitches partially fused at higher frequency

The smoked kymograph paper offers so much friction to an ordinary recording pin that the insect leg cannot overcome it. For this reason a special writer with a free moving needle was designed (Fig. 1*A*). The kymograph was put in a horizontal position, the needle being held in a vertical position. In this way the friction became very small, as it was only caused by the weight of the needle. This detail proved also very useful, because it eliminates the difficulties of recording due to the disturbing influence of small vertical leg movements.

The moving leg can draw an arc of a circle of about 120° maximum size. Therefore, a cylindrical kymograph cannot be used. The part of the paper on which the records are being made must be a plane (Fig. 1*B*).

As it is necessary to place stimulating electrodes on the nerves, the insect is pinned on its back in a fixed position. Under the dissection microscope, the electrodes are brought into place by means of a micromanipulator. Thereafter the whole complex of preparation, electrodes and micromanipulator can be handled as one rigid unit. This is achieved by the use of a big ball-and-socket joint and some other screws and hinges of secondary importance. It is turned upside-down and the leg can easily be put in a horizontal position and adjusted to the paper (Fig. 1*D*, *D′*).

From Fig. 2 it can be seen that the method described enables the isotonic recording of very fast contractions of frequencies up to at least 24 cycles/sec. It should be noted that neither the heights (*h*) of the records nor the lengths of the arcs (*a*) are proportional to the actual contractions. In most cases, however, this is irrelevant, as only qualitative information is required. If small contractions are considered, of course, this proportionality may be a good approximation.

The question may be raised whether the method is really suitable for an analysis of the functions of the distinct muscles in the coxa. For it is inevitable that muscles which are not under consideration in a given experiment still play a part in the result, just because they are present. Denervated muscles may still influence the records because of their elastic properties, and it is even conceivable that muscles which have been intentionally separated from their apodemes may hinder the movement of the leg because of friction and/or inertness. However, from a number of experiments in which an attempt was made to analyse the importance of these objections, it became clear that they can, in most cases, safely be neglected; these experiments have been designed and carried out by G. Becht.

In a succeeding communication some results obtained with this technique are presented.

I am indebted to J. W. Kuiper, E. D. Nijenhuis and F. J. Oppenoorth for their assistance in the development of this technique; the illustrations have been put at my disposal by G. Becht.

D. DRESDEN

Physiology of the Locomotory Muscles in the Cockroach

IN the course of investigations into the mode of action of insecticides, a detailed study of the nervous system in the cockroach has been planned. This study started with the development of a method for the recording of muscle-contractions (see preceding communication). As only incomplete results were available concerning the anatomy and topography of the sense organs, nerves and muscles (cf., for example, refs. 1 and 2), a detailed study has been carried out on this subject. Most of the results have already been published[3]; some analytical results on the fibres will be published elsewhere. The present communication deals with our first physiological approach to the problem. The muscles which have been studied with the preparation described are the extensors and flexors of the coxo-trochanteral joint, namely: 135*a*, *b*, *c*, *d* and *e*, 136, 137, 138, 139 and 140 (Carbonell's numbering[2]).

Extensors (depressors). As compared with the other muscles, it was especially easy to obtain a good preparation of the system 136 + 137 (innervation: nerve 5, ramus 1) (Fig. 1). This system, which is supplied by one axon, behaves entirely as a fast motor-unit. It reacts with clear twitches up to about 6 cycles/sec., which gradually fuse at higher frequencies (Fig. 2). Some superposition occurs, the tetanic height being approximately 1·2 times that of the twitch. The tetanic contraction fatigues very quickly and it disappears almost completely within a few seconds. Because of its simplicity, it is expected that this preparation will be very suitable as a standard for toxicological work.

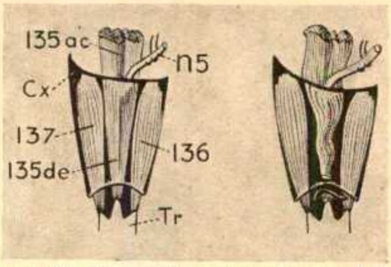


Fig. 1. Medial side of the right mesothoracic coxa of *Periplaneta*. Left: normal. Right: the apodeme of the 135-group has been cut, and the motor-unit 136 + 137 remains

The depressor muscles 135*a* and 135*c* (innervation: nerve 4, ramus 3) represent the strongest group of extensors. They are supplied by very few axons: 135*a* receives three fibres and 135*c* only one. This is reflected in their physiological behaviour. Muscle 135*c* simply behaves as a motor-unit of the fast type, whereas in muscle 135*a* stimuli of successively increasing voltage result in at least three different contraction heights (Fig. 3).

The small band-shaped depressor muscle 135*b* (innervation: nerve 4, ramus 2*b*) is supplied by four axons. It shows scarcely any response to stimuli of low frequencies, up to 25 cycles/sec. Only very minute twitches occur, which could seldom be recorded on the kymograph. Under the dissection microscope, however, they could always be observed very clearly. Stimulation with higher frequencies resulted in a considerable contraction of the 'slow' type. These contractions can last for as long as 10 min. before they exhibit signs of fatigue. If the frequency of the stimuli is increased, the contraction height increases with it, up to a maximum at about 130 cycles/sec. (Fig. 4). In many preparations of 135*b* it was noted that an increase of the voltage of the stimuli induced a rather sharp decrease of the

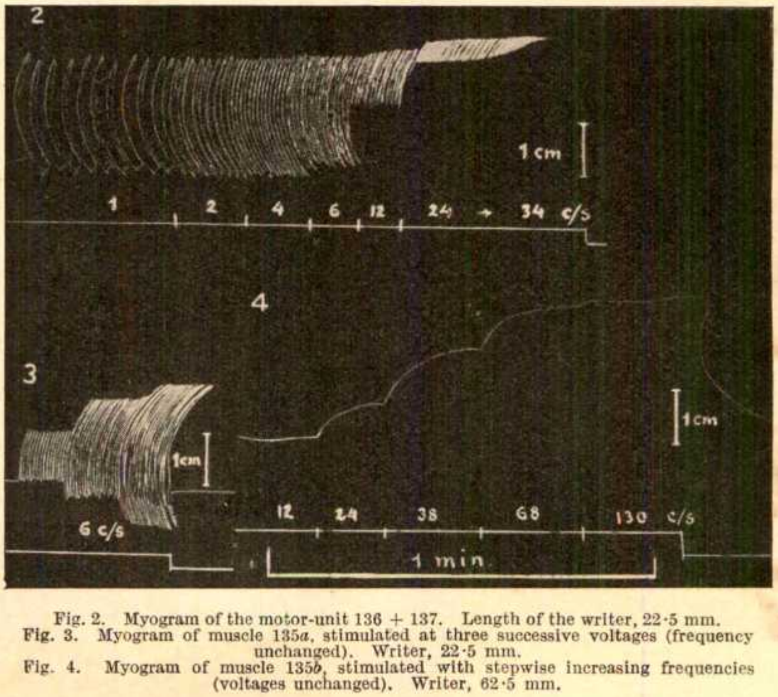


Fig. 2. Myogram of the motor-unit 136 + 137. Length of the writer, 22·5 mm.
Fig. 3. Myogram of muscle 135*a*, stimulated at three successive voltages (frequency unchanged). Writer, 22·5 mm.
Fig. 4. Myogram of muscle 135*b*, stimulated with stepwise increasing frequencies (voltages unchanged). Writer, 62·5 mm.

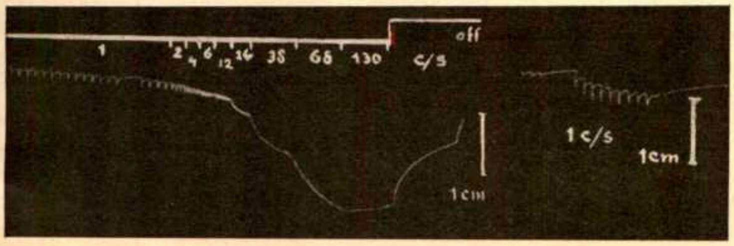


Fig. 5. Myogram of muscles 138 + 139*c*, stimulated with stepwise increasing frequencies (voltages unchanged). Writer, 22·5 mm. Note the 'cock's comb-effect' at 1 cycle/sec.

contraction height. This phenomenon, which was always reversible, points to the existence of an inhibitory fibre in the supplying nerve. Further experiments are needed before a decision can be made on this problem. It is probable that muscle 135*b* will prove to be a very suitable test-object for toxicological investigations on the 'slow-type' muscles.

Flexors (levators). Two groups of levator muscles can be distinguished: 138 and 139*c* on one hand (innervation: nerve 3*B*), and 139*a*, 139*b* and 140 on the other hand (innervation: nerve 6*B*). The nerves supplying the two groups contain at least seven fibres (nerve 3*B*) and exactly seven fibres (nerve 6*B*), respectively. The arrangement of the fibres is rather complicated and will not be discussed here; it is reflected in a more complicated physiological behaviour of these muscles (Fig. 5). Moreover, they all seem to have a 'fast' and a 'slow' component, which adds considerably to the complexity of the system. Records of these muscles have a very characteristic shape which we have called 'cock's comb'-myograms. It is caused by a response to low frequencies (about 5 cycles/sec.) which is intermediate between that of the fast- and that of the slow-type muscles.

These complicated myograms have been analysed a little further in experiments in which ryanodine was administered. Injections of a suitable quantity of this alkaloid result in a very rapid block of the fast muscles (for example, 136 + 137), whereas the slow muscle, 135*b*, is affected at a slower rate. In this respect it is interesting to note that intoxicated insects show a very sluggish behaviour. Now the reaction of 139*a*, 139*b*, 139*c* and 140 to ryanodine consists of disappearance of the fast components (that of 138 is still questionable). These ryanodinized muscles then behave more or less as the slow muscle 135*b*. Therefore, it is believed that the 'cock's comb'-muscles are composed of two different elements, rather than that they represent some sort of intermediate type muscle. However, further evidence is required on this matter.

Some preliminary experiments on the action of γ-BHC on the nerve-muscle preparations have been carried out.

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3-HYDROXYANTHRANILIC ACID, A CARCINOGEN PRODUCED BY ENDOGENOUS METABOLISM

By Prof. E. BOYLAND and G. WATSON

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INVESTIGATIONS into the nature of carcinogenesis by polycyclic hydrocarbons were based on the fact that soot and coal tar induce skin cancer in man. Similarly the study of cancer production by 2-naphthylamine started with the observation that this dyestuff intermediate causes cancer of the urinary bladder in men employed in its manufacture. 2-Naphthylamine does not appear to cause cancer of the skin and produces bladder tumours only in man and dogs. The remote action of 2-naphthylamine is probably due to the fact that the immediate carcinogen is not 2-naphthylamine itself but rather one of its metabolites, 2-amino-1-naphthol, which Hueper[1] showed to be carcinogenic following subcutaneous injection into mice. Also Bonser, Clayson, Jull and Pyrah[2] found that this compound induces cancer when implanted into the bladders of mice, under which conditions the parent amine does not.

The technique of testing substances for carcinogenic action by implanting pellets containing the suspected material into the bladders of animals, introduced by Maisin and Picard[3] and developed by Jull[4], is invaluable in the investigation of the role of metabolism in carcinogenesis. By this method, Bonser, Clayson and Jull[5] found that a number of *ortho*-aminophenol derivatives, in addition to 2-amino-1-naphthol, produce cancer of the bladder: these include 1-amino-2-naphthol, 1-methoxy-2-aminonaphthalene and 3-amino-4-hydroxydiphenyl. Clayson[6] has suggested that aromatic amines other than 2-naphthylamine, including butter yellow, 2-acetamidofluorene, 4-aminodiphenyl and 4-amino-stilbenes, may be active after conversion to *ortho*-aminophenols (cf. Walpole, Williams and Roberts[7]).

The tumours of the bladder which appear in the general population do not differ in their pathology from those induced in chemical workers by 2-naphthylamine and other amines such as benzidine and 4-aminodiphenyl. Such tumours might therefore be induced by analogous carcinogens excreted in urine such as metabolites of tryptophan, *l*,3-hydroxykynurenine[8] and 3-hydroxyanthranilic acid[9], which are *ortho*-aminophenols. Experiments described below show that 3-hydroxyanthranilic acid is, in fact, carcinogenic in the bladders of mice.

Previous studies of the metabolism of 2-naphthylamine by tissue slices[10] showed that although 2-naphthylamine is oxidized to aminonaphthols in

Table 1. CHANGES OBSERVED IN BLADDERS OF MICE FOLLOWING INSERTION OF PELLETS OF DIFFERENT COMPOSITIONS

Composition of pellet	No. of mice				
	Original total	Surviving 40 weeks	Showing hyperplasia or metaplasia	With papilloma	With carcinoma
Paraffin wax, m.p. 56°	20	9	1	0	0
3-Hydroxyanthranilic acid (20 per cent) and paraffin wax (80 per cent)	30	19	2	0	3
Cholesterol	25	8	1	0	0
3-Hydroxyanthranilic acid (20 per cent) and cholesterol (80 per cent)	20	14	2	0	4
2-Amino-1-naphthol hydrochloride (20 per cent) and cholesterol (80 per cent)	25	13	1	2	1
8-Hydroxyquinoline (20 per cent) and cholesterol (80 per cent)	20	13	1	2	4

the liver, the aminonaphthols are very rapidly conjugated with sulphate or glucuronic acid so that no appreciable concentration of free aminonaphthol is present in the tissues. No free aminonaphthol is present in the fresh urine of animals dosed with 2-naphthylamine[11]. Urines of man and laboratory animals contain β-glucuronidase, which can hydrolyse one of the metabolites, 2-amino-1-naphthylglucosiduronic acid, and liberate the carcinogenic 2-amino-1-naphthol. Urines from patients with bladder cancer generally contain more β-glucuronidase than do the urines of normal subjects[12].

The carcinogenic action of 2-naphthylamine is thus dependent on its oxidation to 2-amino-1-naphthol in the liver. The conjugated derivatives of this aminophenol are excreted in the urine. One of these, 2-aminonaphthyl sulphuric acid, is resistant to the enzymic action of sulphatase[13], but the 2-amino-1-naphthylglucosiduronic acid may be hydrolysed by urinary β-glucuronidase to liberate the carcinogenic 2-amino-1-naphthol. *l*-3-Hydroxykynurenine and 3-hydroxyanthranilic acid are also excreted in conjugated forms, but the hydrolytic enzymes would liberate the free *ortho*-aminophenols which might induce bladder tumours.

These results indicate a possible mechanism whereby a natural metabolite might induce bladder cancer. The liability to this form of neoplasia would therefore be dependent, among other factors, on: (1) the sensitivity of the bladder tissue; (2) the intake and metabolism of tryptophan. An inborn or induced metabolic pattern might cause an unusual excretion of 3-hydroxy-anthranilic acid derivatives. Somewhat higher concentrations of 3-hydroxyanthranilic acid were found in urines of patients with bladder cancer than were found in urines of normal subjects[14]. (3) The activity of β-glucuronidase and possibly sulphatase in the urine. (4) The average time during which urine remains in the bladder. All these factors would presumably be less effective with increasing dilution of urine.

The carcinogenic activities of 3-hydroxyanthranilic acid in pellets of paraffin wax and of 3-hydroxyanthranilic acid, 2-amino-1-naphthol and 8-hydroxyquinoline in pellets of cholesterol in the bladders of mice have been investigated by a modification of the methods of Jull[4]. The modification consisted in tying off the lumen of the bladder with silk after insertion of the pellet instead of sewing the lumen. By this method the operation is quicker and the risk of leakage of urine during the post-operative period reduced.

The results summarized in Table 1 show that pellets of paraffin wax or cholesterol did not induce carcinomata in experiments lasting 40 weeks, but that pellets containing 3-hydroxyanthranilic acid or 8-hydroxyquinoline produced tumours in a statistically significant number of mice.

The tests with 8-hydroxyquinoline were carried out since it was thought that the known carcinogenic *ortho*-aminophenols might be biologically active because of their power to chelate metals. If they were carcinogenic by virtue of this property, then other chelating agents would be expected to induce cancer. The fact that 8-hydroxyquinoline has induced cancer is in agreement with this hypothesis.

Other constituents of mammalian tissues which can induce cancer include: (1) cholesterol[15], which is not carcinogenic under the conditions of the present experiments; (2) xanthine, which is excreted in urine of xanthinurics[16] and has induced cancer in rats on subcutaneous injection (Haddow, personal communication); (3) œstrogens, which induce tumours at various sites of different species of animals.

The induction of tumours with 3-hydroxyanthranilic acid and xanthine, known constituents of some urines, indicates that cancer might be induced by abnormally large amounts of normal intermediates of amino-acid or purine metabolism. The ability to excrete abnormally large amounts of such compounds might occur spontaneously or be controlled by genetic or nutritional factors.

We should like to express our thanks to Dr. Cuthbert E. Dukes and Dr. E. S. Horning for their willing co-operation in the pathological diagnosis of the material, and Miss M. Allen and Mr. J. L. Everett for assistance in the experiments.

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [March 16

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LETTERS TO THE EDITORS

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Red-Cell Survival in Familial Hæmolytic Anæmias

When the red-cell hæm of familial hæmolytic anæmia patients is isotopically tagged, as by the administration of glycine-^{15}N, the curves of subsequent isotope-levels may be interpreted in more than one way. Two very different interpretations are given here as subcases of a single model, and their relation to actual cases is discussed.

In cases of spherocytic[1] and sickle cell anæmia[2,3] the ^{15}N-tagged hæm curves show approximately exponential decline following an abnormally rapid and extensive rise. The simplest curve of this kind was reported recently by James and Abbott[3] for a striking case of sickle cell anæmia. As James and Abbott pointed out, their curve has a single-phase decline. This is unlike the multiphasic declines on other and more complicated of the observed curves[1,2].

For simple analysis, assume that the tagged red cells are a single population which is released to the circulation at an exponentially declining birth-rate, and that they are then subjected to a random (or first-order) rate of removal. Distinguishing between these two rates is the most difficult part of interpretation, since evidence is presented that the decline of the curve will follow the slower rate—whether it be the birth-rate or the death-rate. Thus if we let x_0 be total tagging in terms of atom per cent excess of nitrogen-15 in the circulating hæm; b be birth-rate, or daily release fraction of the eventually tagged and yet to be released red cells; t be time after tagging, in days; k be removal-rate, or fraction of circulating tagged cells that are removed daily; and x be concentration of the tag in circulating red cells, in atom per cent excess of nitrogen-15, then our assumptions imply that the daily release of tagged cells will be

$$(x_0 b \exp(-bt)$$

and that the concentration will follow the equation

$$\frac{dx}{dt} = x_0 b \exp(-bt) - kx$$

The solution of this differential equation, which also satisfies the condition that initially $x = 0$, is

$$x = \frac{x_0 b}{(k-b)}\{\exp(-bt) - \exp(-kt)\} \qquad (1)$$

The hæm-tagging curve of equation (1) has the same shape in either of the two possible cases: (I) birth-rate exceeds death-rate ($b > k$), and (II) death-rate exceeds birth-rate ($k > b$). In both cases the declining part of the curve follows the lower of the two rates. Therefore we must use other evidence to distinguish between the rates of release and destruction of the cells.

In cases of familial hæmolytic anæmia, it is almost universally found that the erythroid bone marrow is greatly hypertrophied. This fact can be used to distinguish between the release and removal-rates when it is recalled that in any balanced state the daily production and loss are equal. Thus if M is volume of erythroid marrow, and H is volume of circulating cells, we can choose the normal M to be about 300 c.c. (ref. 4, which gives data implying at least 200, while 300 is more conservative in the present application) and then define hyperplasia ratio as:

$$R_{\text{eryth.}} = \frac{M_{\text{abnorm.}}}{300} = \frac{H}{300}\cdot\frac{k}{b} \qquad (2)$$

Equation (2) uses M as given in ref. 5, in which hV equals the present H. The meaning of this ratio is that: when $R_{\text{eryth.}} > 1$, there is erythroid marrow hyperplasia, and when $R_{\text{eryth.}} < 1$, there is erythroid marrow hypoplasia. Hence if the ratio (k/b) in equation (2) is mistakenly inverted, it has a great effect on one's conclusion about the magnitude of the erythroid marrow.

The whole picture and its importance are easily seen in terms of the beautiful example provided by James and Abbott[3]. Their hæm curve is approximated by the equation

$$x = 0{\cdot}12\,\{\exp(-0{\cdot}052t) - \exp(-t/2)\} \qquad (3)$$

which is the form of equation (1) in which we must choose between

$$\text{I}\ \begin{cases} b = 0{\cdot}5 \\ k = 0{\cdot}052 \end{cases} \text{and II}\ \begin{cases} b = 0{\cdot}052 \\ k = 0{\cdot}5 \end{cases}$$

(The value 0·5 is approximate, since there are not enough early points for better accuracy.) To choose between cases I and II we calculate:

$$R_{\text{eryth.}} = \frac{1{,}040}{300} \times \begin{cases} \text{I} : 0{\cdot}104 \\ \text{II} : 9{\cdot}6 \end{cases} = \begin{cases} \text{I} : \ 0{\cdot}36 \\ \text{II} : 33 \end{cases}$$

where 1,040 represents (0·16 × 385/0·059) from the observed results[3]. While one might expect 10- or 20-fold erythroid marrow hyperplasia in such a severe case of sickle cell anæmia, one would not expect hypoplasia down to less than 40 per cent of normal. For this reason it is highly probable that this is an example of case II, in which the decline of the hæm–nitrogen-15 follows the slower rate of release to the circulation, while the removal of the cells occurs at a faster rate. The observed reticulocytosis of 23 per cent is further support of this conclusion.

In the original report[3] the authors attributed the lower rate to cell removal, but they did not take into account the contraindicating factor of erythroid marrow hyperplasia. Therefore their conclusion, which is the previously common one, should be questioned and re-examined.

The other reported hæm – nitrogen-15 curves for cases of this kind[1,2] are more complicated in having biphasic declines. These can also be treated by the method of this communication if one assumes two populations of cells (analogous to one bimodal population) having different delivery- and/or removal-rates. Again, in these more complicated cases, one must use the erythroid marrow hyperplasia as additional evidence in order to determine whether the slower (decline) rates represent rates of destruction of red cells or rates of delayed release of red cells to the circulation. Here again the presence of marked erythroid marrow hyperplasia implies increase in the ratio (cell destruction-rate : cell delivery-rate).

I thank Drs. D. S. Amatuzio, P. S. Hagen and C. J. Watson for helpful discussions of this and related problems, and the Rockefeller Foundation for a grant at a period during which the last portion of this work was done.

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ABO Antigens in the Human Cornea

IT has been found that mammalian cornea is capable of eliciting an immunity reaction and of succumbing to it[1]. The following is a report of findings that human corneas possess *A* and *B* blood-group specific substances. Homogenized corneal tissue, obtained under sterile precautions by trephining the central portion of the cornea from cadavers, not later than 12 hr. after death, was used for adsorption of high-titred normal human sera. To 0·5 ml. of *A*, *B* and *O* sera, diluted 1 : 2 with normal saline, 0·5 ml. of corneal homogenate was added. The adsorption was carried out at 6° C. for 8 hr., the serum–cornea mixture being shaken every 15–30 min. The anti-*A* and anti-*B* titre of the serum was examined against erythrocytes by the double serial dilution method, both before and after adsorption.

It has been found that corneal material from a donor of blood group *A* significantly reduced the anti-*A* titre of *O* antiserum, while the anti-*B* titre remained unchanged. Similarly, corneal homogenate from a donor of blood group *B* reduced only the anti-*B* titre of the *O* serum. Corneas from *AB* donors reduced both the anti-*A* and anti-*B* titre of the serum, while material from donors of blood group *O* was ineffective in reducing either the anti-*A* or anti-*B* titre.

Eluates were prepared after the adsorption by shaking the washed adsorbates in a 56° C. water-bath[2]. The eluates agglutinated red blood cells of the corresponding group.

Twenty samples of corneas belonging to donors of blood groups *A*-5, *B*-5, *AB*-3 and *O*-7 were examined by adsorption and elution experiments. In all cases identity of antigenic substances of the corneal material and erythrocytes has been proved.

Distinct differences in intensity of agglutination were always observed in the last two to three tubes of the titration.

Table 1. TYPICAL RESULTS OF ADSORPTION AND ELUTION EXPERIMENTS

Titre of serum *O* before adsorption	Corneal material from donor of blood group	Titre of serum *O* after one adsorption with corneal homogenate	Titre of eluate against red blood cells
Anti-*A* 1 : 64 Anti-*B* 1 : 128	*A*	1 : 8 1 : 128	1 : 4 1 : 1
Anti-*A* 1 : 64 Anti-*B* 1 : 128	*B*	1 : 64 1 : 64	0 1 : 4
Anti-*A* 1 : 32 Anti-*B* 1 : 64	*AB*	1 : 8 1 : 32	1 : 2 1 : 8
Anti-*A* 1 : 64 Anti-*B* 1 : 128	*O*	1 : 64 1 : 128	0 0

In one case three consecutive adsorptions with corneal material of the same group were performed. The titre of the antiserum was thus reduced from 1 : 128 to 1 : 1.

The question whether failures of corneal transplantation could be explained on the basis of group incompatibility between donor and recipient is under investigation.

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Chromatographic Behaviour of Hæmoglobin *E*

RECENTLY, the chromatographic separation of four different human carboxyhæmoglobins (normal adult (*A*), sickle cell (*B*),*C* and fœtal (*F*)) on the ion exchange resin 'Amberlite *IRC* 50' (*XE* 64) has been reported by us[1]. It was shown that these hæmoglobins move down the column at different rates in the sequence $F > A > B > C$. Now we are able to describe the behaviour of a third abnormal human hæmoglobin (*E*), using the same chromatographic method.

The blood samples were obtained from three members of a family of Indonesian origin, which has been described briefly[2]. These three patients were suffering from the heterozygous hæmoglobin *E* disease. Using the elution technique[1] we did not obtain a complete separation of the hæmoglobin *A* and *E* present. With the cuvette method, however, the two hæmoglobins were separated quite well (Fig. 1,I). Even a mixture of five different human hæmoglobins can be separated completely into the original components. The rate of displacement of the hæmoglobin *E* is intermediate between those of the normal adult and sickle cell hæmoglobin ($A > E > B$, Fig. 1,III).

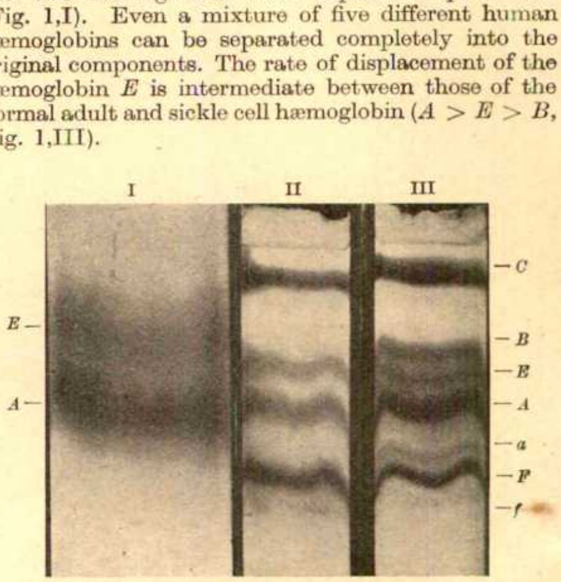

Fig. 1. Chromatographic separation of hæmoglobin-*E* and other human hæmoglobins. I, Hæmoglobin of a patient with heterozygous hæmoglobin-*E* disease; II, artificial mixture of four hæmoglobins (*C*, *B*, *A* and *F*); III, artificial mixture of five hæmoglobins (*C*, *B*, *E*, *A* and *F*)

In these experiments the presence of well-separated but less intense bands of the corresponding major fractions of the various hæmoglobins sometimes occurs (Fig. 1,III *a* and *f*). This is especially the case when the rate of flow of the effluent is low. Also with our elution technique the separation of one hæmoglobin into two components is possible. The first fraction, which represents about 10 per cent of the total amount, moves down the column more rapidly than the major fraction. It may be that this chromatographic inhomogeneity of one hæmoglobin is the same as that reported recently by Morrison and Cook[3]. With our technique, however, we never found a third fraction with a lower rate of displacement.

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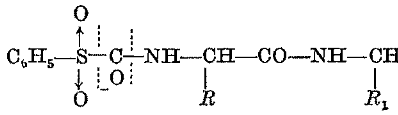
New Methods for the Synthesis of Peptides

In 1947, Ehrensvard suggested the use of a new protective group for peptide synthesis[1]. According to his investigations, the phenylthiocarbonyl grouping (C_6H_5—S—C—O—) can be used advantageously for the protection of the amino-groups of amino-acids. The phenylthiocarbonyl-group could be split off from the N-phenylthiocarbonyl-peptide derivatives by means of lead acetate. Lindenmann, Khan and Hofmann[2] confirmed Ehrensvard's observations; but according to their investigations hydantoins, not peptides, resulted under the influence of lead acetate. As no method was given for splitting off the phenylthiocarbonyl-group, we attempted the application of oxidative methods, and with complete success. The oxidation is carried out with 2·5 moles of perbenzoic acid at − 5° in acetic acid – benzene, benzene – tetra hydrofurane, dioxane or dioxane containing preferably 2 per cent of water. The products of oxidation probably represent a type of mixed anhydrides of carbamic acids with sulphinic acids hitherto unknown:



$$C_6H_5\text{—}\overset{\overset{O}{\uparrow}}{\underset{\underset{O}{\downarrow}}{S}}\text{—}\underset{\underset{}{O}}{C}\text{—NH—}\underset{\underset{R}{|}}{CH}\text{—CO—NH—}\underset{\underset{R_1}{|}}{CH}\text{—COO}R_3$$

(I)

With water, compounds of type (I) disintegrate immediately at the places marked with broken lines, even at − 5°, with the evolution of carbon dioxide, and the corresponding peptides or amino-acids are isolated in excellent yield, by adsorption on a 'Dowex 50' cation exchange resin and elution with diluted ammonia. (When esters are used, it is necessary to carry out the usual alkaline saponification before working them up.) By this procedure, glycine was obtained from phenylthiocarbonyl glycine (yield 74 per cent), glycyl-alanine from ethyl-phenylthiocarbonyl-glycyl-alaninate and L-glutamyl-L-tyrosine from ethyl-phenylthiocarbonyl-L-glutamyl-L-tyrosinate (33 per cent).

A drawback to the use of the phenylthiocarbonyl-group is that only amino-acid esters can be acylated with the chloride[3], so that starting from an amino-acid it takes four steps to prepare a protected amino-acid. Therefore, maintaining the structural principles of phenylthiocarbonyl-derivatives, we prepared[4] methyl-thiocarbonyl-chloride from phosgene and from methylthiol, which is a weaker acid than thiophenol. With this compound the amino-acid anions can be acylated (in water, in the presence of sodium bicarbonate, sodium carbonate or magnesia). Methylthiocarbonyl-glycine (m.p. 118–119°), ethyl-methylthiocarbonyl-glycinate (m.p. 55°), methylthiocarbonyl-threo-β-phenyl-serine (m.p. 129–130°), ethyl-methylthiocarbonyl-threo-β-phenylserinate (m.p. 124°) have been prepared with an average yield of 65–80 per cent. Peptides can be prepared from methylthiocarbonyl amino-acids in the same manner as from phenylthiocarbonyl amino-acids.

However, it has proved more advantageous to use N-benzylthiocarbonyl derivatives instead of methylthiocarbonyl compounds, because they crystallize better and are sparingly soluble in water. We prepared benzylthiocarbonyl-chloride (m.p. 12°; b.p.$_{0 \cdot 01}$ 65°), which was hitherto unknown, by the same method as methylthiocarbonyl-chloride. With benzylthiocarbonyl-chloride the amino-acids and peptides can be smoothly acylated (see Table 1). Acylating amino-acid and peptide esters with benzylthiocarbonyl-chloride in chloroform solution, ethyl-benzylthiocarbonyl-glycinate (oil) and ethyl-benzylthiocarbonyl-glycylglycinate (m.p 119–120°) were prepared in yields of about 80 per cent. Ethyl-benzylthiocarbonyl-glycylglycinate was prepared from benzylthiocarbonyl-glycylchloride (prepared with thionyl chloride) in a yield of 91 per cent, by the mixed anhydride method of Th. Wieland, Boissonnas, and Vaughan (yield 43 per cent), by the phosphoaza method of Goldschmidt (yield 81 per cent) and by Sheehan's new N-N′-dicyclohexylcarbodiimide method[5] (yield 74 per cent). With this last method, ethyl-benzylthiocarbonyl-alanyl-glycinate (m.p. 120–121°, yield 70 per cent), ethyl-benzylthiocarbonyl-glycyl-phenylalaninate (m.p. 108–109°, yield 70 per cent), and ethyl - benzylthiocarbonyl - L - alanyl - glycinate (m.p. 105–106°) were also prepared.

Glycine was acylated to benzylthiocarbonyl-glycylglycine with benzylthiocarbonyl-glycylchloride in water-dioxane in the presence of magnesium oxide in a yield of 43 per cent (m.p. 177–179°).

From the benzylthiocarbonyl-derivatives the benzylthiocarbonyl-group can be split off with perbenzoic acid in exactly the same manner as the phenylthiocarbonyl-group from phenylthiocarbonyl-derivatives. The yields of the peptides were about 65–70 per cent.

We expect that the benzylthiocarbonyl-group could be used, among other syntheses, in particular for the synthesis of peptides of lysine, arginine and ornithine. The benzylthiocarbonyl-group being insensitive to hydrobromic acid, its combined use with the carbo-

Table 1

Compound	Yield (per cent)	Method of preparation
Benzylthiocarbonyl		Acylation with benzylthiocarbonyl-chloride in water-dioxane at 0° in the presence of magnesia, sodium bicarbonate or sodium carbonate.
-glycine (m p. 151–152°)	90	
-alanine (m p. 177–178°)	78 5	
-L-alanine (m p 128–129°)	52 5	
-serine (m p. 146–147°)	88	
-threo-β-phenylserine (m.p 153°)	65	
-phenylalanine (m p. 110°)	82	
-L-glutamic acid (m p. 118–120°)	60	
-glycyl-glycine (m.p. 177–178°)	72 5	

benzoxy group seems to offer new possibilities for the preparation of polyfunctional amino-acid and peptide derivatives. We are continuing our investigations in this direction. A detailed communication will appear elsewhere.

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'Malic Enzyme' Activity in Blowfly Muscle

An investigation of the metabolism of sarcosomes and whole-muscle homogenates isolated from the flight-muscle of the blowfly (*Calliphora erythrocephala*) indicated that the rate of succinate oxidation by these preparations is limited by the steady-state concentration of oxaloacetate produced by further oxidation of fumarate (Lewis, S. E., and Price, G. M., unpublished observations).

The addition of Mn^{++} to these preparations produced a marked stimulation of succinate and malate oxidation. Similarly, the addition of co-enzyme II stimulated the oxidation of both these substrates. These findings suggest that the preparations may contain a co-enzyme II – Mn^{++}-dependent enzyme similar to the 'malic enzyme' found in vertebrate liver[1]. This enzyme reversibly catalyses the oxidative decarboxylation of malate to pyruvate and carbon dioxide at *p*H 7·35 [2]. Since this reaction provides an alternative pathway for malate oxidation, not involving the formation of oxaloacetate, it may be expected to facilitate the oxidation of succinate. The reactions associated with the 'malic enzyme' were therefore examined in an aqueous extract of an acetone-dried powder prepared from blowfly thoraces.

The reduction of co-enzyme II by this extract was measured spectrophotometrically at a wave-length of 340 mμ. The results obtained are shown in Fig. 1. On addition of malate a rapid reduction of co-enzyme II was observed, and in samples to which Mn^{++} was added the rate of this reaction was increased. Under the conditions of this experiment co-enzyme II could not be replaced by co-enzyme I, either in the presence or in the absence of Mn^{++}. When the reduction of co-enzyme II had ceased, the addition of pyruvate in bicarbonate saturated with carbon dioxide resulted in a rapid re-oxidation of the reduced co-enzyme. Since the addition of pyruvate alone caused some re-oxidation of reduced co-enzyme II, this was probably due in part to the presence of lactic dehydrogenase, which we have since shown to be present in our extracts. However, the increase in the oxidation of reduced co-enzyme II which occurs when carbon dioxide and pyruvate are added together suggests that a 'malic enzyme' is also present.

When estimating 'malic enzyme' activity by measuring the reduction of co-enzyme II, Ochoa *et al.*[3] defined one enzyme unit as "the amount of enzyme causing an increase in optical density of 0·01 per minute". On this basis our extract contains 20 units in 4 mgm. of protein, which is equivalent to a specific activity of 5, and is equal to that reported in similar extracts from pigeon liver[2]. Recently a similar enzyme has been shown to be present in hæmolymph from the larva of the silkworm (*Bombyx mori*)[4].

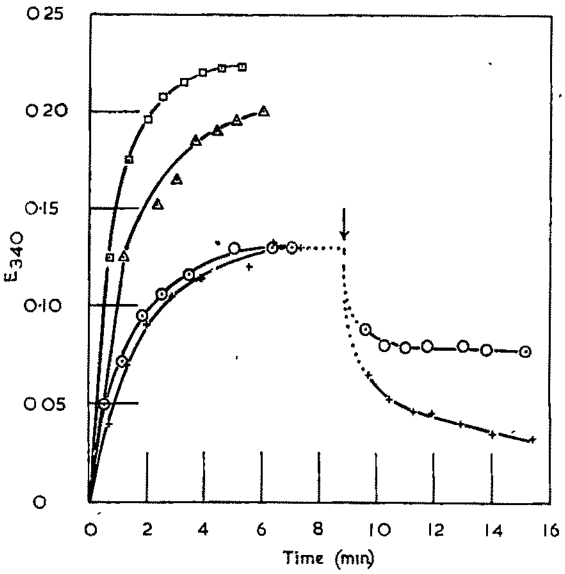

Fig. 1. Reduction of co-enzyme II in the presence of malate; its reversal by pyruvate and carbon dioxide, and activation by Mn^{++}.
△, Control; □, control + Mn^{++}; ○, control + Mn^{++} + 100 μmoles pyruvate added at arrow; +, control + Mn^{++} + 100 μmoles pyruvate in 1 3 per cent bicarbonate saturated with carbon dioxide, added at arrow. Cells contained. extract 0·5 ml; malate (1 33 × 10^{-3} *M*); 'tris' buffer *p*H 7·25 (2 × 10^{-1} *M*); co-enzyme II (6 74 × 10^{-4} *M*); manganous chloride (6 67 × 10^{-4} *M*); water to total volume of 3 0 ml.
(The effect of Mn^{++} and the effect of Mn^{++} plus pyruvate were examined with separate extracts)

Since many 'malic enzyme' preparations also catalyse the decarboxylation of oxaloacetate, the decarboxylase activity of our extracts was also examined. The carbon dioxide produced from oxaloacetate was measured manometrically in the presence of various amounts of extract in the presence and absence of Mn^{++}. The rate of carbon dioxide production was measured during the 5–25 min. period after the addition of oxaloacetate, and, after deducting the value for the spontaneous carbon dioxide production, the Q_{CO_2} values were calculated on the basis of the protein content of the extract. The results given in Table 1 show that the extract catalyses the decarboxylation of oxaloacetate. The fact that the Q_{CO_2} values are reasonably constant shows that the carbon dioxide production is proportional to the amount of extract present. When the Mn^{++} was omitted from the reaction mixture the rate of carbon dioxide production was reduced, both in the presence

Table 1. OXALOACETATE-DECARBOXYLASE ACTIVITY OF ACETONE-DRIED POWDER EXTRACT

Additions to reaction medium	CO_2 produced (μl./hr) Observed	Corrected	Q_{CO_2}
None	164	—	—
0·4 ml. extract *A*	200	36	10·9
Mn^{++}	310	—	—
0·2 ml. extract *B* + Mn^{++}	369	59	27·5
0·4 ,, ,, ,, ,,	408	98	22 8
0·8 ,, ,, ,, ,,	501	191	22·2

Reaction medium. Acetate buffer 0·1 *M* (*p*H 4·5); oxaloacetate 0·02 *M*. Extract *A* contained 8 4 mgm. protein per ml.; extract *B* contained 10 75 mgm. protein per ml; manganous chloride 10^{-3} *M*. (Final volume 3 ml. Temperature 25° C.)

and absence of the extract, and the Q_{CO_2} was reduced also.

The oxaloacetate–decarboxylase activity of this extract is of the same order as that reported for similar extracts from vertebrate tissues[5]. However, since native proteins may catalyse the spontaneous decarboxylation of oxaloacetate the carbon dioxide production in the presence of bovine plasma albumin and Mn++ was examined. This protein increased the rate of carbon dioxide production by 20 µl. per hr., whereas a sample of the acetone-dried powder extract, containing an equal amount of protein, produced an increase of 98 µl. per hr.

Although these extracts catalyse the reactions associated with the 'malic enzyme' we have no evidence to suggest that, in our preparations, both reactions are catalysed by a single enzyme. Evidence on this point can only be obtained after isolation of the systems involved.

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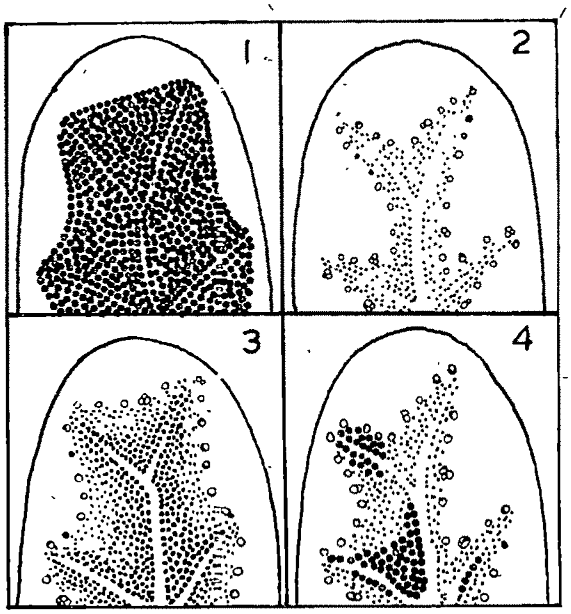
Zymogen Formation in the Mouse Pancreas

There are present in the Golgi zone of each acinar cell of the mammalian pancreas a number of small lipoidal droplets (about 1½µ in diameter) which stain with methylene blue and other vital dyes. Each lipochondrion, or, where vesiculated, its cortex, is intensely osmiophilic and concentrates vital dyes[1]. Hirsch[2], and later Baker[3] and Lacy[4], considered that the prozymogen granules arose within the vacuolated lipochondria and when mature (1½µ in diameter) were released into the apical part of the cell.

The prozymogen granules, however, do not form in the lipochondria, but so far as can be determined with the light microscope, form *in situ*. They arise as small refractile granules at the limit of resolution in size and well spaced from each other, their centres being separated by about 1½µ (Fig. 2). The prozymogen granules, like the mature zymogen, do not concentrate vital dyes and are no more osmiophilic than the cytoplasm. No zymogen or prozymogen granule was ever observed within the interna of the lipochondria.

The observations were made on stained and unstained living pancreas *in vitro* and confirmed on pancreas with intact circulation, and also on material fixed on the slide with osmic acid and various osmic acid mixtures. Repeated intravenous injections of 0·5 c.c. of a 2 per cent solution of pilocarpine every forty minutes over a period of several hours was found the most suitable method for obtaining more or less synchronous and complete discharge of the pancreases of twelve-weeks old mice. The complete cycle of discharge and restitution in the most advanced cells took six hours.



Portions of pancreatic acini in various phases of restitution. 1, full pancreas. Mature zymogen, 1½µ in diameter Lipochondria not shown. 2, early phase of restitution. Prozymogen granules near limit of resolution in size. 3, Middle phase of restitution. First formed apical prozymogen larger than more recently formed basal prozymogen 4, In some of the cells remnants of undischarged mature zymogen are present Prozymogen granules have formed distally to these remnants as well as elsewhere. The vesiculated and non-vesiculated, simple and compound, bodies at the basal edge of the zymogen and prozymogen masses are the lipochondria or Golgi bodies

The onset of prozymogen formation does not require the complete prior discharge of the full pancreas cell. In a cell which has ceased to discharge, having lost only half its mature zymogen granules (or, possibly, even less), prozymogen begins to form immediately basally to the remaining zymogen. This may also be observed in sections of material fixed in Flemming without acetic mixture, stained with analine acid fuchsin and differentiated with methyl green, where the mature granules stain a yellow colour and the smaller prozymogen red. Where the discharge of zymogen goes on to completion, the new prozymogen first forms at the very apex of the cell. Later, prozymogen granule formation extends basally. Thus there is a continuous production of prozymogen, the full complement of granules not being laid down simultaneously. In a fully discharged cell which is well on the way to complete restoration of its zymogen complement, a gradation in size of prozymogen granules from the more advanced apical to the less advanced and more basal ones can readily be seen (Fig. 3). Thus the apical granules may have reached 1µ in diameter while the basal ones have only recently formed and are just visible. Only in the well-rested pancreas are all the granules mature, about 1½µ in diameter. Depletion of the cell occurs either by direct discharge of granules into the lumen, or indirectly by discharge into the long-necked retort-like vacuoles found in discharging cells, in particularly great abundance in animals heavily dosed with pilocarpine or pancreozymin and secretin. The walls of these vacuoles appear to be no more osmiophilic than the cell membranes. Among the fused and unfused zymogen granules present in these vacuoles some discharged lipochondria may also be found.

During discharge the lipochondria remain among, and immediately basal to, the most basal zymogen granules, and on complete discharge lie at the apical surface of the cell. As prozymogen granules form between the lipochondria and either the apical cell wall or the most basal part of the remnant zymogen granules, the lipochondria mark the boundary of the newly formed granules.

Where a mature zymogen granule and a heavily stained lipochondrion were in very close proximity, the latter, on myelination in appropriate solutions, often applied itself to the surface of the zymogen granule, so giving the appearance of a lipoidal sheath around a mature granule. The large blue (not purple) 'puddingstone' masses studied superficially with a number of mature zymogen granules, observed by Worley[5] in resting frog pancreas heavily stained with methylene blue and crushed in Ringer solution, are another type of artefact arising from lipochondria on the way to forming vacuome–crinome bodies[1] as a result of mechanical damage of the vitally stained cells.

A full report of this work is being published elsewhere.

I am indebted to Prof. O. W. Tiegs for the use of the facilities of the Zoology Department, University of Melbourne, where this work was carried out.

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Synthesis of β-Galactosidase in *Ophiostoma multiannulatum* and Some Properties of the Enzyme

THE ascomycete *Ophiostoma multiannulatum* (Hedgc. and Davids.) can grow on a synthetic liquid medium containing salts, vitamins (B_1 and B_6) and a suitable carbon source. In connexion with the development of a method for continuous culture of the fungus[1], some studies on the ability of the organism to utilize different carbon sources were made. More or less pronounced adaptive growth was observed with lactose, cellobiose, raffinose, glycerol and ethyl alcohol, whereas galactose was not metabolized. The growth lag was considerably shortened in the presence of a mixture of amino-acids, and this fact suggested a more detailed study of the factors influencing the synthesis of some of the enzymes involved.

It seemed desirable to investigate β-galactosidase first, as comparative data were available from several other organisms (see, for example, refs. 2–5). The enzyme was assayed by the technique originally described by Lederberg[6] under conditions which give a zero-order reaction with respect to substrate, *ortho*-nitrophenyl-β-D-galactoside.

Different mutant strains of the fungus have been shown to produce varying amounts of the enzyme, but work has been concentrated on a wild strain, *O. multiannulatum* 51. This strain grows in the form of budding conidia at 25–30° C. and, with good aeration, with a minimal mean generation time of about three hours. During the growth, β-galactosidase appears in the medium, but no measurable enzyme activity has been found in the cells. All methods tried for the extraction of fresh or lyophilized cells have failed to give more than mere traces of enzyme. If an enzyme preparation obtained from the medium is mixed with the cells, the enzyme activity is not lost during such extraction procedures. When the fungus is grown on lactose, the enzyme can be obtained from the medium at an early stage of growth, which also indicates that the β-galactosidase of *O. multiannulatum* is an exo-enzyme, in contrast to what has been found in bacteria and *Neurospora*. The enzyme synthesis is inhibited by a glucose concentration higher than 0·05 mgm./ml. in the medium, and when the cells are grown on 0·5 per cent glucose in ordinary shake-culture flasks, no enzyme can be detected until the glucose concentration falls below this value. In a continuous culture, with glucose as growth-limiting factor and with excess nitrogen, a considerable production of enzyme is obtained both at 25° and 30° C.

A partial purification of the enzyme has been accomplished by chromatography and electrophoresis. After the cells had been centrifuged from an immature culture on lactose, the supernatant solution was adjusted to *p*H 7·2 and made 0·02 *M* with respect to tris(hydroxymethyl) aminomethan-hydrochloride buffer (Sigma Chemical Co., *Tech. Bull.* 106), *p*H 7·2. The enzyme could then be quantitatively adsorbed directly on 'Dowex 2' in equilibrium with that buffer according to the technique described by Boman[7]. With 0·2 *M* buffer, more than 90 per cent of the enzyme activity is eluted, leaving about 80 per cent of the protein impurities on the column. After dialysis against 0·01 *M* acetate buffer, *p*H 5·0, the enzyme has been further purified by chromatography on calcium phosphate according to Tiselius[8].

The enzyme preparation is stable even at room temperature in a buffer composed of 0·1 *M* pyridin adjusted with acetic acid to *p*H 5·5, and preliminary experiments show that impurities can be removed by zone electrophoresis employing the apparatus of Porath[9] and the cellulose powder of Flodin and Kupke[10]. By using a volatile buffer system, it is possible to obtain concentrated salt-free preparations of the enzyme by lyophilizing the eluate from the column—a simple method which would seem to be applicable to all enzymes stable under these conditions.

Kinetic studies made on some of these preparations show that the enzyme reaction with *o*-nitrophenyl-β-D-galactoside is competitively inhibited by lactose and non-competitively by glucose. The optimum *p*H of the reaction is about 5, but trivalent anions such as phosphate and citrate move the optimum to higher values much as described by Landman and Bonner[4] for the β-galactosidase of *E. coli*. An Arrhenius plot of the reaction-rate between 20° and 40° C. gives a straight line, but more detailed kinetic observations have been postponed until purer preparations from different strains are available for comparison.

The stability of the enzyme in crude preparations is remarkable. At 65° C., 50 per cent inactivation is obtained after about 20 min. in acetate buffer *p*H 5, and at 30° C. it is stable between *p*H 3 and 8 for several hours. As the purity is increased, this stability seems to be appreciably reduced, probably because of the removal of some stabilizing impurity.

A[1] detailed report of this work will appear later. I wish to thank Prof. A. Tiselius and colleagues at this Institute for helpful discussions. The cost of this work is being defrayed in part by grants to the Institute from the Rockefeller Foundation.

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Decomposition of Xylan by *Sporocytophaga myxococcoides*

That *Sporocytophaga myxococcoides* is unable to grow on xylan and xylose has been shown by several investigators[1]; for that reason the organism was used in an investigation to find if cellulase is able to decompose xylan. Fuller and Norman[2] report a disappearance of xylan from corn stalk cellulose during growth of *Sporocytophaga myxococcoides*.

Two strains have been used; our own was isolated by Dr. H. L. Jensen and another was obtained from Prof. A. J. Kluyver, of Delft. The purity of the cultures was regularly checked by streaking on xylan agar and glucose asparagine yeast extract agar or meat peptone agar.

Strips of absorbent cotton-wool (0·2 gm., 6–8 cm. long) were placed in test tubes; 5 ml. of a medium containing 0·5 per cent wheat straw xylan in a colloidal solution in addition to inorganic nutrients (ammonium nitrate, 0·1 per cent; dipotassium hydrogen phosphate, 0·05 per cent; magnesium sulphate, 0·02 per cent; sodium chloride, 0·02 per cent; ferric chloride, 0·002 per cent) was added, and the cotton-wool was arranged like agar slants. After autoclaving at 115° for 20 min., the tubes were inoculated by moving a little piece of filter paper covered by growth of *Sporocytophaga* gently over the surface of the cotton-wool, and incubated at 30°. Every third day tubes were removed from the incubator for analysis, the purity of each culture was checked by streaking as mentioned above, the liquid was removed and brought to 5 ml., reducing power was determined in 1 ml., and the remainder was used for paper chromatography.

Reducing power[3] increased regularly in the tubes containing cotton-wool plus xylan, as seen in Fig. 1. A small increase was observed on cotton-wool alone. No growth took place on xylan alone.

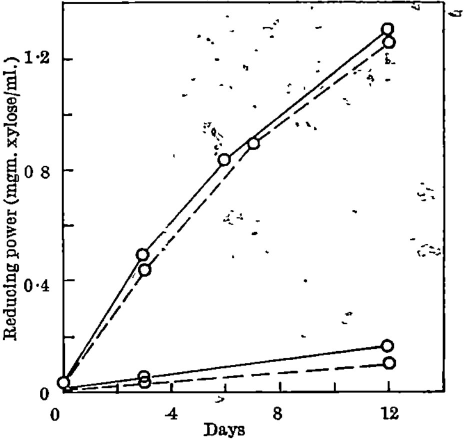

Fig. 1. Reducing power in cultures of *Sporocytophaga myxococcoides* growing on cotton-wool + xylan (upper curves) or cotton-wool alone (lower curves). Continuous line, Lyngby strain; broken line, Delft strain

The paper chromatograms from cultures on cotton-wool plus xylan showed an accumulation of xylose, arabinose, xylobiose, xylotriose and trace of glucose; these are the same reaction products which have been found in previous studies on enzymatic decomposition of xylan[4]. The small increase in reducing power in cotton wool alone was caused by xylose, arabinose and compounds containing uronic acid. These presumably originated from accompanying hemicellulose, since xylose, arabinose and uronic acid were released by treating the cotton-wool with boiling 0·5 *N* sulphuric acid but are not found in aqueous extracts of *Sporocytophaga* grown on glucose agar.

Cell material grown on cellulose or glucose and precipitated in acetone was able to split xylan at almost the same rate. Slight xylan-splitting activity was found in a filtered fluid (Jena glass filter 11 *G* 5) from a cellulose culture.

These experiments suggest that the cellulase of *Sporocytophaga myxococcoides* is able to split xylan; other explanations might, however, be possible. This property is interesting from the point of view of the ecology of the soil micro-organisms, since other organisms might in this way be provided with easily available carbohydrate material.

A more detailed account of this work will appear later.

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Leaf Movements and the *Tagesrhythmik* Explanation of Photoperiodism

Bünning's[1] hypothesis of the relationship between day-length responses and diurnal rhythms as manifested by leaf movements has been the object of several recent criticisms[2-4] as inconsistent with some facts of photoperiodic induction. However, Bünning's scheme is not only a theory of photoperiodism but also a generalization concerning diurnal leaf movements.

Fig. 1 shows a selection of records of the diurnal change of leaf position in *Bauhinia monandra*. The positions were recorded on 16-mm. film using a camera triggered every fifteen minutes. It will be seen that although the shapes of the phases are not exactly as in Bünning's idealized diagrams, the general

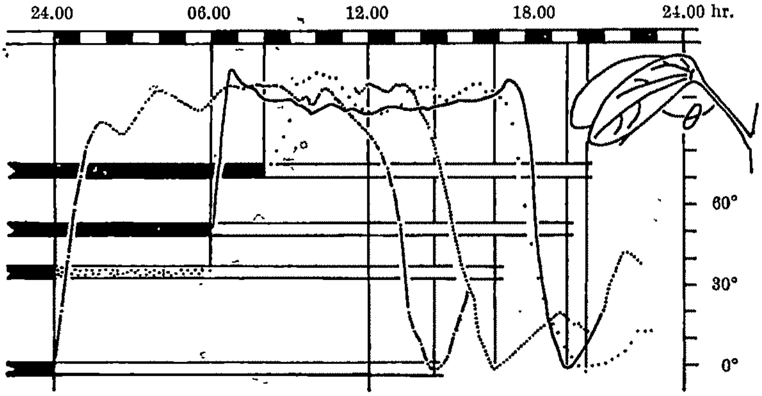

Fig. 1. *Bauhinia monandra.* Changes of leaf angle after beginning illumination at midnight, 6 a.m. and 8 a.m. and (stippled band) at midnight, but with weak light until 6 a.m. In each case the plants were darkened from 6 p.m. the previous evening

features are evident and, in particular, the *hebung* phase begins immediately after illumination as in his diagram for short-day plants. This, of course, might be expected in a tropical species accustomed to a 12-hr. day in Nature.

Nevertheless, if the times from beginning illumination to the onset of downward movement (that is, the duration of the 'photophile' stage in Bünning's terminology) are compared among the graphs, they are obviously not constant. However, the point of beginning downward movement is ill-defined in these records, and as it has also proved very susceptible to extraneous conditions such as humidity, and also age of the leaf, it is doubtful whether it can be regarded as a critical point in the cycle. On the other hand, the timing of the middle point of leaf closure is sharply defined and has proved very uniform after any particular alternation of darkness and illumination. Counting, then, this middle point of closure as the limit of the photophile stage, it has been found that, independently of the time of darkening the previous day, the 'normal' photophile phase of a little more than 12 hours duration (illustrated by illumination at 6 a.m. in Fig. 1) is only adhered to if the duration of the preceding dark period also approximates to 12 hr. With shorter dark periods (as with illumination at midnight) the photophile phase is lengthened; with longer (as with illumination at 8 a.m.) it is shortened. Exactly similar relationships to the length of the previous dark period appear to hold for the related species *B. tomentosa* and also for an unrelated plant, *Talinum triangulare*.

It would then appear that leaf movement in these examples closely parallels the photoperiodic behaviour of short-day plants such as *Xanthium*, in which flowering is said[5] to be dependent on the duration of the dark period. Bünning himself[6] has made a special exception for *Xanthium* from his general rule that the cycle of leaf movement is initiated in the first instance by change from dark to light. In this case, he says, the cycle is set in operation by a change from light to darkness. It is evident, however, that both changes are involved in determining the length of the photophile phase in *Bauhinia* and *Talinum*: agreeing exactly with the photoperiodic behaviour of short-day plants.

There is a second respect in which the leaf movements of these plants seem to agree better with reported features of photoperiodism than with Bünning's generalizations: the effect shown in Fig. 1 of beginning illumination with a period of weak light, which in this case was about 30 foot-candles compared with 600 foot-candles for the rest of the period. It will be seen that this treatment produced the longest photophile phase of all, as if the weak light had made the previous dark period in effect even shorter. Schwabe[7] has provided a parallel in photoperiodism with the observation that when part of the light period in each day is provided by weak light, the effective length of the accompanying dark period in controlling flowering is reduced. In Bünning's schemes, of course, the cycles are controlled by the timing of illumination, not at all by its intensity.

A few other inconsistencies with Bünning's sequences have been noted. For example, when illumination is continued without further intervention of dark periods, the rhythm set up by the initial exposure to light does not continue endogenously, but rapidly decreases in amplitude and is practically indistinguishable after three days. Moreover, although the limits of the phases rapidly become indistinct, it is nevertheless clear they recur after decreasing intervals of time. It appears probable that control of the cycle by the initial illumination scarcely persists beyond the first closure phase, for it is only this phase which shows the strict timing evident in Fig. 1. Referring to the figure again, it also appears doubtful whether any part of the cycle but this first closure is indeed controlled by illumination, for although Bünning postulates that the first effect of transfer to light is invariably the initiation of upward movement of the leaves, these records show that in *Bauhinia* upward movement had already begun before the end of long dark periods. Schwabe[8] has reported an exactly similar behaviour of stomatal aperture. In *Talinum*, on the other hand, the 'opening' phase that is in progress at the beginning of a normal light period is actually a downward movement of the leaves and this, too, begins before daybreak. In *Bauhinia* the rapid opening on first bringing into the light has presumably nothing to do with the diurnal cycle on which it is superimposed, for a similar immediate response may be induced at any time of day by altering light intensity, and apparently without any effect on the timing of the subsequent closure phase. Significantly, the leaf position of *Talinum* is not detectably affected by change of intensity in the daytime and neither is there evidence of accelerated opening when this plant is first brought into the light.

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Effect on Crop Growth of Rain after Prolonged Drought

An investigation of the effect of irrigation on the growth of the sugar beet crop was started in 1955 at Woburn, Beds. Measurements of dry weight and leaf area were made on samples of the crop taken from twelve plots, six of which were irrigated. The experiment also included a comparison of two rates of nitrogen supply, but for the present purpose this can be ignored; the results in Table 1 are means for the two rates. Material was available for sampling on only three occasions, as most of the crop had to be kept for measurement of yield at the normal time of harvest.

Table 1. Effect of Irrigation on Dry-matter Yield and Leaf-area Index of a Sugar Beet Crop on (1) July 27, (2) August 10 and (3) August 24, 1955, and on Net Assimilation Rate, Relative Leaf-growth Rate, and the Increment of Dry-weight Yield in the Intervals between Times 1, 2, and 3

	Dry weight (gm /m.^{2})			Leaf-area index		
Time	1	2	3	1	2	3
Irrigated	226	531	704	1·43	2·35	2·60
Not irrigated	187	300	544	1·03	1·04	1·62
S.E	14	36	56	0·08	0·12	0·17

	Net assimilation rate (gm /m ^{2}/week)		Relative leaf-growth rate (per cent per week)		Dry-weight increment (gm /m ^{2})	
Interval	1–2	2–3	1–2	2–3	1–2	2–3
Irrigated	83	34	26	5	305	173
Not irrigated	53	96	0	20	113	244
S.E	8	14	3	6	30	59

No rain had fallen for three weeks before the first sampling on July 27, and the estimated water deficit on the unirrigated plots was then 4 in. On the irrigated plots it was kept below 1 in. by appropriate irrigation throughout the growth period. The dry-weight yield and leaf-area index (*L*, ratio of leaf area to land area) of the irrigated crop (Table 1) were already much greater than those of the unirrigated crop. There was no rain in the following fortnight, and at the second sampling on August 10 the estimated water deficit on the unirrigated plots had increased to 5 in.; the effect of irrigation on dry-weight yield had also greatly increased. The net assimilation rate (*E*) of the irrigated plants in the interval between July 27 and August 10 was significantly greater than that of the unirrigated plants. On the unirrigated plots, *L* did not increase during the interval, but it increased so much on the irrigated plots that on August 10 it was more than doubled by irrigation. Because of the large effects on both *E* and *L*, the increment of dry-matter yield between July 27 and August 10 was nearly trebled by irrigation.

During the next two weeks, 0·6 in. of rain fell, but in spite of this the estimated water deficit of the unirrigated land had increased to nearly 6 in. on August 24. For the irrigated plants, *E* was less than in the previous period, presumably because of changes in environmental factors other than water supply, but for the unirrigated plants it was greater than before. Consequently, in the second period the effect of irrigation was reversed and *E* was nearly three times as great for the unirrigated as for the irrigated plants. During the second period also, *L* increased more, both absolutely and relatively, on the unirrigated plots, but on August 24 it was still much smaller than on the irrigated plots. However, *E* was so much greater for the unirrigated plots that in spite of *L* being smaller the increment of dry-matter yield was larger, though not significantly, than on the irrigated plots.

These results show that, after prolonged drought, rainfall in amounts very small compared with the soil-moisture deficit, and therefore with amounts used in orthodox irrigation practice, caused such large increases both in leaf growth and in the rate of photosynthesis of unirrigated plants that, temporarily, these plants grew faster than irrigated ones that had never been subjected to severe water stress. It is intended to repeat this work (though the same conditions may not recur in the field in 1956) and, if possible, to imitate the conditions of water supply in laboratory experiments. If the results are confirmed, they may have an important bearing on the efficient use of irrigation water.

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Polymorphism and Parthenogenesis in a Ptinid Beetle

Ptinus latro Fab. (1775) and *P. hirtellus* Sturm (1837) (Coleoptera, Ptinidae) have for long been accepted as separate, sexually dimorphic species. The females of the two forms are abundantly distinct, but no satisfactory separation character for males has ever been described (see Hinton's monograph[1]).

P. hirtellus has been maintained in culture at the Pest Infestation Laboratory for many generations and abundant material of both sexes has been available for study. Attempts to obtain cultures of *P. latro* by similar methods have led to the discovery that this is a parthenogenetic form of unusual type.

Through the kind co-operation of the London area inspectors of the Ministry of Agriculture, Fisheries and Food, a few living female *latro* were obtained during November 1953. These were cultured on a mixture of equal parts of fishmeal and wheatmeal with about 5 per cent dried yeast, at 25° C. and 70 per cent relative humidity, and eventually seventeen larvæ were obtained. From these, seventeen adults were reared, all of which proved to be female *latro*. They were separated into two groups of seven and ten individuals, respectively. The former were kept unmated until death (a matter of several months), whereas the latter were provided with twelve fresh males from a culture of *hirtellus*. No progeny resulted from the virgin females, but the mated females produced twenty-one larvæ. Again exclusively female *latro* were reared.

On the advice of Mr. R. W. Howe, of the Pest Infestation Laboratory, the third generation was cultured (with *hirtellus* males) at 20° C., a temperature which he has found to be the optimal for oviposition in several species of ptinids. This resulted in a very large culture, and between 1,500 and 2,000 adults, all female *latro*, were reared. Many thriving cultures are now being maintained under these conditions, but further experiments with virgin females have again failed.

The biological findings strongly suggest that female *latro* reproduce by parthenogenesis, and this is supported by the extreme uniformity of the reared individuals. However, mating, which takes place very readily with male *hirtellus*, appears to be essential, for we have never succeeded in rearing from virgin *latro*. Under crowded conditions, unmated females will lay a few eggs, but these do not hatch and soon collapse. Preliminary experiments indicate that the mating reaction between female *latro* and male *P. fur* L. or male *P. pusillus* Sturm is weak. Comparatively few instances of attempted copulation have been observed, although a small number of female *latro* progeny have resulted from the latter cross. Thus, on balance, it appears that *hirtellus* and *latro* comprise a single polymorphic species.

One of us (A. R. S.) has investigated the problem from the cytological point of view. The work is at present incomplete, but the results to date show that the male and female *hirtellus* have a diploid constitution ($2n = 18$); female *latro* has 27 chromosomes and is therefore a triploid. Maturation is normal in the male, sperms having $8 + X$ or $8 + Y$. The maturation spindle forms in the unlaid egg; in *hirtellus* reduction occurs, in *latro* the triploid number is retained. Insemination of the *latro* female is essential for the development of the egg but, since the egg does not show reduction, the sperm can play no part in regulation of the chromosome number.

In order to investigate the role of the sperm, *hirtellus* males were sterilized at Harwell by exposure to γ-radiation and mated with *hirtellus* and *latro* females. Copulation was normal but resulted in large-scale production of non-viable eggs. Thus not only is insemination of the *latro* female essential for oviposition but also the sperm must play some part in initiating activation of the egg. Full-length sperms have been observed in the developing *hirtellus* egg, but we are not yet certain that the sperm enters the *latro* egg. Biological and cytological evidence indicates that in *Ptinus latro* we are dealing with thelytokous parthenogenesis of a particular type—either gynogenesis or some form akin to it in which the sperm plays an even more restricted part.

In Coleoptera thelytokous parthenogenesis occurs as a normal method of reproduction only in the Curculionidae[2]. So far as we are aware, parthenogenesis of the type described here is unique within the order. Further details of the biological, taxonomic and cytological aspects of our work will be given in other publications.

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Estimation of Numbers of *Nitrosomonas* in Soil and Culture

Attempts to estimate the numbers of nitrifying organisms in soil have usually been made by some form of dilution technique involving culture of the dilutions in liquid media in tubes (see ref. 1). The number of dilutions, and of replicate tubes at each dilution, that are necessary to give reliable estimates, makes this method extravagant of material and time. Singh[2] developed a dilution method for estimating numbers of Protozoa in soil suspensions, in which Petri dishes, each containing a number of replicate disk cultures on agar, effected a great saving in both these respects. Attempts were made to adapt this method to estimating numbers of *Nitrosomonas*. The medium used was prepared from the following solutions, separately sterilized, and mixed in the proportions of 2·0 ml. each of solutions (I) and (II) to 12·0 ml. of (III).

Solution I: NaCl, 0·2 gm.; $MgSO_4,7H_2O$, 0·05 gm.; Na_2HPO_4, 1·2 gm; KH_2PO_4, 0·6 gm.; $NaHCO_3$, 0·1 gm.; $FeSO_4,7H_2O$, 1·0 mgm.; $MnSO_4,4H_2O$, 1·0 mgm.; tap water to 100 ml.
Solution II: 0 8 per cent w/v $(NH_4)_2SO_4$ in distilled water.
Solution III: 2·5 per cent w/v 'Difco' Bacto-Agar, washed for 24 hr. in running tap water.

Silica gel was found unsuitable owing to the tendency for water to form a film on the surface. This agar medium was used in the following dilution technique, which was tested both with soil and with liquid cultures of *Nitrosomonas*. Eight glass rings (20 mm. inside diameter, 7–8 mm. deep) are arranged in a Petri dish, and heat sterilized. To each ring 1·0 ml. of the medium is added aseptically, the medium being held at 52–55°. On meeting the cold dish and ring, the agar gels and does not spread beyond the ring. To ensure this, the edges of the rings in contact with the dish must be ground smooth. In this way, eight discrete disks of agar can be produced per plate. Preliminary experiments showed that nitrite diffused rapidly through the agar, so that the separate disks must not be connected with an agar film. From a 1 : 5 suspension of the soil or dilution of the culture, further two-fold dilutions are made to give a final dilution of 1 : 81,920. One Petri dish is used per dilution, 0·05 ml. of which is applied to each of the eight disks. After inoculation the dishes are placed in MacIntosh and Fildes jars which are flushed for periods of 2 hr. daily with air drawn through 50 per cent v/v sulphuric acid followed by 1 per cent w/v sodium bicarbonate, in order to remove oxides of nitrogen found to be present in the laboratory atmosphere. After incubation at 18–22° for 21 days, the cultures are tested for nitrite by adding to each disk two drops each of sulphanilic acid solution (0·6 per cent, w/v, in 30 per cent, v/v, acetic acid), and N-(1-naphthyl) ethylene diamine dihydrochloride (0·1 per cent, w/v, in 3 per cent, v/v, acetic acid). These solutions must be stored in the dark. An intense red coloration indicates the presence of nitrite. As a check, uninoculated plates are also incubated. The number of organisms per ml. of original suspension may then be computed by applying Fisher's method of 'negative plates'[3]. Singh[2] has prepared a table from which the number of organisms per ml. of original suspension can be obtained directly when the previously mentioned dilution series and eight replicate 0·05 ml. inocula per dilution are used. Two populations are significantly different in numbers if the number of 'negative' cultures varies by ± 8 or more, that is, + 100 per cent, − 50 per cent.

To test this technique, a suspension in saline of *Nitrosomonas*, previously counted in a hæmocytometer, was used. A dilution series of this suspension was applied to the disks and a parallel series inoculated into test-tubes, each containing 5 ml. of medium without agar, with eight replicate tubes at each dilution. Parallel tests were also carried out in which the counted suspension was added to sterilized Rothamsted soil and serial dilutions made from a suspension of it. The 'recovered' numbers estimated

Table 1

	Hæmocytometer count	Estimated numbers	
		Agar disk method	Test-tube method
Experiment 1			
Saline control	500,000	311,000	650,000
Soil	500,000	5,080 (1 per cent recovery)	931,000
Experiment 2			
Saline control	500,000	380,000	931,000
Soil	500,000	41,400 (8 per cent recovery)	520,000

All figures represent number of organisms/gm. soil or ml saline.

from the disk and tube dilutions obtained in two experiments are given in Table 1.

Both disk and tube methods gave a satisfactory 'recovery' of numbers from the suspensions in saline, having regard to the limited accuracy of a dilution method. The test-tube method also gave satisfactory recovery from the soil suspension; but with disks, recovery was only 1 per cent and 8 per cent in the two experiments.

A recovery test was then made in unsterilized soil to see whether sterilization of the soil had produced substances harmful to growth. A counted suspension of *Nitrosomonas* was added to fresh soil. Numbers were then estimated by the disk method from this soil and from an uninoculated control soil. In a later experiment, a similar test was made with the tube method. The results (Table 2) again show that the fresh soil has interfered with the recovery of added numbers in the disk method, but not with the tube method.

Table 2. RECOVERY OF *Nitrosomonas* FROM UNSTERILIZED SOIL

	No. of organisms added, per gm. soil	No. of organisms estimated, per gm. soil
Agar disk technique		
Uninoculated soil	0	6,040
Inoculated soil	600,000	22,400 (3·75 per cent recovery)
Test-tube technique		
Uninoculated soil	0	59,000
Inoculated soil	500,000	729,000

These results point to some factor introduced by the soil which interferes with growth on agar disks, but not in test-tubes, where it is perhaps diluted out. The nature of this factor will be further investigated.

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Nucleus and Spindle of *Bacillus megaterium* in Fission and Sporulation

IN a recent communication in *Nature*, Yuasa[1] ontends that the 'side-body' of the spores of *Bacillus megaterium* is identical with the spindle of the dividing yeast nucleus, and acts as such in a mitotic division of the bacterial nucleus.

This is quite unacceptable for the following reasons: 1) The theory of a mitotic division in *B. megaterium*, advanced by DeLamater[2], so far from being regarded even as a problematical alternative to the now classical concept of the bacterial nucleus[3], has been very severely criticized on both theoretical and practical grounds by leading authorities in all parts of the world[4]. (2) The 'side-body' has now been proved conclusively to be an artefact caused by partial ejection of the turgid nuclear contents of the spore[5]. (3) The 'large-body' in the vegetative bacillus, which Yuasa claims to be identical with the 'side-body', appears from his diagrams to represent the polar aggregate of basophilic material associated with the growing tip of the cell[6].

The apparent contention of Yuasa that the authors whom he quotes themselves equate this structure in the sporing bacillus with the 'side-body' (that is, the ejected nucleus) of the spore is without foundation.

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Use of Capacity Measurements for the Study of Oxide Films on Metals

ESTIMATES of the thickness of oxide films on metals have long been made by immersion in an electrolyte and measurement of the capacity of the condenser formed by the film as dielectric[1]. It has, however, been pointed out by E. Huddle (private communication) that such measurements are liable to error if the film contains cracks, for these permit the electrolyte to approach closer to the metal/oxide interface. This should cause the 'capacity' thickness to be less than that derived from measurements of gain of weight, for example. A rise in the capacity of anodized films under condition of breakdown has been reported by Young[1].

This behaviour has been turned to advantage in the examination of the films formed in the corrosion of zirconium alloys. When the latter are exposed to water at about 300° C., the rate of corrosion, as measured by the gain of weight, at first falls with time. At a certain stage, called 'breakaway'[2], the film on most alloys becomes less protective, and the rate changes to a constant, higher, value. All the specimens examined in these experiments had suffered breakaway, except those of the alloy 'Zircaloy 2' (1·5 per cent tin, 0·13 per cent iron, 0·05 per cent nickel, 0·12 per cent chromium, balance zirconium), which is very resistant to corrosion.

Specimens of the alloys detailed in Table 1 were pickled in a solution containing 45 c.c. nitric acid (concentrated), 5 c.c. hydrofluoric acid (48 per cent solution), 50 c.c. water and then weighed. After exposure to water at 325° C. for periods up to about 500 hr. they were reweighed, wires were attached to them, and they were waxed, leaving 1 cm.^{2} (apparent

Table 1

(All quantities per cm.^{2} apparent area)

Alloy	Time of corrosion (hr.)	Weight gain W (mgm.)	C (μF.)	$\frac{1}{C}$	$\frac{1}{C.W}$	Corrosion resistance
'Zircaloy 2'*	72	0·1	0·039	26	260	Good
,,	144	0·3	0·029	35	120	
,,	228	0·3	0·029	35	120	
,,	520	0·3	0·025	40	130	
1 per cent chromium, balance zirconium	72	1·0	0·093	11	11	Intermediate
,,	144	2·8	0·257	3·9	1·4	
,,	228	4·7	0·129	7·8	1·7	
,,	520	11	0·392	2·6	0·24	
Arc-melted Kroll zirconium	72	0·5	0·143	7·0	14	
,,	144	1·3	0·135	7·4	5·7	
,,	228	2·1	0·140	7·1	3·4	
,,	520	3·7	0·179	5·6	1·5	
2·5 per cent tantalum, balance zirconium	72	1·3	0·404	2·5	1·9	Poor
,,	520	? flaked	0·526	1·9	—	
0·25 per cent aluminium, balance zirconium	72	∼7 ,,	0·726	1·4	∼0·2	
'Zircaloy 2', 500° C	190	2·1	0·014	71	34	

* 1·5 per cent tin, 0·13 per cent iron, 0·05 per cent nickel, 0·12 per cent chromium, balance zirconium.

area) bare. They were immersed in $N/1$ sulphuric acid, together with a platinized platinum electrode, and the impedance of this cell was measured at 1,000 c./s. using a Wien-type bridge with Wagner earth. Arrangements were made to keep the specimens at a constant, arbitrary, potential of + 1·00 V. (saturated calomel). The a.c. voltage impressed on the cell was not more than a few centivolts (r.m.s.). The cell impedance was expressed as a resistance and capacity in series. The observed capacity values were much smaller than that of the double-layer capacity on metal surfaces, so that the latter, and the capacity of the platinum electrode, which are both in series with the film capacity, could be neglected. The resistance represents that of the electrolyte, which was kept low by the use of a solution of high conductance, together with a contribution from the oxide film which has recently been more fully treated by Young[1].

The capacity results are given in Table 1, together with their reciprocals (which are a measure of 'capacity' thickness) and the gain of weight. Since adherent films were formed in all but two cases, the latter give valid measures of 'weight' thickness. The comparison of 'weight' and 'capacity' thickness, obtained by evaluating $1/C.W$ (C in microfarads/cm.^{2}, W in mgm./cm.^{2}), gives figures which sharply discriminate between 'Zircaloy 2' and the less resistant alloys, suggesting that the films on the latter are considerably cracked whereas those on 'Zircaloy 2' contain few cracks, or, possibly, no cracks at all. This view is supported by the dependence of capacity on time. With 'Zircaloy 2' the capacity quickly settled to a value which remained steady for many hours ; but with the other materials an upward drift began when the specimen was immersed in the electrolyte and was still perceptible 24 hr. later. This is consistent with the slow penetration of the electrolyte into a cracked film. That it is possible, under more drastic conditions, to reduce the 'soundness' of the film on 'Zircaloy 2' is shown by the results for a specimen exposed to superheated steam at 500° C. and 1 atmosphere pressure. This specimen also showed an upward drift of capacity with time.

Some capacity measurements were also made at other frequencies, 60–5,000 c./s. The dependence of resistance and capacity on frequency for both 'Zircaloy 2' and other alloys conformed approximately to the relations derived by Young[1] for crack-free films.

If the films on 'Zircaloy 2' are assumed to be entirely crack-free, their theoretical capacities may be calculated approximately, using Charlesby's[3] value of 27 for the dielectric constant and a density of 5·7 for zirconium oxide. Then $C = 3{\cdot}5 \times 10^{-3}\,\sigma^2/W$ μF./apparent cm.^{2} (σ is true area/apparent area). If the calculated and observed capacities of the 520-hr. film are equated, σ is found to be about 1·5. Adams, Maraghini and Van Rysselberghe[4] reported σ to be $2{\cdot}1 \pm 0{\cdot}2$ for abraded zirconium and, in comparison with this, a value of 1·5 for a bright pickled surface seems reasonable.

These measurements suggest that after 'breakaway' the oxide film on zirconium alloys consists of an outer cracked portion into which water can penetrate, and an inner, crack-free portion which controls the rate of corrosion.

The results obtained with zirconium alloys suggest capacity measurement as a useful method of studying the protective character, as distinct from the thickness, of oxide films formed by corrosion and oxidation.

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The Standard of Length and the Standard of Time

The interesting communication in *Nature* o December 24, p. 1230, from Dr. G. M. Clemence[1], under the title "Definition of the Second of Time", has suggested to me some comments.

First of all, there is, in the first line of the secon column, a slight error : the number of microns i 1 metre cannot be subject to experimental determina tion. The micron, which is sometimes called th 'micro-metre', is, by definition, the millionth part of the metre. What is meant is the 'angström', A. the angström being related to wave-length, by th expression A. = $\frac{1}{6438{\cdot}4696}$ wave-length of the re cadmium line in standard air.

However, precautions were taken to avoid havin two units of length, and the angström will remai what it is nowadays, equal to 10^{-10} m. (personally I hope it will disappear). Indeed, we know that (du to what is unquestionably a lucky chance) the averag of the values obtained by various experimenters since the work of Benoît–Fabry–Perot, for the wave length of red cadmium in standard air is exactl 0·643 846 96μ, the very value which was given b Benoît–Fabry–Perot.

Now, the Comité International des Poids et Mesures has already adopted a Recommendation of its Comité Consultatif pour la Définition du Mètre, which reads as follows: "In view of giving the unit of length a continuity as perfect as possible, when going to the contemplated definition, it is recommended to work out the latter, by using, as an intermediate step, the value $0{\cdot}643\ 846\ 96 \times 10^{-6}$ m. for the wave-length of the red-cadmium line, as specified by the 7th Conférence Générale des Poids et Mesures".

This means that, to the limit of accuracy which may be reached at present (and I wish to add, to the limit of accuracy which can be reached by the present prototype line standard), the metre, defined by means of the wave-length, will be strictly equal to the present metre defined by means of the platinum–iridium prototype. The standard will have been changed, but the unit will not have been changed and this unit will remain the same for all users, as the one and only unit of length, but defined by means of a wave-length.

It will be the same—at least I hope so—for the unit of interval of time. When we are assured of the permanency of an atomic frequency, and physicists, in agreement with astronomers, take such a frequency as a standard, then they will do it so as to determine exactly the number N, for an interval t such that:

$Nt = 1/31\ 556\ 925{\cdot}974\ 74$ tropical year 1900.0 = the second, the tropical year 1900.0 being derived from the tropical year for the time being by applying corrections always known. Until this clock is confirmed to be permanent (perpetual and endless), we shall have to consider that atomic frequency is just a wonderful interpolation tool—or, if we like, a recorder of the standard—but not as a standard itself. In the same manner, the wave-length is still a recorder of the metric unit. It would be nonsense to have one standard for short times and another one for very long times.

The standard of interval of time will have been changed; it will be t instead of the tropical year 1900.0 (in practice, the tropical year of the time being); but the unit, for everyone whatever his branch of learning may be, will be exactly the same: the 'second', the one and only unit of time. The change of standard would not, of course, prevent physicists (or astronomers), after the changes have been made, from carrying out very interesting experiments, in order to determine the possible slight variations of old standards, expressed in the new units recognized as absolute invariants.

It does not appear that the simultaneous existence of two units extremely close to each other has serious drawbacks. We have already experienced those drawbacks with units of volume (cubic decimetre and litre). But we are still feeling those drawbacks and we hope to remove them by means of the new French law which is now in preparation.

It is true that the unit of length and the unit of time will no longer be independent. But I think we can leave it to the third generation of our successors to adjust the definitions of the metre and the second with the sufficiently accurate value that they will have then been able to obtain for the velocity of light. It will be, as it is even now, a question of accuracy.

What follows in Dr. Clemence's communication is a matter of astronomy, and there I declare myself incompetent.

Dr. Clemence has seen the present communication, and desires me to say that he regrets his error in confusing the micron with the angström, while still asserting the principle of his argument. Further, he agrees completely with my views, with the exception of the question of the desirability of changing the definition of the metre, which he has not studied sufficiently to form a competent opinion.

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Thermal Conductivity of Solid Argon at Low Temperatures

VALUES which are fairly reproducible for the thermal conductivity K of an inert gas solid, argon, have been obtained over a range of temperatures from 2° to 25° K., corresponding to temperatures $\theta/40$–$\theta/3$ since the Debye characteristic temperature θ for solid argon is about 80° K. These measurements were made by filling a thin-walled 'Inconel' tube of diameter 0·5 in. and length about 3 in. with argon at a temperature of approximately 78° K., through a capillary tube. During filling, the gas pressure was maintained above the triple-point pressure to ensure that liquid argon was produced in the specimen tube, and this gradually solidified from the bottom and from the walls of the tube to produce a homogeneous solid. The 'Inconel' tube, for the thermal conductivity of which small corrections were applied to the results, was mounted in a thermal conductivity cryostat described previously by White and Woods[1].

As shown in Fig. 1, the thermal conductivity of solid argon from the lowest temperatures rises approximately as T^2 to a maximum value of 0·045 watts/cm. deg. at 7° K. and then decreases. Above 15° K., the conductivity may be approximately expressed by $K \simeq 0{\cdot}28/T$ watts/cm. deg. It is interesting to compare this latter relation with the formula proposed by Dugdale and MacDonald[2] for

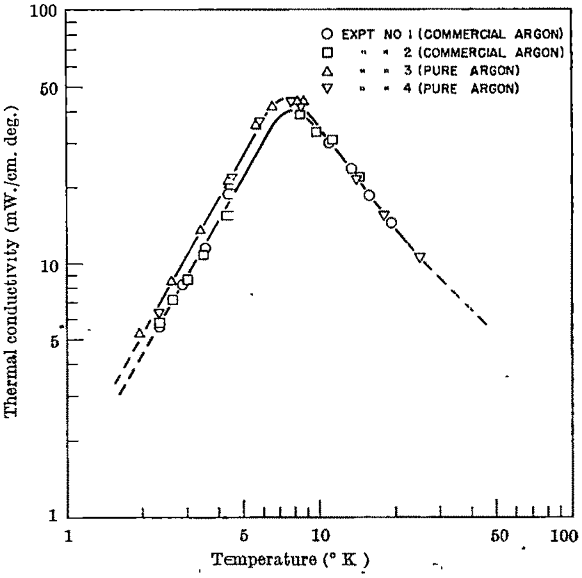

Fig. 1 Thermal conductivity of solid argon at low temperatures

the lattice thermal conductivity of a simple dielectric solid in the temperature region ($T \sim \theta$), where anharmonic coupling between the lattice waves is the dominant cause of thermal resistance, namely,

$$K = \frac{1}{3}\, v.C.A_0/\alpha\gamma T$$

Substituting experimental values for the specific heat per unit volume C, the lattice constant A_0, the velocity of sound v, the thermal expansion coefficient α[3], and a probable value of $\sim 2{\cdot}5$ for the Grüneisen constant γ[4], $K \sim 0{\cdot}4/T$ watts/cm. deg. is obtained.

Thermal resistance due to the scattering of lattice waves by grain boundaries, static imperfections, etc., has been discussed by Berman[5] and Klemens[6]. The temperature dependence of our results and the small magnitude of the conductivity at temperatures below 6° K., suggesting a mean free path $\sim 10^{-4}$ cm., seem to indicate that the dominant mechanism producing thermal resistance below the maximum is that of scattering by dislocations.

Previous measurements by Webb and Wilks[7] on solid helium indicated that at very low temperatures $K \propto T^{2{\cdot}3}$ and just above the maximum in the so-called umklapp region $K \simeq A\, e^{\theta/bT}$, where $b \simeq 2$. We suggest that in the case of argon, the conductivity in this region is considerably reduced by the presence of dislocations or other static imperfections, which would mask such temperature dependence. However, it is intended to continue this research and extend it to other inert gas solids, and a fuller account of the methods and results will be published elsewhere.

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Dependence of the Elastic Properties of Cadmium on Temperature

Yousef and Kamel[1] have studied Young's modulus and the internal friction of cadmium as a function of temperature at 50 cycles per second. Young's modulus vs. temperature curve of polycrystalline cadmium shows a sharp break at about 80° C., while the same metal in the single-crystal form behaves in a normal manner. This suggests that it may be due to stress relaxation at grain boundaries. One would then expect a higher transition temperature at higher frequencies. The same behaviour would also be expected in the case of the rigidity modulus. The variation of the elastic constants of polycrystalline cadmium with temperature at 100 kc./s. has therefore been studied.

Specimen rods of rectangular and cylindrical cross-sections are cut from 99 per cent pure cadmium supplied by B.D.H., Ltd. Natural frequencies, longitudinal and torsional, of the specimens are measured as a function of temperature, using the composite oscillator method[2]; the results are presented in Fig. 1. The square of the natural frequency is taken as a measure of the related elastic constant. A sudden change in the gradient of (frequency)^2 vs. temperature curves occurs at 130° C. Bordoni and Nuovo[3] measured the velocity of longitudinal waves in cadmium as a function of temperature at 9 kc./s. Their results show a transition at 127° C. Thus the transition temperature is dependent on frequency and increases with it.

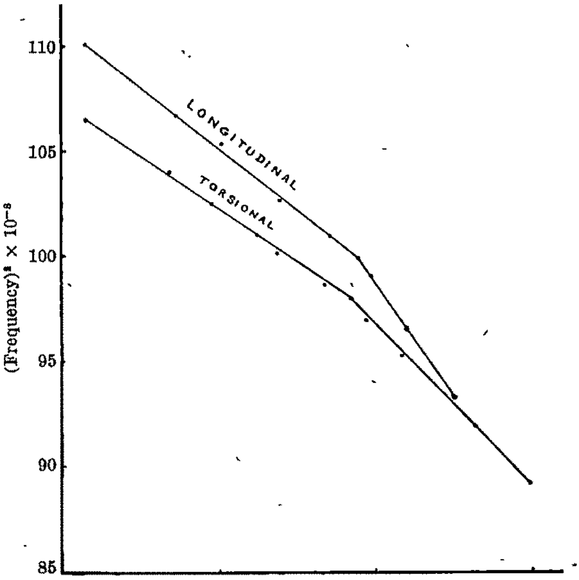

Fig. 1

The activation energy associated with the above phenomena has been calculated using the transition temperatures from elasticity data at 50 c./s. and 100 kc./s. and is found to be 40,000 cal./mole. This may be regarded as in fair agreement with the value, 32,000 cal./mole, calculated from internal friction data by Yousef and Kamel.

Absence of the transition phenomena in the single crystal and its dependence upon frequency in polycrystalline cadmium proves that the mechanism involved is stress relaxation at the grain boundaries.

I thank Prof. S. Bhagavantam for his guidance and encouragement during the course of this work.

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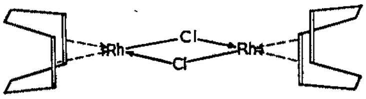
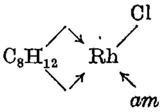
Olefin Complexes of Rhodium

Stable olefin complexes are formed only by metals near the end of each transition series in the Periodic Table, and these metals form a triangle in the Table, Cu(I) ; Pd(II), Ag(I) ; Pt(II), {Au(I)}, Hg(II). It is characteristic of the complex chemistry of metals inside the triangle that they tend to form stronger complexes with ligands containing donor atoms from the third or subsequent rows of the Periodic Table than with the corresponding ligands containing donor atoms from the second row (counting hydrogen and helium as the first row)[1]. This rule of co-ordination chemistry also extends to metals bordering on the 'olefin-complex triangle', especially to the metals to the left of the triangle. It seems reasonable to expect, therefore, that the triangle might eventually be extended to the left in the Periodic Table. With this object in view, we are attempting to obtain olefin complexes of cobalt, rhodium, iridium, iron, ruthenium and osmium, using the strongly chelating di-olefin, 1 : 5-*cyclo*-octadiene, and are now reporting briefly a series of rhodium complexes. When an ethanolic solution of rhodium chloride ($RhCl_3$) to which 1 : 5-*cyclo*-octadiene (C_8H_{12}) has been added is boiled under reflux, a very stable yellow crystalline solid of the composition $C_8H_{12}RhCl$ is deposited. It is diamagnetic and dimeric, and so must have the chloro-bridged structure (I), in which the metal will have square planar (*dsp*^{2}) co-ordination. When it is treated with an amine, *am*, the bridge is split to give mononuclear complexes of the type (II). Derivatives of $(C_8H_{12})_2Rh_2Cl_2$ (I) in which the chlorine atom is replaced by other univalent acid radicals, for example, bromine, iodine and SEt, were prepared. The stability of the derivatives falls rapidly in the order Cl > Br > I > SEt, as would be expected, since this is the order of increasing *trans*-effect of these acid radicals.



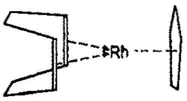
(I) Proposed structure of $(C_8H_{12})_2Rh_2Cl_2$. The dotted lines representing bonds between the olefinic double bonds and the metal are intended to imply a scheme of bonding such as has been suggested in the ion $[C_2H_4PtCl_3]^-$ (see ref. 4)



(II)

A novel derivative $C_8H_{12}RhC_5H_5$ (III), in which he metal atom is co-ordinated by nine carbon atoms, as been prepared by treating (I) with *cyclo*pentaienyl sodium. It is a beautifully crystalline solid, nelting at 108° C. without decomposition, is mononeric, and is readily soluble in organic solvents. It is nteresting because very few types of purely hydroarbon co-ordination compounds are known, and ntil recently those few, for example, $\{(CH_3)_4Pt\}_4$ nd the metal bis*cyclo*pentadienyls, have all contained ydrocarbons as anionic ligands. Very recently, 'ischer[2] has described some purely hydrocarbon comlexes which contain only uncharged hydrocarbon gands, for example, dibenzenechromium, $(C_6H_6)_2Cr$. n the complex (III) we have both uncharged and nionic hydrocarbons as sole ligands in a metallic comlex. The compound is analogous to $(CO)_2CoC_5H_5$ [3], which the cobalt atom has been replaced by hodium and the two carbon monoxide molecules by he di-olefin.

Attempts to prepare cationic and anionic olefin omplexes of rhodium, such as $[C_8H_{12}Rh\,am_2]^+$ and $C_8H_{12}RhCl_2]^-$, indicate their possible existence; ndeed, a pure salt $[C_8H_{12}Rh\{(NHEt)_2C_2H_4\}]\,[BPh_4]$ as been isolated, but all the anionic complexes which e have tried to prepare up to the present have proved nstable.



(III) Proposed structure of $C_8H_{12}RhC_5H_5$. The bond between the rhodium atom and *cyclo*pentadienyl anion will be of the same type as occurs in ferrocene, but its exact nature is still controversial (for example, see Pauson, *Quart. Rev.*, 9, 391 (1955) and references quoted therein)

It is interesting that Rh(I), which is isoelectronic with Pd(II) but not of common occurrence in rhodium compounds, should occur in the olefin complexes. In Rh(I) the rhodium atom is in the highest valency state, where all its *d*-orbitals can be filled and a vacant *p*-orbital remain. The dimagnetism of $(C_8H_{12})_2Rh_2Cl_2$ (I) confirms that electronic arrangement. This suggests that the vacant *p*-orbital is necessary to provide sufficiently strong dative π-bonding (by *dp*-hybridization) to bind the olefin to the metal[4].

Full details of this work and a discussion on the general structure of olefin complexes will appear in due course elsewhere We are greatly indebted to Imperial Chemical Industries, Limited, Billingham Division, for a gift of the *cyclo*-octadiene used in the above investigation.

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Jan. 2.

[1] See Leden and Chatt, *J. Chem. Soc.*, 2936 (1955).

[2] Fischer, E. O., scientific meeting of the Chemical Society, at Burlington House, London, Dec. 15, 1955.

[3] Fischer and Hafner, *Z. Naturforsch.*, **10b**, 140 (1955).

[4] Cf. Chatt and Duncanson, *J. Chem. Soc.*, 2939 (1953).

Boundary Problems in the Sedimentation and Electrophoresis of Complex Systems in Rapid Reversible Equilibrium

Many problems of current interest, for example, the dissociation of nucleoproteins, the reaction of antigens with antibodies, and the combination of proteolytic enzymes with inhibitors, to mention only a few, are at first sight open to attack by the conventional methods of sedimentation and electrophoresis. To a greater or less extent, however, in all these instances, instead of the underlying process of differential transport leading to a simple resolution of the components at the boundaries between solution and solvent, the situation is confused by re-equilibration as the reactants and products tend to be separated from one another. This effect has been much discussed[1–3], but an exact theoretical treatment of the general case seems to be prohibitively difficult if all factors, including the finite rate of approach to equilibrium and the simultaneous spread of the boundaries through diffusion, are taken into account. Even so, Ogston and Field[3] have calculated the form of the sedimentation boundary by numerical methods for the particular case of the dissociation of human hæmoglobin.

In these circumstances, it is a considerable help to have a treatment for an idealized system in which diffusion is ignored, and in which equilibrium is taken as being attained instantaneously. The interpretation of experiments with actual systems can then be carried out by analogy. This approach proved useful recently[4] for interpreting the sedimentation of α-chymotrypsin[5] and mercuripapain[6] under conditions where reversible polymerization occurs, and it is now extended to the more general case of two substances, A and B, reacting reversibly to form a third, C, in accordance with the equation $A+B \rightleftharpoons C$.

Consider a boundary between solution and solvent after transport by electrophoresis or sedimentation has occurred for a time t sec. Assume that the boundary is sharp at $t = 0$; and measure distance, x, from the initial position of the boundary, and in the direction of the solution. Let the respective velocities of A, B and C be v_A, v_B and v_C in the direction of x, and let the molar concentrations of A, B and C be a_0, b_0 and c_0 in the unchanged body of the solution, and a, b and c at x. Equilibrium will be assumed to be governed by the equation $a.b = k.c$, where k is a constant.

The rate of change of concentration with time at any point in the boundary where A, B and C co-exist is the combined result of the migration and the reaction of each of the species. Since mass is conserved, it follows that:

$$\frac{\partial a}{\partial t} + v_A \frac{\partial a}{\partial x} = \frac{\partial b}{\partial t} + v_B \frac{\partial b}{\partial x} = -\frac{\partial c}{\partial t} - v_C \frac{\partial c}{\partial x}$$

It will be shown elsewhere that these partial differential equations can be solved to give

$$a = \frac{k}{\lambda - 1} \cosh^2 \frac{\varphi}{2} \left\{ 1 - \frac{\Phi - \varphi}{\sinh \varphi} \right\}$$

$$b = \frac{k}{\lambda + 1} \sinh^2 \frac{\varphi}{2} \left\{ 1 + \frac{\Phi - \varphi}{\sinh \varphi} \right\}$$

$$c = \frac{ab}{k}$$

where φ is a convenient parameter defined by

$$\cosh \varphi = \frac{2(v_C - v_A)(v_C - v_B)}{(v_A - v_B)(v_C - x/t)} - \lambda$$

$$\text{and } \lambda = \frac{2v_C - (v_A + v_B)}{v_A - v_B}$$

Φ is a constant determined by a_0, b_0 and c_0. The concentration gradients $\partial a/\partial x$, $\partial b/\partial x$ and $\partial c/\partial x$, which determine the schlieren patterns seen during optical analysis of the boundaries, are readily obtained by differentiation of the respective expressions for a, b and c.

The detailed application of these equations cannot be discussed here; but to give an indication of their use, the shape of the sedimentation boundary has been worked out for an example in which, for illustration, a_0, b_0 and c_0 and k have been given the respective values of 2·0, 1·0, 1·0 and 2·0 moles/litre × 10^4; and v_C, v_A and v_B the respective values of 14, 10 and 8 Svedberg units.

The boundary is found to keep its essential shape and merely to stretch out with time. It can therefore be represented by a 'reduced' form in which concentration, or alternatively the derivative of concentration, is plotted as ordinate against sedimentation coefficient as abscissa (see Fig. 1).

Dotted lines show the contribution each constituent would make to the boundary if no re-equilibration occurred. They demonstrate how completely the form of the boundary is changed by re-equilibration. Among the points to notice are: (1) the value of the concentration of B that would be deduced from the slow peak at $S = 8·0$ units is $0·26 \times 10^{-4}$ compared with the true equilibrium value of $1·0$ $10^{-4}\ M$; (2) although two-thirds of A is uncombine there is no peak corresponding to the sedimentatio constant of A at $S = 10$; (3) the broad peak stretch ing from $S = 10·5$ to $S = 12·0$ suggests the presen of two complexes; (4) there is no peak at $S = 1$ in spite of the presence of complex having th sedimentation constant.

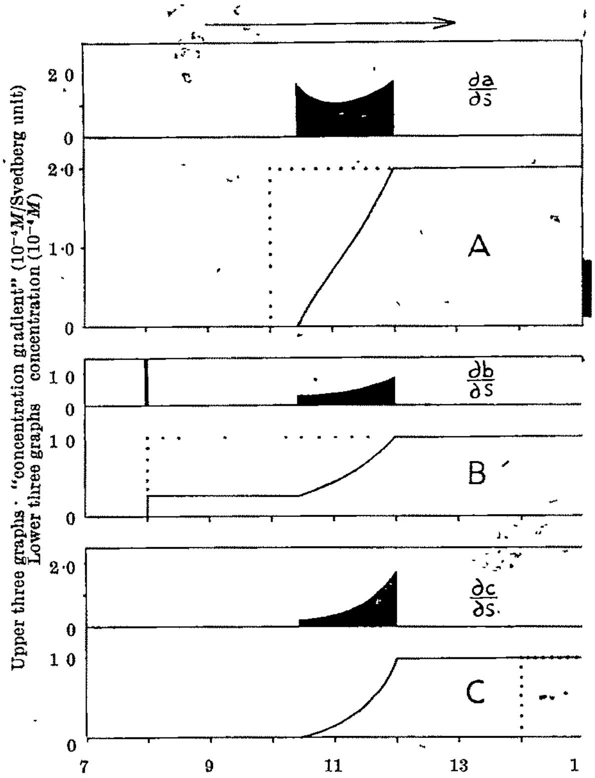

Fig. 1. Sedimentation of a complex molecule C in equilibrium with its components A and B. ———, Calculated concentration assuming re-equilibration without diffusion. Blocked areas represent contributions to the schlieren pattern (refractive index factors not included) . . . . ., calculated concentration assuming no re-equilibration or diffusion

In this example, therefore, an interpretation the sedimentation pattern which neglected the effe of re-equilibrium would lead to a wrong estimate the nature of the complex present and of the co centrations of the uncombined constituents.

We are indebted to Prof. R. E. Peierls for h advice and interest. One of us (R. C. Ll. J acknowledges the award of a maintenance grant fro the Department of Scientific and Industrial Researc

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[1] Tiselius, A., *Nova Acta Soc. Sci. Upsal.*, IV, **7**, No 4, 1 (1930).

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[5] Massey, V., Harrington, W. F., and Hartley, B S, *Disc. Farad Soc*, [**20**, 24 (1955)].

[6] Smith, E. L, Kimmel, J. R., and Brown, D. M, *J. Biol. Chem* **207**, 533 (1954).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, May 7

Royal Society of Medicine, Experimental Medicine and Therapeutics Section (at 1 Wimpole Street, London, W 1), at 2 p.m —Annual General Meeting; followed by a Symposium on "Anti-tumour Agents"

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m —Annual General Meeting, Mr C F. Floyd "An Introduction to Microwaves and Waveguide Transmission".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p m —Prof. T. S. Simey. "Class Conflict and Social Mobility". (First of three Cantor Lecures on "Some Recent Studies of Sociology".)

Society of Chemical Industry, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 15 p m.—Annual General Meeting; Dr. W. P Grove "The Radiochemical Centre at Amersham".

Tuesday, May 8

Wright-Fleming Institute of Microbiology (at St. Mary's Hospital Medical School, London, W 2), at 5 p m —Prof L Pillemer (U.S A) · "The Nature of the Properdin System" (Almroth Wright Lecture).

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C.2), at 5.30 p m.—Mr J. Bell "Ship Stabilization · Automatic Controls, Computed and in Practice".

University College, London (in the Anatomy Theatre, Gower Street, London, W C 1), at 5 30 p m.—Dr. Luther H Evans "Certain International Aspects of Librarianship".*

Tuesday, May 8—Thursday, May 10

Perkin Centenary Celebration (at the Royal Institution, Albemarle Street, London, W.1).

Tuesday, May 8

At 3 p m.—Prof. John Read, F.R.S . "The Life and Work of Perkin".

Wednesday, May 9

At 11 a m —Mr Clifford Paine · "The Development of the Dyestuffs Industry".

At 3 p.m.—Mr. J. G. Evans: "The Tinctorial Arts To-day".

Thursday, May 10

At 11 a.m —Sir Alexander R. Todd, F.R.S "The Development of Organic Chemistry since Perkin's Discovery"

Wednesday, May 9

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a m.—All-Day Section Discussion on "Supersonic Flight".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C 2), at 2 30 p m.—The Right Hon. the Earl of Halsbury. "Automation"

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5 30 p m.—M. P. S. Hirtz (Paris) "Recent Oil Development in France".

Newcomen Society (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 6 p m —Dr. Joseph Needham, F.R.S. "Iron and Steel Production in Ancient and Medieval China". Second Dickinson Biennial Memorial Lecture.)

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 15 p.m —Annual General Meeting 6.45 p.m.—Dr. Norman C. Wright · "National Taste and National Waste"

Thursday, May 10

Royal Aeronautical Society, Graduates' and Students' Section (at 4 Hamilton Place, London, W.1), at 7.30 p m.—Sir Frederick Handley Page "Some Thoughts on Present-Day Aircraft and the Future".

Friday, May 11

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4 30 p m —Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at) p.m —Prof. H S. W. Massey, F.R.S. · "The Exploration of the Upper Atmosphere".

Saturday, May 12

British Psychological Society, Social Psychology Section (at Bedford College, Regent's Park, London, N.W.1), at 2.15 p.m.—Symposium on "Personality and its Social Setting".

British Psychological Society (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C 1), at 2.30 p.m.—Dr J O Wisdom: "Models for the Mind-Body Relationship".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Organic Chemist (with a good honours degree (or equivalent) in chemistry and preferably experience in analytical technique) in the Coal Survey Laboratory in Sheffield, for investigations of the complex character of coals—National Coal Board, Staff Department, Hobart House, Grosvenor Place, London, S W.1, quoting SS/257 (May 11).

Assistant Lecturer (Grade B) in Physics at Brighton Technical College—Director of Education, County Borough of Brighton Education Committee, 54 Old Steine, Brighton 1 (May 12).

Assistant Lecturer (with a university degree or diploma in horticulture, and a sound knowledge of practical horticulture) in Horticulture—Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, near Preston (May 12).

Junior Chemist (with a B.Sc. degree or an A.R.I.C qualification) on the Engineer's Staff, for analytical and experimental work concerned with sewage purification and sludge disposal—Clerk to the Board, Birmingham Tame and Rea District Drainage Board, Clerk's Office, 115–117 Colmore Row, Birmingham 3 (May 12).

Lecturer or Assistant Lecturer in Physiology—The Registrar, The University, Sheffield (May 12)

Lecturer (with at least a good honours degree and capable of teaching to B Sc. (special) or A.R.I.C. standard, and preferably with industrial, teaching and/or research experience) in Physical and/or Inorganic Chemistry—The Principal, Stockport College for Further Education, Wellington Road, South Stockport (May 12).

Principal Lecturer in Applied Chemistry, Senior Lecturer in Radar and Telecommunications or Electronic Instrumentation, Senior Lecturer in Engineering Physics, Senior Lecturer or Lecturer in Mechanical Engineering: Applied Thermodynamics, Senior Lecturers or Lecturers (2 or more) in Electronics, Senior Lecturer or Lecturer in Chemistry, and a Senior Lecturer or Lecturer in Physics; at the Royal Military College of Science, Shrivenham—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting Ref. No. S.4584/56/8 (May 12).

Assistant Lecturer (preferably with special qualifications and experience in poultry husbandry) in Animal Husbandry at the School of Agriculture, Sutton Bonington, near Loughborough—The Registrar, The University, Nottingham (May 19).

Lecturer in Electrical Engineering—The Registrar, The University, Sheffield (May 19).

Lecturer in Mathematics—The Secretary, The University, Aberdeen (May 19).

Lecturer (with a special qualification in applied mathematics, and preferably an interest in fluid dynamics) in Mathematics—The Registrar, The University, Manchester (May 19).

Assistant Lecturer and a Lecturer in the Department of Applied Mathematics—The Registrar, The University, Liverpool (May 23).

Lecturer (with a special qualification in organic chemistry and undertaken independent research in some branch of this subject) in Chemistry—The Registrar, The University, Reading (May 25).

Assistant Lecturer or Lecturer (with special qualifications in stratigraphy and/or palæontology) in Geology—The Registrar, The University, Sheffield (May 26).

Henry Bell Wortley Chair of Metallurgy—The Registrar, The University, Liverpool (May 26).

Senior Lecturer or Lecturer in Biochemistry—The Registrar, The University, Sheffield (May 26).

Assistant Lecturer in Chemistry, and a Research Assistant in the Department of Chemistry—The Registrar, The University, Manchester 13 (May 28).

Assistant Lecturer (preferably with an interest in economic geography) in Geography—The Registrar, University College, Leicester (May 31)

Engineer (with an honours degree or equivalent in physics or electrical engineering, and experience in the design and construction of electronic apparatus) in Charge of Nuclear Equipment—Dr. F. B. Kipping, University Chemical Laboratory, Pembroke Street, Cambridge (May 31)

Lecturer in Experimental Physics of the Solid State, and Research Fellows and Students in Experimental Solid State Physics—Professor of Natural Philosophy, The University, Glasgow, W.2 (May 31).

Assistant Lecturers (2) (honours graduates in chemistry with research experience) in Chemistry—The Registrar, College of Technology, Manchester 1 (June 1).

Lecturer (with an honours degree in physics and postgraduate research experience) in Physics, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 1).

Lecturers (2) in Mechanical or Production Engineering—The Registrar, College of Technology, Manchester 1 (June 1).

Senior Lecturer in General and Social Psychology at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (Australia, June 30).

Abstractor, Scientific Assistant grade (graduate, under 32 years of age, with a good reading knowledge of Russian, also preferably other Slav and unusual languages, and a knowledge of plant biology) —Commonwealth Forestry Bureau, South Parks Road, Oxford.

Assistant Lecturer (Grade B) in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St John Street, London, E.C 1.

Assistant Lecturer (Grade B) in the Department of Electrical Engineering and Physics—Clerk to the Governing Body, Borough Polytechnic, Borough Road, London, S.E.1.

Assistant Lecturer, Grade B (with an honours degree in chemistry, and able to teach one branch of chemistry up to B.Sc special chemistry degree standard) in the School of Chemistry—The

Registrar, College of Technology and Commerce, The Newarke, Leicester.

ASSISTANT PROFESSOR OF BIOCHEMISTRY—The Chairman, Department of Biochemistry, Dalhousie University, Halifax, Nova Scotia, Canada.

ASSOCIATE PROFESSOR, and an ASSISTANT PROFESSOR IN THE DEPARTMENT OF PHYSICS—University of New Brunswick, Fredericton, N B., Canada.

COMPUTER (preferably woman graduate) IN THE MATHEMATICS DEPARTMENT—Assistant Secretary, University College, Gower Street, London, W.C.1.

GEOLOGISTS (preferably single, with an honours degree in geology, although those with lower qualifications may be considered; of high physical standard and a genuine interest in polar research and travel, and a real enthusiasm for hard work under trying conditions) with the Falkland Islands Dependencies Survey, for service in the Antarctic—The Crown Agents, 4 Millbank, London, S.W.1, quoting M3B/43195/TA.

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT—The Principal, Royal Technical College, Salford 5.

LECTURER (with a degree in electrical engineering or equivalent, and experience in radio engineering) at the R.E.M E. Training Centre, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. D.165/7A.

PHYSICIST (preferably with an honours degree in physics, and a good knowledge of and special interest in electronics) to work on problems associated with the maintenance and development of electronics equipment used in the various branches of medical research and investigation—The House Governor, Westminster Hospital, St John's Gardens, London, S.W.1.

SENIOR LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—Northern Polytechnic, Holloway, London, N.7.

SENIOR MATHEMATICAL MASTER—The Headmaster, King's College, Taunton.

SENIOR SCIENTIFIC OFFICERS (honours graduates or equivalent, and preferably with some industrial and technical experience); and SCIENTIFIC OFFICERS (graduates, preferably with an honours degree or equivalent), for work which will include research into problems connected with the coking industry, the preparation of technical reports, and may involve participation in operational research in the provinces from time to time—The Secretary, British Coke Research Association, 74 Grosvenor Street, London, W.1.

SPECIALIST (Plant Pathologist) (with at least a second-class honours degree in botany followed by one year's postgraduate training or approved experience in applied plant pathology or mycology, preferably including the study of virus diseases) IN THE DEPARTMENT OF AGRICULTURE, Gold Coast Local Civil Service, for duties which are concerned with the cultivation of cocoa and include planning and execution of plant pathological investigations, directing and advising phytosanitary measures, and administering staff, equipment and laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD 63/13/09.

STATISTICIAN (with a good honours degree in mathematics or statistics, and preferably an interest in agricultural research)—The Secretary, Grassland Research Institute, Hurley, Maidenhead, Berks.

WARDEN/LECTURER (with a degree or national diploma in agriculture and good practical experience, and preferably experience in teaching) IN CROP HUSBANDRY—The Principal, East Riding Institute of Agriculture, Bishop Burton, Beverley, E. Yorks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Regional Advisory Council for Higher Technological Education. Seventh Annual Report for the twelve months ended 31st August, 1955, submitted to the local education authorities of London and the Home Counties, November, 1955. Pp. 40. (London: Regional Advisory Council for Higher Technological Education, 1956.) [202

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1 (No. 2): The Moinian and Dalradian Rocks between Glen Roy and the Monadhliath Mountains, Inverness-shire. By Dr. J. G. C. Anderson. Pp. 15–36+plate 4 (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 7*s*. [202

Statement on Defence. (Cmd. 9691.) Pp. 32. (London: H.M. Stationery Office, 1956.) 1*s*. 3*d*. net. [212

Air Ministry. Meteorological Office. Professional Note No. 117: Barometric Changes and the Efflux of Gas in Mines. By C. S. Durst. Pp. 15. (M.O. 524q.) (London: H M Stationery Office, 1956.) 9*d*. net. [212

National Institute of Industrial Psychology. Report 11: Speed and Precision in Manual Skill. By D. F. Vincent. Pp iii+19. (London. National Institute of Industrial Psychology, 1955.) [212

London School of Hygiene and Tropical Medicine. Report on the work of the School for the year 1954–1955. Pp. 128. (London London School of Hygiene and Tropical Medicine, 1956.) [222

Society for General Microbiology. Special Report. Constituents of Bacteriological Culture Media a Review of Information available on Methods of Manufacture. Prepared by the Standardization Sub-committee of the Society for General Microbiology. Edited by G. Sykes. Pp. iv+33. (Cambridge. At the University Press, 1956.) 4*s*. net. [222

Bulletin of the British Museum (Natural History). Zoology. Vol 3, No. 6: The Cephalopoda of Madeira—Records and Distribution. By W. J. Rees and G. E. Maul. Notes on the European Species of *Eledone*. By W. J. Rees. Pp. 257–293+plates 9 and 10. (London: British Museum (Natural History), 1956.) 16*s*. [222

Other Countries

United States Department of the Interior. Geological Survey. Bulletin 1015–A: Fluorspar Deposits near Meyers Cove, Lemhi County, Idaho By D. G. Cox. Pp. ii+19+5 plates. 1.25 dollars. Bulletin 1015-D: Chromite Deposits in the Central Part of the Stillwater Complex, Montana. By A. L. Howland. Pp. iv + 99–121 + plates 8–11. 1 50 dollars. Bulletin 1015–I: Geology of the Dry Valley Quadrangle, Idaho. By Earle R. Cressman and Robert A. Gulbrandsen. Pp. 257–270+plate 27. 1 dollar. Bulletin 1017: Lead-Zinc Deposits of Cordillera Blanca and Northern Cordillera Huayhuash, Peru. By Alfred J. Bodenlos and George E. Ericksen. Pp. vii+166+12 plates. 2.75 dollars. Bulletin 1021–B: Hawaiian Volcanoes During 1952. By Gordon A. Macdonald. Pp. v+15–108+14 plates. 55 cents. Bulletin 1024–B: Investigations for Radioactive Deposits in Southeastern Alaska. By Walter S. West and Paul D Benson. Pp. iv+25–57+plates 7–9. 55 cents. Bulletin 1025: Bibliography of North American Geology, 1951. By Ruth Reece King, Virginia M. Jussen, John S. Pomeroy and Vsevolod L. Skitsky. Pp. iii+378. 1.25 dollars. Bulletin 1033–B: Geophysical Abstracts 161, April–June 1955. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky and Others. Pp. iii+75–137. 25 cents. (Washington, D.C.: Government Printing Office, 1955.) [222

United States Department of the Interior. Geological Survey. Water Supply Paper 1199: Quality of Surface Waters of the United States, 1951. Parts 7–8: Lower Mississippi River Basin and Western Gulf of Mexico Basins. Prepared under the direction of S. K. Love. Pp. ix+490. 1.75 dollars. Water Supply Paper 1200: Quality of Surface Waters of the United States, 1951. Parts 9–14: Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin. Prepared under the direction of S. K. Love. Pp. x+285. 2 dollars. Water Supply Paper 1276: Surface Water Supply of the United States, 1953. Part 3-B: Cumberland and Tennessee River Basins. Prepared under the direction of J. V. B. Wells. Pp. vii+278. 1 dollar. Water Supply Paper 1357: Computations of Total Sediment Discharge, Niobrara River, near Cody, Nebraska. By B. R. Colby and C. H. Hembree. Pp. vii+187+7 plates 70 cents. Water Supply Paper 1362: Quality of Surface Waters for Irrigation, Western United States, 1952. Prepared under the direction of S. K. Love. Pp viii+179. 75 cents. Water Supply Paper 1267: Water Levels and Artesian Pressures on Observation Wells in the United States, 1953. Part 3: North-Central States. Prepared under the direction of A. N. Sayre. Pp. vi+254. 1 dollar. Water Supply Paper 1330–A: Water Requirements of the Pulp and Paper Industry. By Orville D. Mussey. Pp. viii+71+1 plate. 60 cents. Professional Paper 245: Geology and Ore Deposits of the Boulder County Tungsten District, Colorado. By. T. S. Lovering and Ogden Tweto. Pp. viii+199+27 plates. n.p. Professional Paper 262: Pleistocene Geology of Eastern South Dakota. By Richard Foster Flint. Pp. vi+173+7 plates. 3 dollars. Professional Paper 268: The Central Kuskokwim Region, Alaska. By W. M. Cady and R. E. Wallace, J. M. Hoare and E. J. Webber. Pp. vi+132+9 plates. 3 75 dollars. Professional Paper 274–B: Dakota Group on Northern Front Range Foothills, Colorado. By Karl M. Waagé. Pp. iii+15–51. 45 cents. (Washington, D.C. Government Printing Office, 1955.) [222

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures, and Condition of the Institution for the year ended June 30, 1954. Pp ix+455+77 plates. (Publication 4190.) (Washington, D.C.: Government Printing Office, 1955.) [222

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The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

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Applications (eight copies), should be sent to the Registrar, from whom further particulars may be obtained, by May 26, 1956.

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(f) One Senior Lecturer or Lecturer—Chemistry.

(g) One Senior Lecturer or Lecturer—Physics.

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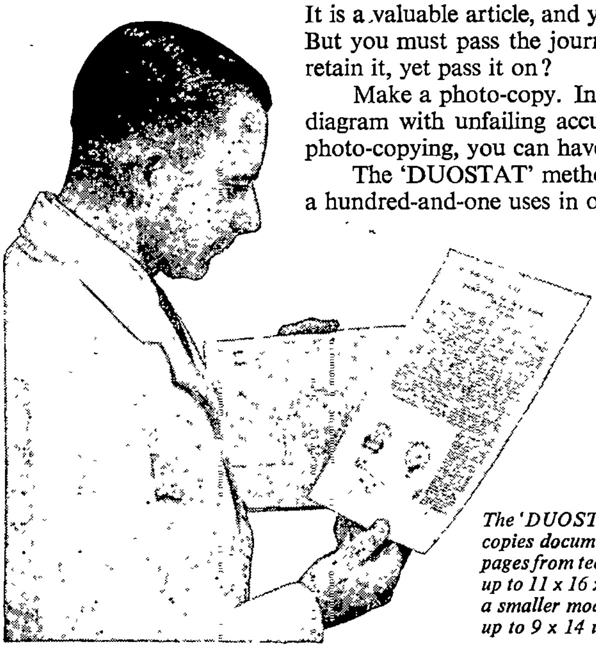

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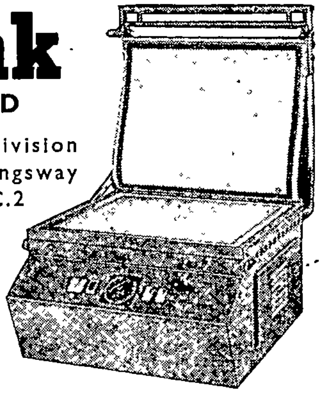

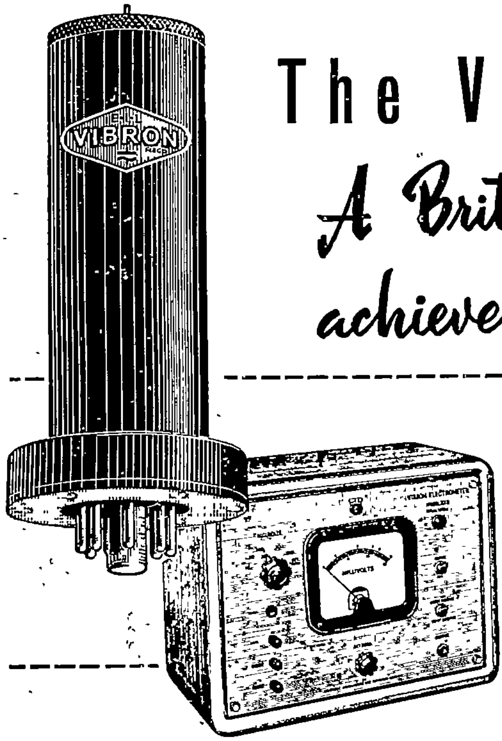

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NUCLEAR POWER AND ITS DEVELOPMENT IN BRITAIN

THE reference in the recently issued annual report of the Department of Scientific and Industrial Research to the European Organization for Nuclear Research is comparatively brief; but it is clear that the scale of the British contribution in this field is growing. The Advisory Council notes in this report that impressive progress has been made since the inter-government convention came into force in October 1954, that the staff of the Organization is now between two and three hundred and that some research is already in progress. In the year covered by this report, Great Britain's contribution was almost £360,000; £520,000 was provided in the Estimates for 1955–56; while those for 1956–57 provide £930,000, or more than 10 per cent of the Department's gross budget of nearly eight and a half million pounds. Besides this, there are the Department's grants to universities for nuclear physics research, which are running at the rate of a quarter of a million a year, and there is the proportion of the vote for atomic energy which is spent on research and development. For 1955–56 and 1956–57 the vote itself is a little more than £54 million and £68 million, respectively; but the Civil Estimates give no information as to expenditure on research and development. It can only be assumed that approximately £2 million in 1955–56 and £2·5 million in 1956–57 which is being expended on work by industry and at universities is for such purposes.

It is clear, therefore, that neither the annual report of the Department of Scientific and Industrial Research nor the Civil Estimates gives the scientific and technical world sufficient information for a sound judgment as to whether or not the scientific and technical effort in Britain in the nuclear energy field, either in research or in development, is in balance with other activities and resources of the country. When all allowance is made for the extent to which security considerations make it imprudent to disclose the nature and magnitude of that effort where it relates to defence, maintenance of secrecy is detrimental to the efficient use of resources in the development of nuclear energy for peaceful purposes and to effective co-operation with industry. Nor is it reasonable to withhold information which would enable better judgment to be formed as to the scale of the British contribution to European co-operation in that field, when that contribution exceeds 10 per cent of the total budget of the main institution in Britain for the administration of Government support for research.

Concern in this respect might be less were it apparent that the Office of the Lord President of the Council was being appropriately strengthened to discharge its growing responsibilities for the general supervision of the nation's scientific effort. The Civil Estimates for 1956–57 disclose no such signs. The staff of nine remains unchanged, and the estimate of £14,345 compares with £13,370 in 1955–56 and with a staff of eighteen and vote of £19,400 for the presumably subordinate Atomic Energy Office, and a staff of twenty-three and vote of £28,620 for the University Grants Committee. The unsatisfactory situation which leaves the House of Commons with no minister or parliamentary under-secretary directly responsible for the nation's vast interests in science and technology persists, and the Bill to change the administration of the Department of Scientific and Industrial Research does not touch this formidable problem, which has recently been the subject of 'questions' in the House.

Quite apart from this question of the balance and effective co-ordination of the research effort of Britain, it is not surprising, therefore, that the Government should have been pressed for more information as to its attitude to European co-operation in the development of nuclear energy for peaceful purposes and to the industrial development of nuclear energy in Britain itself. On the first point, the Lord Privy Seal, Mr. R. A. Butler, on February 29, declined to say anything about the discussions then proceeding at the ministerial meeting of the Council of the Organization for European Economic Co-operation in Paris, nor did a bulletin issued that week by the Information Division of the Treasury add to Mr. Selwyn Lloyd's statement of February 15. Although no ministerial pronouncement has yet been made, it would seem that at that meeting the Foreign Ministers of the six countries constituting Euratom avoided discussions in February. The Organization for European Economic Co-operation, however, comprises eleven countries, including Britain as well as these six, and there appears to be no reason why it should wait on the six before determining its part in the development of nuclear energy.

The meeting of Ministers in Paris in the first week in March appointed a special committee which is to formulate detailed proposals during the next three months on five specific questions. Two of these relate to procedure. The committee is to make recommendations on the functions of a steering committee for nuclear energy which is envisaged as the permanent organ of the Organization for European Economic Co-operation for co-ordinating and directing European co-operation in this field, and also on the means of co-ordinating the action of existing organizations, such as Euratom. This committee is also to report on the nature of security controls required to prevent the diversion of fissile material, on the joint undertakings to be sponsored by the Organization for European Economic Co-operation, and on the steps to be taken to keep intra-European trade in nuclear equipment and materials as free from restrictions as possible. The committee was specifically authorized to consult the United States Government about the implications of the American offer to sell or lease 20,000 kgm. of uranium-235 for use in research and power reactors in countries outside the United States not at present producing it themselves.

These are sensible decisions; but what needs to be emphasized is that bold decisions are required and that they cannot be postponed if Western Europe is to reap the advantages which nuclear energy can offer. Such questions as whether nuclear energy is to be developed for peaceful purposes only, whether the proposed Commission shall have supranational powers or not, and whether it shall be the sole owner of fissile material cannot be evaded indefinitely. The answers to be given determine alike the form of the organization itself and the extent of the support which it receives from different countries. Moreover, they may react on the form which developments take in particular countries, and for that reason alone the growth of Euratom may prove to be closely related to the way in which the development of nuclear energy proceeds in Britain. One such point is in regard to the control of private industrial development, on which Mr. Butler was also questioned on February 29. Mr. Butler replied that since at present the essential nuclear fuel can be obtained only from the Atomic Energy Authority, the administrative control through the Authority is adequate for the Lord President of the Council to carry out his duties under the Atomic Energy Act; however, the Lord President is considering to what extent the growing interest of private industry in this field would call for the exercise of powers available under the Atomic Energy and Radioactive Substances Acts, 1946–54, to supplement or replace existing arrangements. Pressed further, Mr. Butler said that he is satisfied that the powers under these Acts are adequate.

A further statement on the relation between the State and private industry in the development of nuclear energy was made by Mr. Butler on March 14. In reply to specific questions from Mr. W. N. Warbey, he said that the current civil allocation of plutonium and uranium-235 is sufficient for the present programme of more advanced types of civil power and research reactors, and that in spite of the main limiting factor of the shortage of suitably qualified scientists and engineers both in the Atomic Energy Authority and in industry, no radical departure from the nuclear power programme outlined in the White Paper of February 1955 is contemplated. Mr. Butler said that the Government considers that the relation between the State and industry in this field should be one of close partnership subject to the maintenance of a proper degree of control by the Government; much of the necessary research, development and production will have to be carried on by the Atomic Energy Authority, if only because of the high cost of the capital facilities required. Some activities, such as the import and processing of uranium and the separation of uranium-235 in the diffusion plant, must remain responsibilities of the Authority alone, because they concern defence as well as civil requirements, and the nuclear fuel required by industry would be provided on loan. On the staff question, he said afterwards that 3,465 out of 4,202 established non-industrial Civil servants have accepted offers of employment and signed contracts with the Authority, and that the Authority's total staff is at present about 22,000.

For the rest, the Government hopes that both private and nationalized industry will enter as rapidly and extensively as possible on the commercial application of nuclear energy. The nuclear power stations to be built in Britain for the production of electricity will be designed and constructed by private industry —and private industry, not the Authority, will fulfil export orders. The Authority will give industry the maximum of help which its technical resources permit, subject to safeguarding two points: first, the Authority should, where appropriate, be paid for commercially valuable information (including the use of patents owned by the Authority) which has been acquired at considerable expense; and, second, that firms are not enabled to use the assistance afforded by the Authority to build up exclusive rights for themselves.

The access agreements made by the Authority with private firms contain provisions to cover these points. Such agreements naturally vary according to the nature of the transaction, and Mr. Butler pointed out that it would not be consonant either with sound commercial practice or with the Authority's freedom to manage its day-to-day business on commercial lines that it should be required to publish such details, or that the Lord President should be answerable for them. In an earlier answer on February 22, Mr. Butler had indicated that the terms for the loan of nuclear fuel will cover the cost of fabricating the fuel elements, a percentage of the total cost of the fuel, including a part for research and development, the cost of fuels spent in running the reactor, and the cost of re-processing spent fuel elements. On March 21, Mr. Butler declined to give further details about particular agreements, but said that payment for the use of patented inventions would depend on the extent to which patents owned by the Authority were in fact used, and that the Lord President does not at present intend to make an order providing that the acquisition, production or use by private industry of nuclear fuels or plant for the production or use of nuclear energy will be permitted only under official licence. It may, however, be necessary later to re-examine the extent to which the Government should use the powers available in regard to safe construction and operation under the 1948 Act.

Mr. Butler also answered a number of questions regarding the export of nuclear energy plant and equipment. Discussions proceeding for some time between the Atomic Energy Authority and representatives of the heavy electrical plant manufacturer on the possibilities of export trade in nuclea power reactors are being widened, and considerable publicity is being given to the United Kingdom's achievements and potentialities. The United Kingdom has already established a substantial export trade in isotopes and new types of instruments for use in industry and research; but the commercial development of nuclear power is still in its infancy, and a substantial demand for, or expor of, power reactors is unlikely for some years. Long-term plans in this field are already being considered by the Lord President and the Atomic Energy Authority with the President of the Board of Trade. Mr. Butler agreed that the proposals made by the working party of the Organization for European Economic Co-operation for the nuclear energy industry would offer an admirable outlet for the industry of Britain but declined to enlarge on the subject.

It may be recalled that on February 28, in welcoming President Eisenhower's imaginative offer to supply uranium for the development of the peaceful uses of nuclear energy, the Prime Minister referred to developments under the Colombo Plan and Bagdad Pact, as well as in bilateral arrangements between the United States and Great Britain and certain countries in Africa and Asia to help them in training in the peaceful uses of nuclear energy. On March 21, Mr. Butler again emphasized the disability of Britain, compared with the United States, in regard to supplies of enriched uranium; but he undertook to consider further the allocation of such supplies between defence and civil needs and the possibility of obtaining supplies from the United States. Again, in the debate on the international situation in the House of Lords on March 27, Lord Layton pleaded for strong support by Great Britain of the proposals made by the Organization for European Economic Co-operation for the co-operative control of the development of nuclear energy, urging that it is all-important that we should be associated at the start with the development for peaceful purposes of nuclear energy.

Lord Reading, in replying for the Government, claimed that the Government is at present considering how far the Euratom proposals and those of the Organization for European Economic Co-operation can usefully be dovetailed one into the other, and that it is not at all indifferent towards the idea of assisting the various European organizations which exist. Nevertheless, it may be doubted whether, even from the point of view of Britain's own interests, the Government has been sufficiently imaginative as regards the proposals for European co-operation in this field. A central organization strong enough to control the uses of nuclear fuel, to promote the joint construction of nuclear power plants and to negotiate with the United States on the offer of uranium would have advantages also in the administration of technical aid from Europe to the undeveloped countries of Asia and Africa. Particularly in the Middle East, it might offer some prospect of abating the political tension which too often has attended the giving, or even the offer, of assistance by individual countries.

But the questions and statements in Parliament regarding the development of nuclear energy for industrial purposes have scarcely so far touched on the vital issues. The important question, now that a beginning has been made with such applications in industry, is not so much whether the conditions of co-operation between the Atomic Energy Authority and private industry ensure the Government the necessary control, or even that industry pays a reasonable price for the information and technique placed at its disposal. There is little reason to fear that the national interest will suffer in either of those respects. What is much less certain is that the conditions of co-operation are such as to encourage the initiative and enterprise and the taking of risks that are inseparable from new ventures.

While British firms are at last being allowed to participate in the design of nuclear power stations, in research into nuclear power plants for aircraft engines, in the development of an atomic submarine for the Royal Navy, and in the development of nuclear power for shipping, and one is being supplied with fuel for the research reactor which it is to build for itself, it must be remembered that there are only a few enterprises in Britain that have the technical and financial resources to take up nuclear engineering. There has indeed been a further relaxation of the old secrecy about the technical processes in Britain's nuclear factories, and the British Government is prepared to supply natural uranium for any power station which a British firm may sell abroad.

None the less, it will take all the technical skill and enterprise which Britain's scientists and engineers can produce to offset the advantage which the United States possesses in being able to offer much more abundant supplies of the enriched uranium for the same purpose; so long as restrictions inevitably imposed by bilateral agreements between users of uranium and the British or American Governments remain, the nuclear energy authorities will be the final arbiters of the speed of progress, and doubts will persist as to whether the possibilities are being explored with all the imagination and enterprise that are available. One advantage of associating private industry with a public authority is that the former can take risks that no public body can afford to do with public money.

But industry cannot be kept indefinitely in leading strings and subject to monopoly rights over the whole field of nuclear energy which the Atomic Energy Authority has hitherto possessed. Even now it is doubtful whether the nuclear physicists and engineers in Britain as a whole possess the experience to judge whether the programme set forth a year ago in the White Paper is still sound, or whether a further experimental programme even on the design of nuclear power plant is desirable. Until, however, such questions can be discussed realistically and responsibly in the scientific and technical Press, it is impossible to judge whether the efforts of the thousand scientists and technologists which Sir John Cockcroft estimates are working on nuclear power development in Britain are wisely directed, and how sound in relation to available resources is the annual expenditure of £200 million on nuclear power stations contemplated from 1965 onwards.

It would not be reasonable to suggest that the Atomic Energy Authority is averse to experiment outside its own establishments; but it is understandable that it may be somewhat prejudiced in its judgment. Nor, even with the strongest motives for encouraging development in industry, rather than in its own establishments, can it be assumed that the Authority is necessarily the best judge of the worth of an experiment. It is altogether in the nation's interest that industry should be encouraged to engage in longer-range experiments, while the Authority is preoccupied with the immediate development of nuclear power stations; and if some relaxation of the Authority's right to acquire the patent of any invention which it judged relevant to the development of nuclear energy would stimulate such enterprise, the relaxation would be well worth while. What matters above all in such a field is imagination and enterprise, and methods of control or forms of organization which repress initiative and discourage experiment and the taking of risks, either by the industrial firms or at the international level, so far from ensuring security endanger the whole economic future of Britain.

It should not, therefore, be taken for granted that the Authority's present ideas of its partnership with industry should govern that partnership indefinitely. Industry may be content to rent fuel from the Authority in the first instance; but if industry's first designs work, it may reasonably expect permission to fabricate the actual elements itself from billets of uranium supplied on a rental basis. Nor would it be unreasonable for industry to hope in due course to take a larger part in applied nuclear research, and to be admitted to real partnership with the Authority on common research projects. Such developments could not fail to be in the national interest; and although they are not immediate issues, it is not too early to be giving thought to such differences of interpretation of the "close partnership" and their reconciliation, as well as to the relative scale of the total effort which Britain can afford to make in the development of nuclear energy. The secrecy problems now arising in development work out of the association of the Authority with different industrial interests should be handled from the start with sufficient forethought to avoid prejudicing future relations of the Authority with industry in general. The draft statute for an international atomic agency, approved in April in Washington by a group of nations, should stir the British Government and the Atomic Energy Authority to think ahead and approach problems of secrecy, security control and industrial partnership with vision and energy.

BIOLOGY OF PUBERTY

Growth at Adolescence

By Dr. J. M. Tanner. Pp. xii+212. (Oxford: Blackwell Scientific Publications, 1955.)] 32*s.* 6*d.*

HUMAN growth and maturation have been explored during recent years with immense enthusiasm, particularly in the United States. On the descriptive plane much information has been accumulated from anthropometric, photographic and radiological observation. Some physiological and endocrinological facts have also been gleaned, and much has been written on the psychology of adolescence. What biological insight has been obtained into the processes which overtake the human body at puberty? In this succinct monograph Dr. J. M. Tanner provides an appraisal which displays the real achievements as well as the considerable deficiencies in our present knowledge. The achievements rest mainly on the more exact description of the 'external' events of pubescence, the changes in dimensions of the body and its segments, the relative growth of different tissues, the individual variability of response and the developmental contrast of male and female. The deficiencies affect particularly our understanding of how the sequence, synchrony and changing tempo of events are regulated, and what is happening to the brain and endocrine system.

The merit of Dr. Tanner's presentation is that he conducts the reader with directness to the essentials. At the outset he insists on the use of 'velocity' rather than the usual 'distance' curves of growth to display the sharpness and timing of the adolescent 'spurt'; and he explains also that many of the shortcomings of the data arise from failure to follow the same children consecutively. The adolescent spurt is shown to be a general event affecting the facial, cranial and body skeleton, in a particular sequence, as well as viscera, musculature and other tissues. Coupling these morphological changes with events in the reproductive system leads him to a consideration of the concept of bodily maturity and of its assessment. The main conclusions here are the existence of a "tendency for a child to be advanced or retarded as a whole; in the percentage attained of his eventual size, in his skeletal ossification, in his permanent dentition, doubtless in his physiological reactions, and also in his intelligence test score" (p. 62), and the inadequacy of chronological age to reflect the physiological status of the individual.

Of the factors determining or modifying growth at adolescence, very little can at present be said of the genetic basis or of the influence of race or climate; rather more is known of nutritional effects, where it seems likely that "the time of occurrence of the adolescent spurt is a more sensitive indicator o nutritional deficiency than is the growth rate at earlier periods" (p. 85); there are definite socio-economic differences in growth for which various explanations are considered (though the significance of differential fertility is not); information on the effect of illness appears to be very limited (but Harris's bone lines are not mentioned). Substantia evidence is adduced for the belief that the onset o adolescence has been speeding up in many countries during the past fifty years or more. Whether the adult body size has also increased with this accelerated maturity is said to be a matter of dispute (p. 86) although no data are given opposing the affirmation (p. 92) that the "ultimately reached adult size is greater".

The possibilities of predicting size and physique o attainment of maturity from chronological or developmental age have naturally engaged much attention Such predictions are complicated by the influence which the time of onset of the adolescent spurt exerts on the developing physique. Nevertheless, the extent to which the pre-adolescent physique can be remoulded by this factor is stated to be relatively small, and no 'radical' change in body build ensues. This conclusion is important enough to deserve a more detailed demonstration, as is the claim "that there is little doubt that someone used to looking at children's photographs could predict with accuracy the adult somatotype from a picture taken at age 5 or even earlier" (p. 78).

Of the complex and interrelated endocrinological happenings at adolescence Dr. Tanner shows how limited and careful interpretation must remain at present. When it comes to tracing the changes in mental ability at puberty and their relation to neural events, the information peters out.

This book will certainly be of service to a wide circle of students of human biology and medicine. It provides also the basis for an attractive and highly instructive pre-clinical course for medical students.

J. S. Weiner

CHEMICAL TECHNOLOGY

Encyclopedia of Chemical Technology

Edited by Raymond E. Kirk and Donald F. Othmer. Vol. 11: Polyols to Rutin; pp. xvi+950. Vol. 12: Sabadine to Stilbestrol; pp. xvi+955. Vol. 13: Stilbite to Thermochemistry; pp. xvi+952. Vol. 14: Thermodynamics to Waterproofing; pp. xvi+980. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953–55.) 30 dollars each volume.

THESE further four volumes of Kirk and Othmer's "Encyclopedia of Chemical Technology" deal with subjects from polypropylene to water. Vols. 1–10 have already been reviewed in these columns (*Nature*, 164, 935 (1949), and 173, 228 (1954)). The "Encyclopedia" is designed to provide, from an industrial point of view, a summary of knowledge of materials, methods, processes and equipment for the chemist and the chemical engineer. It contains authoritative articles, arranged alphabetically, by experts from the chemical industry and research institutions in the United States. Thus it is an American production. It provides a vigorous, clear, informative and up-to-date picture of chemical technology as practised in the United States. It will be valuable, and even indispensable, in chemical laboratories and industrial libraries; it would indeed be useful to individual men of affairs to provide them with information about other subjects not immediately in their purview. It is useful also to the teacher of chemistry and chemical engineering and to the student, for the articles relating to the scientific basis of technology seem to be presented in a way which includes the essentials without overloading them with unnecessary details. Furthermore, the lay-out of the articles, the arrangement and the printing are very satisfactory and the diagrams are well chosen and highly informative.

The subjects dealt with in these four volumes include articles on the main branches of chemical industry, among which may be cited, for example, printing, pulp, pyrotechnics, rayon, refrigeration, rubber, salt, silicones, soap, solvents, steel, sugar, sulphuric acid, tanning, tea, textile technology, tobacco, varnishes, industrial wastes and water. There are also valuable articles on techniques: for example, powder metallurgy, pressure measurement, technique for high pressures, radiography, sampling, size measurements of particles, staining, temperature measurement, ultrasonics, vacuum technique, and viscometry (volume measurement is cross-referenced to fluid mechanics in an earlier volume). Another class of article is that relating to particular processes, such as power generation, quality control, safety precautions, sedimentation, silvering, size separation, spraying, etc.

Then there are articles dealing with the properties, production, and use of individual chemical substances or classes of substances. Many of these articles, like those relating to silica and inorganic silicates, are highly informative. It is useful to have recent information such as is provided by the articles on titanium, tantalum, the terpenes, the vat dyes, etc. There are a number of articles relating to pharmaceutical products, and substances of therapeutic value such as streptomyces antibiotics, stimulants and depressants, sulphur drugs, thyroids and antithyroid preparations, vaccines, vitamins, etc.

Besides all this, there are a number of satisfactory articles on the physical-chemical basis of chemical technology: radicals, radiochemistry, Raman effect, reaction kinetics, stereochemistry (organic and inorganic), thermochemistry, thermodynamics, valence, vapour-liquid equilibria, etc.

Separated in this way, some indication is given of the contents of these present volumes under review. There are other articles which lie outside such a classification: for example, those on trade marks and smokes and fumes. The latter article includes a table of the threshold or maximum concentrations, for continuous eight-hour exposure with no impairment of health, of various gases and vapours present in industrial atmospheres, together with the dangerous and fatal concentrations. It also provides tables of collector equipment for solid and liquid aerosols, their efficiency and the estimate of costs. Much attention has been paid to atmospheric pollution by industry in the United States during recent years, and such an article summarizing some of the results of inquiry is particularly useful.

There are other articles which also lie rather outside the strictly scientific field; those, for example, on materials such as salad dressings, shampoos, tints, hair dyes and bleaches. These take up about fifty pages of these four volumes of 950 pages each; whether that is in proportion to the magnitude of these frills of civilization to that of the total chemical industrial trade of the United States has not been ascertained.

One can open the books at random and almost at any place find points of interest—a very good test of such books. For example, opening at p. 929 of Vol. 13, the reader finds a note on thallium oxide: "which begins to sublime at 300° C. in high vacuum although its boiling point is at least 1,080° C. . . . at higher temperatures some peroxide is formed". These are interesting facts, which accord with the reviewer's experience. Higher up the page, "the addition of 0·5 to 5 per cent Thallium to gold or silver for electrical contacts is claimed to reduce the tendency of these to stick"; that might be a useful tip.

The thirty-four page article on thermodynamics is particularly clear. It uses the nomenclature recommended by the American Institute of Chemical Engineers, which differs from the international one only in that A is used instead of F for the total work function.

Most of the articles are informative and satisfying: the expert in any particular field or the person who needs to follow up a subject could no doubt pick some holes, or be disappointed that there is not more detail. The merit of an encyclopædia, however, depends very much on striking the right balance between scrappiness and prolixity, and these volumes seem generally to contain well-balanced articles.

The survey article on the sugars perhaps omits too much, and that on the proteins seems to include very little of the results of interesting recent attacks on their structure by X-ray methods.

Some articles in some of their aspects and in relation to the quotation of bibliographical references are apt perhaps rather to overstress recent work in the United States and to understate the scientific development of the subjects as resulting from a world-wide effort. This is a tendency in every country, particularly in regard to technological subjects rather than to fundamental scientific subjects, and it should be avoided so far as possible.

This fifteen-volume work as a whole (there is one volume yet to come) is beautifully produced. Although it is costly, it is a worthy publication of a great industrial nation, and most technical libraries will need to keep it readily available.

A. C. Egerton

SKYHOOKS AND SATELLITES

200 Miles Up

The Conquest of the Upper Air. By J. Gordon Vaeth. Second edition. Pp. xiii+261. (New York: The Ronald Press Company, 1955.) 5 dollars.

The approaching International Geophysical Year of 1957–58, with the incidental project of an artificial satellite, has stimulated the second edition of this book, which first appeared in 1951. As head of the New Weapons and Systems Division in the United States Office of Naval Research, Mr. Vaeth speaks authoritatively, and it is good to read an account of upper-air research which, intended primarily for the general reader, is so completely scientific in its outlook. People naturally want to know also how far at the present time the fantastically improbable has developed towards the fantastically possible, and there is a little speculative spacemanship at the end. But this is not confused with actual achievements or projects seriously in hand, and the great value of the book is in its emphasis on the real objects of high-altitude exploration.

The reader will probably turn first to Chapter 12, which outlines the possible construction, and the problems of launching, instrumenting, and tracking the Minimum Orbital Unmanned Satellite of the Earth (entitled MOUSE) suggested by Dr. S. F. Singer. Circulating at a height of about two hundred miles, in a track passing over two stations near the poles, this would release stored information to the stations every half-revolution. (One can forecast that the whimsical trend of scientific jargon will find an appropriate name for the reception of these observations, such as 'taking the Mickey'.) Trial runs may first be made with uninstrumented projectiles. Launching will most likely be from ships at sea—not, as in the almost prophetic diagram in the "Principia", from a mountain-top. The life of such a satellite is expected to be a day or two.

The earlier chapters give an excellent account of the physics of the atmosphere, the information sought, the various instruments used, and the telemetering equipment for transmitting results from rockets and balloons. Pictures of the complete laboratories and radio stations fitted in modern rockets give a good idea of the complicated tasks each fulfils in its short mission. The activities at the White Sands Proving Ground are described at first hand, and the development from the early captured *V*2 to the W.A.C. Corporal is explained with a good deal of technical detail. The progress of the modern balloon, culminating in the gigantic Skyhook cells, which may be as large as three million cubic feet, is fully dealt with. To the rocket-minded, this revival of interest in large balloons may seem like an echo of the 1930 period. But the firing of a rocket is an event, and the recovery of the remains an enterprise, while unmanned balloons carry the routine traffic of the upper air, and are very much less costly. Indeed, Mr. Vaeth says that it is probable that the first steps towards a closer acquaintance with Mars will be made in the summer of 1956 from a manned balloon observatory, carrying a 6-in. telescope and spectrographic equipment above the disturbances of the earth's atmosphere. Little information is available about this, except that the craft will be called Explorer III, as a successor to the balloons manned under the late A. W. Stevens. Incidentally, Skyhook balloons, travelling rapidly in high-altitude winds, have been shown to account for many 'flying saucer' observations; indeed, as the photographs of them show, they look like nothing else. But the author records one unidentifiable object that was definitely not a balloon, and refuses to be drawn into controversy.

Admirable photographs, a readable style, and an objective approach make this a book which will be received both with enjoyment and with confidence.

G. R. Noakes

DIELECTRIC CONSTANT AND LOSS

Dielectric Behaviour and Structure

Dielectric Constant and Loss, Dipole Moment and Molecular Structure. By Prof. Charles Phelps Smyth. (International Chemical Series.) Pp. x+441. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64*s*. 6*d*.

During the past ten or fifteen years, measurements of the dispersion of dielectric constant have been characterized by a new and altogether higher level of precision. This has been achieved partly by the development of microwave methods and partly by experimentation at low temperature when the dispersion is shifted into the radio- and audio-frequency region. The use of microwaves has the unique advantage that the investigation of electrolyte solutions has become practicable. Prof. C. P. Smyth's book is a timely summary of the knowledge and attitudes that are the result of these advances. The subject is treated in two parts. The first, a discussion of the dielectrical properties of matter, occupies rather more than half the book; the second part is devoted to a survey of dipole moments as a tool in the study of molecular structure. Comparison with the author's previous book published twenty-five years ago shows how great has been the expansion of the subject in the intervening time.

In fundamental theory the developments represent a consolidation rather than an advance to new positions, and it is perhaps of interest to glance at the current picture of the mechanism of dipole reorientation. Hindered rotation, introduced as a macroscopic concept twenty years ago by Debye and Fowler, emerges with a new look. The Lorentz field employed by Debye has tacitly been dropped in favour of the Onsager field, and the Onsager equation is accepted as a reasonable approximation for non-associated polar liquids. Analysis of dipole reorientation as a kinetic process has led to the evaluation of thermodynamic parameters which have illuminated the molecular interpretation of dielectric relaxation. It is agreed that a molecule usually rotates as a unit, the rotation of a prolate molecule about its long axis being demonstrably the easiest, although there are isolated examples of very large molecules wherein reorientation occurs by intramolecular torsion. The hindering effect of adjacent dipoles is emphasized by the observation that the energy barrier opposing reorientation is greater for a pure polar liquid than for a solution in a non-polar medium of the same viscosity. Associated liquids remain a difficult problem in spite of the early success of the Kirkwood equation relating the dielectric constant of water to its dipole moment. In this treatment the reorienting unit is a single molecule, an assumption powerfully supported by the fact that the dielectric loss in the principal dispersion region—rather surprisingly for a quasi-crystalline liquid—is compatible with a single relaxation time. Earlier theories which explained the high dielectric constant of associated liquids by the rotation of molecular aggregates (the simplest expression of co-operative effects) are therefore suspect, at least in their simplest form. In solids, transitions signalize the onset of molecular rotation which often is relatively free in crystals of high symmetry. The mechanism of dipole reorientation in ice is still unsettled, but there is now definite physical evidence in favour of a process involving non-classical proton transfer in certain solid alcohols.

Prof. Smyth writes for the chemist rather than the physicist or electrical engineer. In deriving the basic equations—not always rigorously—he is at pains to describe the physical background, a point which will commend itself to non-mathematical readers. A careful balance is maintained in areas of controversy, and his book is recommended to the honours student, general reader and specialist alike.

J. C. D. Brand

MICROSCOPY OF VEGETABLE FOODSTUFFS

Mikroskopische Untersuchung pflanzlicher Nahrungs- und Genussmittel

Von Dr. Gustav Gassner. Herausgegeben von Dr. Friedrich Bothe. Dritte, verbesserte Auflage. Pp. xvi+400. (Stuttgart: Gustav Fischer Verlag, 1955.) 33 D. marks.

ALTHOUGH the late Prof. Gustav Gassner's book on the microscopy of foodstuffs of vegetable origin, which was first published in 1931, has now reached its third edition, the reviewer has only recently had an opportunity of studying it for the first time. The author having died while the preparation of the third edition was still in progress, the work has been completed by Dr. F. Bothe. It must at once be emphasized that this book deserves to be much more widely known and used in Great Britain than it appears to be at present, and it is a work of reference that merits a place on the shelves of all public analysts, economic botanists and microscopists who are concerned with maintaining the standard of purity of foodstuffs, and detecting adulterants in them.

As its title implies the subject-matter of the book is essentially the microscopical structure of the products described in it, and it includes but little information concerning their sources and uses, although these are briefly mentioned.

The book is divided into thirteen chapters, twelve of which deal with such topics as cereals, starches, vegetables, condiments, beverages, spices, and seeds and fruits that are valued because of their content of oil. To give a few specific examples, the reader will here find particulars of the microscopical structure of a wide range of peas and beans, of arrowroot and sago, of dill and vanilla, of such diverse fruits as apples and dates, of cocoa and coffee, not to mention such homely vegetables as spinach and parsnips. There is a special chapter devoted to the microscopy of honey, and another on fungi includes details of morels and truffles and even of the *Penicillium* that is used for flavouring Roquefort cheese. The remaining chapter includes simple, effective, practical directions for examining foodstuffs under the microscope. The book ends with a good subject-index; but there is no bibliography.

The 866 line drawings by which the book is illustrated constitute one of its most useful features, and what a pleasure it is to find that all of them are original, well drawn, and show very clearly those characters that have proved to be the most valuable for diagnostic purposes. The illustrations are at a few selected magnifications, which have been used as standards throughout the book, so that the reader can at once form a mental picture of the relative sizes of the tissues and cells, as well as of the bodies enclosed in them, such as starch grains or crystals.

Although much of the information in the book is already available from other sources, it is an advantage to have clear and simple descriptions of the salient diagnostic characters of such a wide range of materials brought together within the compass of a book of no more than four hundred pages. The microscopical descriptions are so easy to understand that they could have been written only by a botanist with an intimate first-hand knowledge of his subject. Indeed, the whole book is manifestly based on the practical experience of the author and his colleagues.

Since the subject-matter is arranged according to the uses of the various items, rather than on a botanical basis, it follows that products derived from closely related botanical species are not always described in the same part of the book. Thus, for example, seeds derived from species of *Brassica* are described partly under oil seeds and partly under spices. This, however, is no serious disadvantage provided the reader realizes the position.

The reviewer is interested to note that many of the substitutes and adulterants described in this book are precisely the same as those which he has encountered in the course of his own work. It is indeed fortunate for microscopists whose business it is to ensure that a high standard of purity is maintained in economic plant products, that those bent on adulteration and substitution are so conservative in the selection of the materials they employ for these purposes.

C. R. Metcalfe

Gas Kinetics

An Introduction to the Kinetics of Homogeneous Gas Reactions. By A. F. Trotman-Dickenson. Pp. x+322. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 40*s.*

A NEW account of chemical kinetics by an active worker in the field is generally welcome, and the present volume is no exception to this. In his preface the author states that the book is written chiefly for undergraduates and for those beginning research. Almost inevitably the author's background and his desire for completeness render the treatment over-elaborate for the student and more suitable for the research worker, for whom the copious bibliography should be useful. Certain sections, such as that on transfer reactions, concern relatively new, expanding topics which would enhance an undergraduate course and which are almost unavailable at 'text-book' level. The book deals largely with the author's interests and, although this leads to a certain bias, it has the advantage that much recent work is collected together for the first time, and the writing shows considerable freshness of approach.

Certain diagrams and tables are difficult to follow, partly because there is a tendency to include excessive detail; and in some respects the text falls between two ideals. For example, in discussing Slater's theory, the reviewer feels that either a brief outline of the theory followed by its results should be given, or sufficient detail to enable the reader to work through an example for himself.

The general level of clarity of definition and readability is good, but occasionally, as in the all-important first sentence of the introduction, the style is obscure. The book is stimulating, good value and it deserves to be read. K. E. Howlett

Transistor Audio Amplifiers

By Richard F. Shea. Pp. xiii+219. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 52*s.* net.

JUNCTION transistors are rapidly replacing thermionic valves for audio-frequency amplification in many applications. Many circuit engineers with a particular interest in this topic will therefore be interested in this new book by R. F. Shea, which deals exclusively with it.

The book contains a mixture of theoretical and practical information. In common with most publications on transistors, it hinges on the use of 'equivalent networks'; one reason for this is that the internal feedback that occurs in transistors makes any other method of calculating their performance very difficult. It is a pity, however, that the author has not said more about the why and how of these networks before using them.

Almost a quarter of the book is devoted to listing manufacturers' data on a large number of American transistors. Scarcely any use is made of this material, which is, in any event, of little value in a book aimed at teaching fundamentals.

The book deals with the theory of the basic amplifier arrangements. It also has a chapter on pre-amplifiers where low noise and a reasonably high input resistance are required. Power amplifiers are discussed in some detail; in the case of class *B* circuits particularly, little is said about the relative merits of the various arrangements or how they can best be driven. Finally, there is a useful chapter on the design of four practical amplifiers.

This book will probably find a place on the library shelves at establishments interested in transistor circuits. Some engineers may find it of sufficient value on some topics to acquire their own copies.

D. D. Jones

An Introduction to Interferometry

By Prof. S. Tolansky. Pp. viii+223+5 plates. (London: Longmans, Green and Co., Ltd., 1955.) 21*s.* net.

THIS book on interferometry sets an example that might well be followed in other branches of physics, for it is not often that an acknowledged authority sees fit to write a text-book on his own subject for ordinary-degree students. It is refreshing to read a work at this level written by an expert teacher who is, at the same time, completely familiar with the practical details of the experiments and instruments he describes.

The subject-matter is necessarily far more than could normally be included in a degree course, but those who have to teach physical optics will find the book a source of inspiration for the particular sections of interferometry with which they may wish to deal. A great variety of interferometers is included, with emphasis on practical detail and the particular uses to which they are put in practice. The theory is elementary, and no elaborate mathematics is used.

The excellence of the book is somewhat marred by evidence of careless and hurried writing. Some of the earlier diagrams are poor (for example, in Figs. 2.11 and 5.7 rays are shown passing through lenses without deviation, and in Fig. 4.6 reflected rays do not obey the law of reflexion); punctuation is sometimes incorrect, and there is constant use of the adverbs 'thus' and 'hence' as conjunctions. I hope that there will soon be a second edition in which all the diagrams and the text match the very high standard of the contents. H. Lipson

The Mechanism of Evolution

By W. H. Dowdeswell. (The Scholarship Series in Biology.) Pp. ix+99. (London: William Heinemann, Ltd., 1955.) 6*s.*

THE concept of evolution has revolutionized biological thought during the past century, yet its full significance tends to be missed in school science courses, leaving a prevailing impression of something vast and rather unreal, which took place in the remote past. Mr. Dowdeswell's remedy is to incorporate with the classical evidence an understanding of the ways in which small evolutionary changes going on now, in wild populations around us, can be studied experimentally. The fact that many such experiments could be undertaken by the schools themselves makes it all the more stimulating.

After a preliminary survey of the historical background, variation is described in the light of modern genetics. There follows a discussion of natural selection and the effects of such factors as population size, continuity or isolation upon it. Examples drawn from many fields, including the author's own researches, lend intense vitality to the account. In conclusion, practical advice is given on experimental studies, and there is a summary of the present status of evolutionary theory, followed by a glossary and bibliography.

The book should prove immensely useful not only to the sixth-form boys and girls for whom it is intended, but also to teachers and first-year university students. Maurice Ashby

COLLOIDS AND THEIR BEHAVIOUR*

By Sir ERIC RIDEAL, F.R.S.

SINCE Graham's time there have been several attempts to define in a sufficiently embracing manner what is generally designated the colloidal state of matter. While the majority of workers in this field agree that form is an important factor, there is little doubt that Bancroft went too far in relying on this as the sole criterion, and McBain was too inclined towards a vitalistic view. The recognition that there exists between any two phases a third or interphase—the forgotten dimension of W. Ostwald—and that the properties and reactivity of matter constituting that phase or, as Sir William Hardy termed it, matter in the boundary state, differed from that in either of the bulk phases embracing it, leads us to attribute 'colloidal' properties to such manifestations, the *Kapillarchemie* of Freundlich. The greater the influence of matter in the boundary state on the system as a whole, the more manifest will be its colloidal properties. Evidently the two bulk phases must be so disposed relative to one another that interphase may constitute an appreciable fraction of the whole, and it is this interdispersion which is revealed in such a wealth of variety of forms.

Of fundamental importance in our approach to colloid science are the properties of liquid and solid surfaces.

Liquid–vapour and liquid–liquid interface are surfaces of equipotential and their free and total surface energies are readily measurable; in consequence, both the thermodynamic treatment and experimental investigations into the surface properties of capillary-active solutions and the behaviour of monolayers is well advanced. These investigations have added strength to the assumption that molecules at interfaces are orientated, and the unique properties of matter in the boundary state are in great measure due to this asymmetrical disposition. Detailed examination of monolayers both by means of surface pressure and surface potential measurements has presented us with examples in two dimensions of all the three well-known bulk states of aggregation, solid, liquid and gaseous, and as we might anticipate from the fact that orientation is one of the important features, we find in addition a large variety of orientated liquid or nematic states. The extension of the interphase in the bulk phases in these systems results in the formation of mists, foams and emulsions. In the former, the formation and growth of nuclei consisting of clusters of molecules, which in turn may either disintegrate again or re-arrange themselves to a more stable configuration and then proceed to grow by condensation of molecules taking place at a greater rate than evaporation, is a sequence of processes which, thanks to the investigations of Frenkel and Becker and Döring, have been capable of being analysed, while the experimental investigations on light scattering commenced by Tyndall in the Royal Institution has, as is well known, led to a wealth of information in such varied fields as coagulation at the hands of Whytlaw-Gray and La Mer and size and shape distribution by Debye.

We note that the growth of mists can take place either by further condensation of vapour or by coagulation of mist particles already formed. Our knowledge concerning the stability of emulsions is, in spite of their importance, still very incomplete. It is clear that since the interfacial free energy at the boundary of immiscible liquids is relatively great, two-component emulsions must be relatively unstable, and the first requisite of an emulsifying agent is to lower the interfacial surface tension. The distortion of a spherical drop leads to an increase in area, and in order to maintain a low interfacial tension more emulsifying agent must flow into the interface from one of the bulk-phase reservoirs. Further, if the emulsifying agent is present at the interface as a compressible two-dimensional liquid possessing a bulk-surface viscosity rather than as a vapour, a mechanical as well as a surface-tension brake is put on the extent of distortion of the sphere, and the stability of the emulsion is enhanced.

A simple picture of the process of curving an originally plane interface shows that the magnitude of the partition coefficient of the emulsifying agent between the two bulk phases serves as a criterion as to whether an oil-in-water or water-in-oil emulsion can be formed and where the inversion point is to be found. Attention may be directed to the possible significance of the inversion point in living systems. Among the more important factors contributing to the stability of colloidal suspensions are the electric charge and the extent of interaction of the colloid with its dispersion medium, that is, solvation.

Electric charges on colloid dispersions may come into existence through either surface ionization or through selective adsorption of ions from the medium. Pauli was a protagonist of the first view, regarding colloid particles as large ions, and his school has presented us with a wealth of analytical data in support of it. We can divide the distribution of the ions near the surface into two regions: those at or near the surface, confined in what is termed the Helmholtz or Stern double layer, and the diffuse or Gouy atmosphere, respectively. It is the latter that is responsible for electrokinetic phenomena. On adding electrolyte, the thickness of the diffuse layer decreases, the surface ionization is reduced and the adsorption of counter ions increased until coagulation and eventual precipitation ensue. The kinetics of this process have been examined and the results shown to be compatible with those anticipated from the effects of Brownian movement. By some, the ions held in the diffuse layer are regarded as being held by the type of restraint postulated by Donnan. On this view, the effective equivalent concentrations of multivalent ions would stand in the sequence M, $\sqrt[2]{M^{\cdot\cdot}}$, $\sqrt[3]{M^{\cdot\cdot\cdot}}$, an order given by the ordinary lyotropic series; but that physical or dispersive forces play an important part in such adsorption is clear from a consideration of the effectiveness with which wool can be dyed with the anions of many organic acids, or as seen in the following series of salts required to coagulate an arsenious sulphide sol:

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* Substance of a course of three lectures for school teachers delivered at the Royal Institution on February 28, March 6 and 13.

Salt in millimoles/litre

Sodium chloride	51	Morphine hydrochloride	0·425
Guanidine hydrochloride	16 4	Neofuchsine hydrochloride	0 114

Ionic exchange at the surface of ionogenic colloids may result in the precipitated colloid containing more of the precipitating ion than is necessary for neutralization of the electric charge.

The results of adding electrolytes to the hydrous oxides in the sol or dispersed form are more complicated, for these colloids represent a transition between the hydrophobic and the hydrophilic systems. A sol of sufficient concentration of, say, ferric hydroxide undergoes gelation on addition of a small quantity of electrolyte. The sol particles must be regarded as networks of ferric hydroxide, containing, if made by hydrolysis of the chloride, a certain number of chloride ions with positive charges on the network. On reducing the charge, portions of the network are without charge and can adhere to one another. A very open structure is thus built up, containing both water of hydration and water within the network.

The network maintains a distended form partly owing to the residual charge and partly owing to the osmotic pressure maintained by the Donnan distribution. These gels, slowly and more rapidly, in the presence of large quantities of electrolyte, may become more and more compact and indeed may gradually lose their water of solvation as the network links join up by chemical interaction. Ferric hydroxide may be converted into goethite, Fe(OH)O. The conversion is also naturally accelerated by warming. During this process of contraction the residual aqueous phase separates, a phenomenon termed syneresis.

If, first, sufficient electrolyte be added to cause the sol to gelatinize, this rigid network may be broken up by agitation; and on allowing it to stand, those portions of the fibrils which are not charged may in virtue of their Brownian agitation recohere to form a rigid gel again. This is a thixotropic system and is well exemplified in, say, a 0·5 per cent suspension of the well-known clay bentonite. We note, on the progressive addition of an electrolyte, first the cessation of lateral Brownian agitation, then of rotational motion. At this stage the system is still thixotropic. Further addition of electrolyte produces aggregation and then true coagulation. Important examples of thixotropic systems are found in Nature, for example, protoplasm. If we examine the still more solvated systems such as the proteins, starches, agar agar in water and many polymers in non-aqueous systems, these do not flocculate when brought to the isoelectric point but may be caused to gel, in which form they are quite stable. But large quantities of salt are required to precipitate them. The contrast between the salt sensitivity of the suspensoids and the solvated colloids is made use of in the determination of the gold number. For many proteins small quantities of salt are required to render them soluble.

The stability of these highly hydrated colloids may be reduced by methods other than salting out. Thus we may dehydrate the solvated groups by addition, say, of alcohol, when the viscosity rapidly decreases and the sol becomes optically opaque and sensitive to flocculation by electrolytes (Fig. 1). We also find that there are substances which render the dispersion still more stable to electrolytes and counteract the sensitization produced by alcohols. These are peptizing agents and include such substances as acetamide, urea or sodium thiobarbiturate.

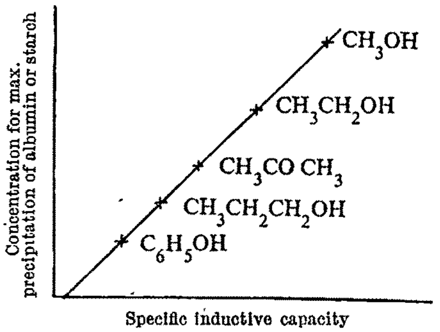
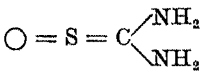


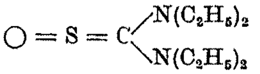
Fig. 1

We can imagine with Katz that these substances are adsorbed by the colloid by covalent linking and alter the relative number of the polar and hydrated groups; thus



$$O = S = C\begin{matrix} NH_2 \\ NH_2 \end{matrix}$$

introduces two new polar groups on adsorption and is consequently a peptizing agent; but



$$O = S = C\begin{matrix} N(C_2H_5)_2 \\ N(C_2H_5)_2 \end{matrix}$$

or, say, tannic acid, renders the sol more hydrophobic and is thus a sensitizing agent. Just as the more hydrophobic metallic hydroxides can acquire a thixotropic state by careful adjustment of the extent of charge and solvation, so these more solvated systems, on sensitization by, for example, alcohols, can link up and form a separate but highly solvated phase, the so-called coacervates. These can also be formed by mixing two oppositely charged hydrophilic colloids together, for example, gelatine and gum arabic at a *p*H less than 4·8, when the gelatine is positively charged and the gum arabic negative. It is possible that the carefully balanced system sol $\rightleftharpoons$ coacervate $\rightleftharpoons$ gel plays an important part in the phenomenon of narcosis, a view long held by Claude Bérnard.

We have seen that the gel structure is produced by the interlocking of the solvated fibrils. It is pertinent to inquire how a solvent reacts with a dispersible solid, for example, a solid polymer. In general, these are partly crystalline and partly amorphous. The ratio of crystalline to amorphous phase is revealed by X-rays or by density determinations, varying greatly with the nature of the polymer and the state of tension and extension. We regard the fibrils as constituting both the amorphous as well as when adlineated the crystalline portion, the consequent structure being termed a fringed micelle.

In the amorphous portion the specific heat is greater than in the crystallite and possesses more entropy since the fibrils here can move. On addition of a solvent, the free spaces in the amorphous portion are filled, the movement of the fibrils is restricted and the entropy decreases; thus the preliminary wetting should be accompanied by a heat change. On adding more solvent, the swollen fibrils distend further and the crystallites commence to be pulled apart. At this stage the fibrils acquire more movement, the entropy increases and the process of imbibition goes on until, if the polymer be cross-linked, a steady and permanent extension is obtained. The conditions for equilibrium in such swelling are given by the thermodynamic relation:

$$\Delta H = \Delta F - T\Delta S$$

Since $\Delta F = 0$ at equilibrium, $\Delta H = -T\Delta S$. The heat of mixing of two liquids is given approximately by the difference in their cohesive energies:

$$\Delta H = KV\left(\sqrt{\frac{E_1}{V_1}} - \sqrt{\frac{E_2}{V_2}}\right)^2 (1 - V)^2$$

where E, the cohesive energy, is given by the latent heat of evaporation:

$$E = L - RT$$

The swelling powers and cohesive energies for a number of organic liquids when brought into contact with vulcanized rubber have been found to conform to this simple idea with remarkable exactness.

NEW SYSTEM OF ELECTRIFICATION FOR BRITISH RAILWAYS

By G. H. PLATT

King's College, University of London

THE recent announcement by the British Transport Commission of its decision to adopt the 50 cycles/sec. single-phase alternating current system for future main-line electrification of British Railways is of great interest to all in the electrical industry and of far-reaching importance to the nation as a whole.

The advantages of electrically operated railways are too well known to need elaborating here; but briefly they are:

(*a*) The greater power available enables faster services to be run and permits more frequent trains over any given track. This is most apparent in urban and suburban passenger services; but is equally important in handling the traffic over a busy main line.

(*b*) Above some particular traffic density, the cost per ton-mile is less than with other forms of motive power.

(*c*) Very much less coal is needed than for steam traction, owing to the much greater thermal efficiency of modern power stations than the steam locomotive. Moreover, the coal used in power stations is of inferior quality, and the use of nuclear energy will further save coal.

(*d*) The absence of smoke and dirt makes for general cleanliness.

Details of the British Transport Commission's scheme have already been published (March 1956). The new system is concerned principally with main-line electrification. The London Transport Executive and Southern Region systems are unaffected. Their form of power supply is the most suitable one for underground and suburban traffic, and the cost of converting that of the Southern Region is unwarranted for the amount of locomotive-hauled traffic involved.

For ordinary long-distance main lines, however, the conditions are quite different. The use of a.c. supply for electric railways offers great advantages from the transmission point of view in that a high voltage can be used on the overhead wire, and transformed down at the point of use, that is, on the locomotive. On the other hand, an a.c. motor has disadvantages for traction compared with its d.c. counterpart. A system using a.c. of low frequency (15–25 c./s.) is in fairly wide use, but has the disadvantage of requiring its own generating plant and supply network, entirely separate from those of the public supply, or else expensive frequency-changing substations employing rotating machinery. Rotating machines for the conversion of a.c. to d.c. have long been rendered obsolete by the development of the mercury arc rectifier and the majority of electric railways using alternating current to-day convert the a.c. supply to d.c. at 1,500 or 3,000 volts in substations alongside the tracks. With main-line locomotives this means that heavy currents have to be collected. The weight of copper in the overhead system is thus considerable, the supports must be proportionally strong and the total cost is high.

By feeding the contact wire with a.c. at 25 kV. the current to be collected is greatly reduced and the whole overhead system can be made much lighter and cheaper. In addition, substations can be placed much farther apart so that fewer are needed, and furthermore, the substations themselves are simpler and cheaper, containing only static transformers and switchgear. This is an important advantage, as the cost of the fixed installations does not vary greatly with the traffic density. Hence the use of a.c. supply may make it financially justifiable to electrify lines which would otherwise be uneconomic due to their lighter traffic.

In this connexion a special survey of the proposed Euston–Manchester–Liverpool route has shown that some startling economies will be effected by the use of a.c. This system will require twelve substations only instead of seventy for d.c., and need 68 per cent less copper and 17 per cent less steel for the overhead equipment. An additional saving in this case is that only seventeen instead of two hundred and fifty miles of 33 kV. feeder lines will be necessary to take the current from the Central Electricity Authority.

This change in supply has been made possible largely by the progress in rectifier design, which has now made it practicable to carry the rectifiers on the locomotives themselves. Those already in service mostly utilize mercury valves of the 'Ignitron' or similar type; but successful trials have been run recently on British Railways by a motor-coach employing a germanium rectifier. This is an important advance in this field.

The new system also offers greater scope for development in design and technique than other systems. With d.c. supply, the motive power must of necessity employ d.c. motors; but by bringing the a.c. right into the locomotive the maximum freedom is given for the development of its design. Locomotives with rectifiers, various types of converters and straight a.c. motors are in use experimentally in France, and some of these have been found to have special advantages for certain kinds of traffic.

The low-frequency, single-phase a.c. commutator motor is considered by some to have better characteristics than the d.c. machine for main-line work, and the development of the former to operate satisfactorily on 50 c./s. has made considerable progress during the past few years in France. This type may yet become a serious rival to the d.c. series machine.

Up to now, however, the rectifier locomotive has given the most promising results, and has been found to have unexpected operating advantages over even its d.c. rival. On the Valenciennes–Thionville line, B_0—B_0 type mixed-traffic locomotives with 'Ignitron' rectifiers and having 84 tonnes adhesive weight haul freight trains of 1,400 tonnes, whereas the absolute maximum loading of a modern 1,500-V. d.c. locomotive of the same type and weight would be 900 tonnes only. This is due to improved adhesion characteristics at starting and at low speeds.

The motors used in rectifier locomotives are of the d.c. series type, specially designed to work satisfactorily on the pulsating output from the single-phase rectifiers. Biphase or 'full-wave' rectification is used, the output from which can be considered as a smooth d.c. voltage having superimposed on it an alternating e.m.f. of comparable magnitude and a frequency of 100 c./s. This introduces problems of commutation and heating in the motors; but by paying special attention to the design of the motors and including smoothing chokes in the circuit the difficulty can be overcome satisfactorily. With the ordinary d.c. system the problem does not arise, since rectifiers having six or more phases are used and the a.c. component or 'ripple' is in consequence insignificant.

The cost of the rectifier locomotive, according to the French figures, is comparable with a d.c. machine of the same rating, both in first cost and maintenance. Allowing for the improved performance, the rectifier machine shows a considerable economy in operating a given service. The use of semiconductor rectifiers in the future should show an even greater saving. The above-mentioned British survey shows that sixty fewer locomotives will be needed for these services.

The provision of sufficient clearances for a contact-line voltage of 25,000 volts is not easy in Britain. In some tunnels the cost of providing clearances would be prohibitive, and therefore it is proposed to employ a much lower voltage, namely, 6,600 volts, over certain sections, combined with the use of dual-voltage equipment.

The taking of large amounts of single-phase power from the public supply network suggests problems of unbalance on the three-phase system. Experience in France has shown that any disturbance has remained within acceptable limits, and no trouble is anticipated in Britain with its more heavily-loaded grid. The proposed scheme has the full concurrence of the Central Electricity Authority.

In addition to its major advantages, the use of a.c. supply simplifies very considerably the supply of power to locomotive auxiliaries, train lighting and heating, etc., a single transformer sufficing to provide supplies at any voltage required.

It is evident that the British Transport Commission's choice of the 50 c./s. alternating current system is based on a balanced judgment of the many factors involved. The Commission's readiness to profit by the latest technical developments is to be highly commended.

I would like to thank the Chief Electrical Engineer of the British Transport Commission for placing information relating to the proposed developments at my disposal.

A NOTABLE BIOCHEMICAL JUBILEE

IN 1906 Arthur Harden and William John Young, of the Lister Institute of Preventive Medicine, made two communications to the Royal Society of London on the alcoholic ferment of yeast juice; the first described the effect of phosphate on the rate of fermentation of glucose, and the second the separation from the juice by ultrafiltration of an inactive residue which could be re-activated by a soluble, heat-stable coenzyme in the filtrate.

Harden's experiments arose out of an attempt made with Allen Macfadyen to produce an anti-enzyme by the injection of yeast juice into animals, in the course of which it was found that normal serum increased the fermentation of glucose by yeast juice. In further experiments, Harden and Young fortunately adopted a volumetric instead of a gravimetric method, which enabled them to follow the rate of production of carbon dioxide continuously; they found that the filtrate from boiled yeast juice also increased the fermentation, with an initial rapid evolution of carbon dioxide, proportional in amount to the volume of juice added, and a prolongation of fermentation at a slightly higher basal rate. The effect was traced to the phosphates present in the juice, the extra carbon dioxide corresponding to one molecule for every atom of phosphorus added as orthophosphate; after the fermentation the phosphate was present in a form not precipitated by ammoniacal magnesium citrate, and presumed to be as an ester. The ester was afterwards identified by Young as fructose diphosphate; later, Harden and Robison found that a hexose monophosphoric ester was also formed which was shown by Robison to be an equilibrium mixture of glucose, fructose and mannose esters.

Harden and Young also dialysed the fresh juice, to find out the effect of the complete removal from the juice of the dialysable substances passing into the filtrate of boiled juice. They used for this purpose the rapid method of ultrafiltration under pressure through a filter of gelatin supported in the pores of a Chamberland filter candle, which had been devised by C. J. Martin, then director of the Lister Institute. In this way, the juice was separated into a residue and a filtrate, each of which was itself incapable of fermenting glucose, but which together fermented it as actively as the original juice. Since soluble phosphates did not activate the residue, it was concluded that the filtrates contained a distinct factor, to which the name 'coenzyme' and later 'cozymase' was given.

Their work was simple but precise, and its very precision was perhaps a bar to their further elucidation of the phenomenon of phosphorylation. Harden perceived that inorganic phosphate was necessary for the rapid rate of fermentation, that is, the process of esterification was necessary; but it seemed that the ester formed (hexose diphosphate) could not be an intermediate, since it was only fermented very slowly by the juice. Harden and Young considered that a coupled reaction occurred:

$$2C_6H_{12}O_6 + 2H\mathit{R}_2PO_4 \rightarrow 2CO_2 + 2C_2H_6O + 2H_2O + C_6H_{10}O_4(PO_4\mathit{R}_2)_2$$

in which by the phosphorylation of one molecule of sugar the breakdown of a second molecule was induced; when all the inorganic phosphate was esterified, the rate of fermentation fell to the basal rate, dependent for a supply of phosphate on the slow hydrolysis of the phosphoric esters.

It was not until 1945 that Meyerhof showed that the two phases were due to a destruction of the adenylpyrophosphatase of yeast during the preparation of the juice, so that the coupled reaction:

3-Glyceraldehydephosphate + phosphate + cozymase ⇄ 1-3 diphosphoglyceric acid + dihydrocozymase

1-3 Diphosphoglyceric acid + adenosine diphosphate ⇄ 3 phosphoglyceric acid + adenosine triphosphate

came to a halt for lack of the phosphate-supplying mechanism of the apyrase:

Adenosine triphosphate → adenosine diphosphate + phosphate

Harden's facts, however, were incontrovertible and induced an autocatalytic fermentation in the science of biochemistry the course of which need not be recapitulated here. Though he realized the fundamental nature of his work, he was habitually restrained and would have thought it regrettable hyperbole to say to his colleague in 1906: "This day we have lighted such a candle in England as I trust shall never be put out". But it is no exaggeration to say now that their work is the source, reflected and amplified by many later workers, of our understanding of intermediary carbohydrate metabolism and many other phosphorylation mechanisms in animals, plants and micro-organisms.

IMMUNOLOGICAL TOLERANCE

A MEETING was held on March 8 at the Royal Society on the subject of "Immunological Tolerance", under the leadership of Sir Macfarlane Burnet. Following the definition of Billingham, Brent and Medawar, immunological tolerance is a specific weakening or suppression of reactivity caused by exposure of animals to antigenic stimuli before the maturation of the faculty of immunological response. In his opening paper, Prof. P. B. Medawar (University College, London) referred to the experimental demonstration of tolerance against such varied antigens as the erythrocyte agglutinogens, the tissue antigens responsible for transplantation immunity, bacterial antigens and purified proteins. Marked differences are found between the first two of these antigens: the erythrocyte antigens are stable, cytoplasmic, and elicit a transient gamma-globulin response, whereas the unstable, nuclear, tissue antigens elicit a permanent state of heightened graft resistance mediated by leucocytes rather than serum.

In contrast to the suppression of reactivity brought about by agents such as cortisone or radiation, tolerance is specific: the response to one antigen is suppressed without altering the response to others. Another essential property is that the suppression is central, acting on the tissue producing the antibody. Tolerance differs in this respect from immunological paralysis, or the enhancing of tumour growth by antiserum or tissue extracts. A comparable specific and central suppression of the immunological response has been demonstrated by Chase in the inhibition of sensitization to simple organic compounds by prior oral feeding. Medawar then returned to the subject of the biological implications of immunological tolerance[1].

In a paper on "Erythrocyte Antigens and Tolerance Phenomena", R. D. Owen (California Institute of Technology) drew two conclusions from his earlier work on stable erythrocyte mixtures in twin cattle. From the observation that the antigenic types derived from each twin occur in equal proportions in the blood of each twin, it follows that no selective pressure is exerted in favour of hæmatopoietic tissue of native origin, and that tolerance is therefore complete. From the observation that no more than two types of cell are found in twins which differ by several antigens (with the exception of *J*), it follows that sub-cellular transformations do not occur, and that hæmatopoietic cells are in this sense fully autonomous. Attempts to mimic the chimerism of twin cattle in rats by means of parabiosis have been unsuccessful; but Ripley has produced a similar condition by injection of embryonic rats with embryonic liver and spleen cells through the chorionic blood vessels. Chimeras have also been produced in rats after injection of hæmatopoietic tissue into irradiated recipients, by Lindsley, Odell and Tausche. Owen then described his own work on acquired tolerance in man, where past exposure to *Rh* antigens *in utero* weakens the adult antibody response. *Rh*-negative women who complete three or more *Rh*-positive pregnancies without developing antibodies tend to have *Rh*-positive mothers. This tolerance is, however, not associated with a reduced incidence of erythroblastosis. Owen finally described an effect of injection of human erythrocytes into new-born chickens. The antibody response of the recipients as adults is delayed, weakened and tends to the production of incomplete antibody.

B. Cinader and J. M. Dubert (Lister Institute and Institut Pasteur) gave an account of their joint work on "Specific Inhibition of Response to Purified Protein Antigens". New-born rabbits were injected with highly purified human albumen, and litter mates left as controls. When challenged with the same antigen as adults, the controls produced antibody detectable by a gel-diffusion technique, and also by agglutination of tanned erythrocytes coated with antigen. The animals injected at birth failed to produce antibody, constituting an example of actively acquired tolerance. Tolerance of the injected animals was also exhibited in experiments with human albumen labelled with radioactive iodine. The labelled protein was eliminated slowly and continuously from the tolerant animals, in contrast to the controls, which exhibited a sharp rise in the rate of elimination as the immune response developed. Tolerance in this instance was shown to be specific, by means of cross-tests with tobacco mosaic virus and also diazotized human albumen. The diazotized human albumen provides a refined demonstration of specificity, since it is an antigen which normally elicits antibodies of two distinct types, specific either for the diazo group or for the albumen. Those tolerant animals which responded to the diazotized human albumen produced antibody only against the diazo group, as could be shown by absorption tests with human albumen. In a single animal, administration of diazotized human albumen appeared to weaken the tolerance to normal albumen, indicating that the state of tolerance can itself be modified experimentally.

Applications of immunological tolerance were described in papers entitled "Tolerance of Ascites Tumour Cells", by H. Koprowski (Lederle Laboratories, New York), and "Acquired Tolerance of the Rous Sarcoma Agent in Turkeys", by R. J. C. Harris (Chester Beatty Research Institute). Koprowski was able to obtain, from two transplantable mouse lymphomas, lines that would grow in normally resistant mouse strains; and from a rat hepatoma he obtained a line which would grow in mice. The transformation was made by inoculation of tumour cells into unborn mice of the prospective host strain, thus inducing a state of tolerance which enabled the tumour to grow progressively. The tumour masses which developed after birth served to start the transformed line of tumour, if necessary re-inoculating fœtal mice to complete the transformation. The adaptation of the transformed tumour lines to their new hosts was incomplete, as judged by the dosage of tumour cells needed to kill the new hosts as compared with hosts of the strain of origin. The transformed mouse-tumour lines appeared to retain antigens characteristic of their strains of origin, as indicated by adoptive immunization tests. The rat tumour retained the characteristic rat *V*-chromosomes, and could be transplanted back into rats. In tests with a variety of animal viruses, the transformed-tumour lines appeared to provide better hosts for virus multiplication than the original lines, and to be more susceptible to oncolysis by viruses.

Turkeys which had been rendered partially tolerant to chicken antigens were used by Harris, in an attempt to separate the Rous sarcoma agent from chicken antigens. If inoculated soon after hatching with chicken antigens, a proportion of turkeys are rendered susceptible to the Rous sarcoma virus and other non-virus chicken sarcomas. Live blood cells, blood cells killed by freezing or heating, or skin grafts, are all active for this purpose as chicken antigens. While growing in susceptible turkeys, the Rous sarcoma progressively loses its content of virus infective in chickens. This may indicate a conversion of the virus to the turkey antigenic type; but since virus assays were not also carried out in turkeys, it may instead indicate a decrease in the virus content of the tumour cells. After a single passage back into chickens, the sarcoma regains its full content of virus infective in chickens.

Parallel papers were presented by M. Hašek (Czechoslovakian Academy of Science) on "Tolerance Phenomena in Birds", and by R. E. Billingham and L. Brent (University College, London) on "Analysis of Tolerance induced in Newly Hatched Turkeys and Chicks". Work in London and Prague has shown that tolerance is readily produced in birds by the introduction of foreign cells into the embryo, intravenous injection and parabiosis being particularly effective methods. Hašek concentrated on the manifestation of tolerance as a suppression of hæmagglutinin production, and Billingham and Brent as a prolongation of the survival-time of skin grafts. In order to weaken or suppress reactivity to skin homografts, Billingham and Brent find that live, nucleated cells are essential. According to the criteria of hæmagglutinin suppression and prolonged graft survival, tolerance is produced more readily within than between species. The combinations of species tested were between chicken, turkey, duck, pheasant, goose, guinea fowl and pigeon. As expected on Darwinian principles, they find that tolerance produced between some strains of poultry is weaker than between others. The degree of tolerance which could be produced between species appeared to vary in accordance with their systematic relationship.

Induction of tolerance by intravenous injection of antigens into new-born chickens or mice was also described by Billingham and Brent. This method proved to be more economical than injection into the embryo. Nearly half the chickens injected with blood from another strain exhibited a degree of tolerance, although only a small proportion of skin homografts on new-born chickens take permanently This discrepancy is ascribed to the delay in vascularization of the grafted skin.

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[1] *Nature*, 176, 852 (1955)

OBITUARIES

Prof. F. Riesz

The distinguished Hungarian mathematician, Friedrich (Frigyes) Riesz, died recently. He was born on January 22, 1880, at Györ, and studied at Zurich, Budapest, Göttingen and Paris, taking his doctor's degree at Budapest in 1902. In 1911 he was appointed to a supplementary professorship at Kolozsvár (Cluj), becoming Professor Extraordinarius in 1912 and Professor Ordinarius in 1914. In 1919 Riesz moved with his university to Szeged, and in 1945 he was appointed to a chair in Budapest. In 1922 he became editor of a newly founded periodical, the *Acta Scientiarum Mathematicarum* of Szeged which quickly established a distinguished place for itself among the world's mathematical journals.

Riesz was one of the pioneers of functional analysis and we owe to him many of the fundamental ideas of the subject, which were later incorporated in an axiomatic formulation by S. Banach and his collaborators. Riesz's principal contributions may be summarized as follows: the Riesz–Fischer theorem (1907) on the equivalence of Hilbert's space o sequences of convergent sum of squares with the space of functions of summable square, which is the mathematical basis of the equivalence of matrix mechanics and wave mechanics; the Stieltjes integral representation for linear functionals on the space of continuous functions (1909); the theory of L^p spaces (1910); the first systematic discussion of analytic functions of operators (1913); the definition and properties of general completely continuous operators (1916); and the foundation of the theory of partially ordered vector spaces (1928). In 1952 there appeared the "Leçons d'analyse fonctionnelle", written jointly with B. Sz.-Nagy, and easily the most readable introduction to functional analysis that has yet appeared.

Riesz constantly strove to simplify the presentation of the theory of the Lebesgue integral; he introduced the systematic use of step functions (1912), and he proved (1931) the famous 'rising sun lemma', which leads to an easy proof of the differentiability almost everywhere of a monotone function.

He was one of the creators of the theory of subharmonic functions. Other fields to which he contributed include the theory of functions analytic in the unit circle, orthonormal series, inequalities and ergodic theory. He gave several proofs of the fundamental spectral theorem in Hilbert space. An early paper (1908) on topology contains ideas (bicompactness, the filter theory of limits) that had to wait until the late 1930's for their full development.

Riesz's work is characterized throughout by simple and powerful ideas and by lucidity of presentation; his papers are always easy to read. He never generalized for generalization's sake; his aim was always to put the main ideas in a setting that would illustrate their significance and their power as vividly as possible.

F. Smithies

Dr. Eugene C. Crittenden

Eugene Casson Crittenden, formerly associate director of the United States National Bureau of Standards and for many years chief of its Electrical Division, died in Garfield Hospital, Washington, D.C., on March 28 at the age of seventy-five.

After graduating in 1905 and a period of postgraduate work and teaching, all at Cornell, Dr. Crittenden joined the National Bureau of Standards in 1909 and was assigned to the photometric laboratory, where he was afterwards to make many important contributions towards the establishment of modern photometric units, standards and methods of measurement. During 1921–46 he was chief of the Electrical Division and thus also became responsible for work which, in collaboration with other national laboratories, led to the replacement of the obsolescent system of international electrical units by the present system of absolute electrical units. Under his leadership the Division expanded substantially, and sections for research in radio and electronics were established which eventually became major organizational units of the Bureau—for example, the Central Radio Propagation Laboratories at Boulder, Colorado, and the former Ordnance Development Division, now the Diamond Ordnance Fuze Laboratories of the Department of the U.S. Army. In 1933 Dr. Crittenden was made assistant director of the Bureau and became concurrently responsible for supervision of its over-all research and testing activities; and in 1946, when the title was changed to associate director, he assumed the full-time responsibilities of this post, which he held until he retired in 1950. For his outstanding services to the Bureau he was awarded in 1949 one of the first Gold Medals of the Department of Commerce for Exceptional Service. He continued to act as a consultant to the Director of the Bureau until the onset of his last illness a few months ago.

Dr. Crittenden is best known both in his own country and internationally for his many activities and services which, combined with those already mentioned, played an important part in the developments which led to the international adoption in 1948 of the present electrical and photometric units and standards. He was vice-president of the International Commission on Illumination during 1939–48 and president of its U.S. National Committee from 1928 until 1935. During 1946–54 he was the member for the United States on the International Committee of Weights and Measures, of which he was vice-president from 1950 until 1954, and he had been a member of this Committee's advisory body for electricity and photometry since 1933. He also participated in the work of the International Organization for Standardization and the International Committee of Legal Metrology. Dr. Crittenden was for many years on the Standards Council of the American Standards Association, of which he was chairman during 1945–48, and in his time he served as president of the Illuminating Engineering Society, the U.S. National Committee of the International Electrochemical Commission and the Optical Society of America, as well as associate editor of the *Review of Scientific Instruments*. He also participated in the work of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Institute of Physics and the National Research Council.

Dr. Crittenden will long be remembered by his former colleagues on international committees, for he always brought to their deliberations wise counsel based on great knowledge and experience and expounded with good humour. Photometry was the primary interest which eventually led him to become a renowned exponent of international collaboration in all matters concerned with metrology. He is survived by his wife, formerly Norma M. Snyder, a daughter and a son.

H. Barrell

Dr. A. L. Stern

Arthur Landauer Stern died suddenly on April 26 at Chorley Wood at the age of eighty-eight. He was born on May 6, 1867, the eldest of seven children of Moritz and Fanny Stern, of Birmingham. At King Edward VI High School he was a Foundation Scholar; and in 1887 from Mason College he obtained honours B.Sc. (London). He was then Tangye Research Scholar and personal assistant under Sir William Tilden, working on compounds of phosphorus. After that, under Dr. Cornelius O'Sullivan, he worked on chemical problems of fermentation and brewing, and soon became chemist and brewer at Messrs. Bass, Ratcliffe and Gretton, under O'Sullivan. An early piece of work was to show that glucose from various sources was the same substance, and thus he helped to lay one of the foundation stones of modern organic chemistry. He obtained his D.Sc. (London) in 1894.

On the death of O'Sullivan in 1906, Stern succeeded him as head brewer at Bass's New Brewery. He reorganized the research, with prescience concentrating on the biological side (Dr. Arthur Slator was then his chief assistant). Under his direction, the rate of multiplication of yeast cells was shown to be subject to simple mathematical laws. On the industrial side, a series of researches revolutionized the maturation of beer. It is forty years since Stern substituted metal tanks with single-feed cylinders in the racking room instead of the old single wooden casks; and his method has now become standard practice. Many technical processes were influenced by him, from the better use of fuel in breweries to the bottling of beer and its dispatch overseas so that "Bass" should arrive in perfect condition in diverse climates. Incidentally, he, under O'Sullivan, brewed the famous King's Ale of 1902.

Stern's brewery was a happy place. He was not only a master brewer, but also had happy relations with his staff, and took a personal interest in them and their families. He was a man of wide interests, and although he retired early, he never lost contact with scientific affairs.

He had a very happy married life, saddened only by his wife's death last year. He leaves seven children, all of whom went to universities, four of them following scientific careers; his eldest grandchild is about to enter Cambridge to read science.

Mr. Harold Picton

Harold Picton, who died on March 21 in his eighty-ninth year, will be remembered for his contributions to science, education and international understanding.

Picton was a son of the Rev. J. A. Picton, Unitarian minister and M.P. for Leicester, and grandson of Sir James Picton, of Liverpool. After graduating at University College, London, he worked in Sir William Ramsay's laboratory. With S. E. Linder he published a series of papers on colloidal solutions. Sols of arsenious sulphide were prepared in various grades down to one in which the submicroscopic particles passed through porous pot and diffused, yet still scattered light, giving the Tyndall effect. Picton and Linder were the first to show the migration of such particles in an electric field, the arsenious sulphide moving to the anode and ferric hydroxide to the cathode. They studied the precipitation of these sols by electrolytes and showed the presence of the positive ion in the precipitated arsenious sulphide. The efficiency of the electrolyte as coagulator was also related to the charge on the positive ion. This is known as the Hardy–Schulze Law, but, as Prof. W. C. McC. Lewis wrote, it "might perhaps more legitimately be known as the Schulze–Linder–Picton–Hardy Law". This work undoubtedly laid the foundation of much of the modern view of suspensoid colloidal systems.

In 1900, after a few years as science master at Parmiter's School, Picton joined his friend, the Rev. J. E. Bennett, who had opened a small residential school, Clacton College, and shortly afterwards he succeeded him as headmaster. This was a remarkable school which anticipated many modern trends in education. A family spirit was developed both in and out of the classroom. Discipline was strict but kindly, and was based on rules laid down by an elected school council. The physical, mental and spiritual aspects of personality were provided for in a well-balanced whole. Games were played but were not over-emphasized, and boys were encouraged to take up other interests such as gardening, photography, and the study of church architecture and of prehistoric remains. A number of worked flints and mammalian bones and teeth were collected from the Pleistocene deposit on the Clacton foreshore and this section of the school museum was afterwards presented to Charterhouse School.

From his mother (née Jessie C. Williams), who was brought up in Hamburg, Picton acquired a deep love of Germany. From 1914 onwards he strove to promote a better understanding between the Germans and the British. In five books published between 1918 and 1948 and many other writings he stressed the better elements in German life and culture. His "Early German Art and its Origins" (1939) was an important work. For six years he lived near Berlin but returned to England in 1934 after the rise of Hitler. From that time he exposed the horrors and dangers of the Nazi dictatorship; but always insisted that the whole German nation should not be condemned for the crimes of the Nazis. He worked untiringly to help refugees from Germany.

Harold Picton was a man of vigorous and many-sided personality to whom men were more important than systems. He had a genius for friendship and he gained the affection as well as the admiration of his pupils, who will never forget the debt they owe him. He did not marry but adopted a son, who survives him. G. M. Bennett

Dr. Harry J. Deuel, jun.

Dr. Harry J. Deuel, jun., whose death at the age of fifty-eight occurred on April 17, had been an active force in the field of nutrition for more than a quarter of a century, his major interest being the biochemistry of lipids. His group at the University of Southern California has established a vast amount of biological data on the digestibility of fats and the lipid composition of the tissues of different animals under varying experimental conditions. This quantitative information has been, and will continue to be, of great value to innumerable workers in this field.

It is not only as an accumulator of facts that Dr. Deuel will be remembered; he also made notable contributions to advancing knowledge, especially in connexion with the composition of cerebrosides, the conversion of carotene to vitamin A, the nutritional importance of dietary fat and the effect of hormones on lipid metabolism. He had a wide knowledge and interest in all work in the lipid field, and many will recall happy hours of argument and discussion in which he took a leading part. This width of experience found expression during the past few years in his writing "The Lipids; their Chemistry and Biochemistry", two volumes of which have already been published. The third and last volume was nearing completion at the end of last year. This work is likely to become established as a standard work in this field—a fitting memorial to its author.

Harry Deuel took great delight in meeting people. As a Fulbright Fellow at Cambridge during the past year, he was able to renew many old friendships and to make many new ones. He carried through an active programme of lectures and visits, both in Britain and on the Continent. Those who had the privilege of meeting or hearing him during this past year will find inspiration, not only from the scientific contributions he made on many occasions, but also from his immense courage and fortitude. He was a man that so many of us were happy and proud to have known. A. C. Frazer

NEWS and VIEWS

Anatomy at Cape Town: Prof. M. R. Drennan

After forty-three years of almost continuous service to the University of Cape Town, Prof. M. R. Drennan retired from its chair of anatomy at the end of 1955. He arrived in South Africa from Ayrshire in 1913, the year of the first discovery of a fossil human skull, the Boskop skull, in South Africa, and no single personality has impressed his stamp more profoundly upon the first medical school to be established in South Africa. Not only as a contributor to Cunningham's "Anatomy", but also as the author of his own concise text-books on osteology, embryology and physical anthropology, his name is familiar to medical students throughout the Commonwealth. Among some thousand registered medical graduates directly influenced and inspired by his teaching are such figures of eminence as Thomas J. Dry, of the Medicine Section of the Mayo Clinic, Sir Solly Zuckerman, of Birmingham, and David Slome, of the Royal College of Surgeons of England. Amid the spectacular South African discoveries in physical anthropology of his generation, Drennan's shine with characteristic brilliance. His recognition of the Boskop fossil type as still extant in a Hottentot being dissected (1924), of the Australoid fossil skull from the Cape Flats (1929), of pedomorphism in the pre-Bushman Plettenberg Bay skull (1931), of the Neanderthaloid features in the Florisbad skull (1935) and of the Rhodesian affinities of the Saldanha Bay skull (1953) are classical contributions to prehistory. His collection of extant, recent and fossil human material from the southern extremity of the Old World land mass established a crucial centre of research that has been steadily illuminating human anatomy and history in Africa from the Middle Stone Age to the modern era. In approximately a hundred publications, Drennan's originality has ranged over topics historical and educational as well as the more strictly anatomical and surgical. As past president of the South African Archæological Society, member of the Historical Monuments Commission from its inception, fellow and council member of the Royal Society of South Africa, director of the South African Museum and in numerous other professional and public capacities, he has given and will doubtless continue to give unremitting service in many capacities to South African science.

Prof. L. H. Wells

Dr. L. H. Wells, who succeeds Prof. M. R. Drennan, is returning to South Africa, whence he went as senior lecturer in physical anthropology to the Department of Anatomy at the University of Edinburgh in 1951. Educated at St. John's College and the University of the Witwatersrand at Johannesburg, he showed an early leaning towards anatomy by graduating M.Sc. with a thesis entitled "The Foot of the South African Native", and by his appointment first as a graduate demonstrator and later as a junior lecturer in anatomy, prior to taking his medical qualification, by which time he already had a number of publications to his credit. His early interest in physical anthropology and human and comparative palæontology, stimulated by the head of the Department of Anatomy at Johannesburg, Prof. R. A. Dart, and by the work of the late Robert Broom, has continued unabated to the present time, being recorded in a long series of papers which report the results of studies on a wide variety of subjects ranging from the peroneus tertius muscle of the baboon and the anatomy of the Bushman to human remains of the Dark and Middle Ages in south-east Scotland. The appointment of an anthropologist of Dr. Wells's calibre to the chair at the University of Cape Town will undoubtedly further the study of anthropology in Africa, while bringing him into closer touch with the important discoveries of fossil primate remains which continue to be made on that continent.

The Perkin Centenary

To mark the centenary of W. H. Perkin's discovery of the first synthetic dye, the *Manchester Guardian* has included a supplement in its issue of May 7 in which various contributors discuss the many developments that have resulted from this great event made when organic chemistry was still in its infancy. The first article is a personal recollection of Perkin by his nephew, Mr. Arthur H. Waters, who relates how he can remember his uncle back to about the year 1880 (when Mr. Waters was six years old). The article is a charming reminiscence of a man who, though his name to the outside world was illustrious, was to his kith and kin a simple, kindly soul—a religious man deeply interested in social welfare, temperance and evangelism; a great lover of children; a vegetarian; a keen recruit to the ranks of bicyclists in the early nineties; and a man who scarcely ever mentioned chemistry in the family circle. Mr. Waters's contribution is followed by one by Prof. W. Bradley (Department of Colour Chemistry and Dyeing, University of Leeds) on Perkin's scientific work and life. Two more articles continue in the biographical vein: "The Perkin Family and the Textile Industry", by R. G. Fargher (director of research and development, Samuel Heap and Son, Ltd.), in which are discussed the parts played in the textile industry by two of Perkin's gifted sons, namely, William Henry and Arthur George; and "Pullar and the Dyers' Reaction", by J. L. Crockatt (director and general manager, J. Pullar and Sons, Ltd., Perth), in which is retold the story of Perkin and the young dyer, Robert Pullar, of Perth. The remaining three articles deal with the more modern industries that have grown up as a result of Perkin's work. Under the heading "A More Fragrant World", Paul F. Spencer (chief chemist, Cusson Sons and Co., Ltd.) discusses synthetic odours and flavours, and in a rather longer article, "Raw Materials derived from Coal", L. W. Blundell (president of the National Benzole and Allied Products Association) writes on the importance of the residues from gas-works. The last, and longest, article is by Frank L. Rose (research manager, I.C.I. (Pharmaceuticals), Ltd.) on "Perkin's Influence on Medicine: the Development of Drugs and Antibiotics", a field in which the name of Ehrlich, working first with methylene blue and congo red, stands head and shoulders above the rest. Of all the lines developed from Perkin's dye, this is perhaps the one in which the most amazing developments have been made; certainly it has been the one most beneficial to mankind.

Supply of Scientists and Technologists in Britain

In his presidential address to the Institution of Chemical Engineers on "The Technological Awakening", given on April 24, Mr. J. A. Oriel welcomed the Government's new awareness of the value of technology, which he thought was due largely to the work of the chemical engineer during the past thirty-five years, and he urged that the situation should be examined constructively and with a view of helping rather than of controversy. He deprecated controversy over the relative merits of an education in the arts or in the sciences. This is a passing phase, although at present there are too many 'scientific illiterates, and it is regrettable that we should not have at the head of affairs, at a time of great technical improvements, more men with technical imagination capable of inspiring those working under them. Nor did Mr. Oriel think there is much advantage to be gained by comparing the position in Britain with that in the United States and the U.S.S.R. We do not wish to follow the U.S.S.R. in forcing men to adopt scientific or technological careers; but we cannot deny that we force men into National Service, and the Government has not grasped the seriousness of diverting from their profession when they are badly needed those chosen because of their ability for special training in science and technology.

Mr. Oriel thinks that the number of boys reading science has already increased, and that the quality will also improve. He believes that the technological sub-committee of the University Grants Committee will provide the necessary guidance and impetus to technological education, but pointed out that the universities can help to improve the status and outlook of teaching staff in the technical colleges by inviting their assistance in research and allowing more research carried out at the technical colleges to rank for the preparation of Ph.D. theses. He also suggested that universities hold on to their graduates too long; a university should retain only a very small number of those who have obtained their first degree, and only then after satisfying itself that they are really men who will benefit by a period in research, which normally, Mr. Oriel suggested, should be pursued at a different university. In general, the undergraduate after three or four years should move into industry or teaching, and those clearly designed for first-grade technologists should move elsewhere to a college also open to men who had already spent from two to five years in industry. In such institutions we may expect to find the interchange of ideas and techniques that will really make Britain a leader in quality of technologists. As regards the technical colleges, where the expansion in technical education will come, Mr. Oriel pointed out that the municipal or regional patriotism of the local education authority can be a source of strength as well as a weakness, and he appealed for full support of the 'sandwich' system by members of the Institution who as managers are in a position to help. Given such support and a right attitude by parents, teachers and university professors as well as industry, Mr. Oriel sees no reason why Britain should not double its output of well-trained scientists and technologists within five years.

Physical Society's Handbook of Scientific Instruments and Apparatus

THE "Handbook of Scientific Instruments and Apparatus, 1956 Exhibition", published in connexion with the fortieth annual exhibition of scientific instruments and apparatus of the Physical Society, to be held in the Halls of the Royal Horticultural Society, London, during May 14–17 (see *Nature*, April 7, p. 653), is not only a detailed catalogue and guide to the exhibits but is also a valuable reference book and useful indication to recent progress and development in the design and production of British scientific instruments and apparatus (pp. xvi + 257 + 88; from the Society, at 1 Lowther Gardens, Prince Consort Road, London, S.W.7; 6*s*. or 7*s*. 6*d*. by post). It is arranged in the numerical order of the stands, totalling 131, which this year are to be housed in both the Old and New Halls of the Horticultural Society, thus giving much-welcome increased space for the display and demonstration of the exhibits. The exhibitors include, as formerly, government research establishments, universities, and scientific and technical publishers, in addition to about ninety-five manufacturers of scientific equipment. A brief description is given in the handbook of each particular item to be exhibited, in many cases also accompanied by an illustration, and a note is added to show whether the instrument or apparatus to be demonstrated is merely a prototype, is in production or can be made to order. The excellent indexes of both exhibitors and exhibits which preface the handbook will be found to be most helpful to users. To those who are unable to visit the exhibition, the handbook can be recommended as a comprehensive catalogue of modern physical apparatus and a quick reference book to the leading manufacturers. The advertisement section alone, consisting of eighty-eight pages, is in itself a most valuable collection of interesting information.

British Chemical Engineering

THE first number of *British Chemical Engineering* is attractive and readable (Drury House, Russell Street, London, W.C.2). There is always a place for commercial journals in engineering, which is commercial itself in essence. They will be read by engineers if they contain the news. The news is not solely a matter of research work, but of developing ideas, new emphasis, new invention and the plain story of what the other man is doing. The development of ideas in chemical engineering has shown a change since the War. The straight classification of techniques into unit operations has yielded to an insistence on fluid flow, heat and mass transfer as fundamental to them all. The strength of present design methods is shown in the first article on achievements at Windscale. These were made (and made better according to Sir Christopher Hinton) without benefit of pilot plant. This view is also put forward by Lincoln T. Work in the last article. The leader and editorial comments are well written and well informed. The criticism levelled at the lack of chemical engineering research in government stations is not founded on a careful study of the work going on, but on the annual report of the Department of Scientific and Industrial Research, which is condensed. Other articles are of a good standard and the features well planned. This is altogether a professional production and will need to maintain a level to justify a title which involves so much.

Nematologica: New Journal of Nematological Research

A NEW international quarterly journal of nematological research, *Nematologica*, has been founded through the initiative of Dutch workers, after informal discussion among some of the participants at the third symposium on plant nematology, held at Wageningen in July 1955. The editorial board consists of J. H. Schuurmans Stekhoven, J. W. Seinhorst, M. Oostenbrink, and P. A. van der Laan, of the Netherlands; they are assisted by advisory editors from fourteen countries, including the United States and the U.S.S.R., with F. G. W. Jones and B. G. Peters from Great Britain. The first issue (1, No. 1; 1956. Pp. 80+10 plates. Leyden: E. J. Brill; 28 florins per volume of four parts) contains about half the communications to the above symposium, and the second is to contain the remainder. The editors state that, in consequence, these two issues will not be representative of future issues, for the communications were all relatively short and most of them in the field of agricultural nematology. Although future issues are to be concerned primarily with this aspect, it is hoped that the journal will cover the field of nematology in general, "except for papers on medical and veterinary subjects", and will also include studies in "taxonomy, physiology, morphology, genetics, and other more fundamental research". The journal also incorporates the *Nematological News* of Dr. A. H. Meyl (Germany); in the first issue, two pages of small print are devoted to this very useful feature.

Geographical Trends in the Soviet Union

In the September issue of the Russian journal, *Nauka i Zhizn* (Science and Life), K. V. Zvorykkin and G. M. Ignat'ev emphasize the importance of a closer connexion between geographical exploration and agriculture, as exemplified by some recent surveys by the Geography Department of the University of Moscow. Both geology and geography, they write, must to-day subserve strictly practical and utilitarian ends, with perhaps less of the glamour and adventure that enlivened the exploits of old. The former must be used for seeking far and wide for new oilfields or promising formations, and the latter for exploring throughout the length and breadth of the vast Soviet territories for more farmland to meet the rapidly increasing needs of a growing population and rising standard of living. However, the surveys they describe did not go very far afield: they went no farther, indeed, than Ryazan, which is practically in the Central Russian or Moscow region, and is not so very distant south-east from the University itself. The expeditions were mainly intended as practice and experience in agricultural survey work for the students and others, more particularly on existing or potential collective farms and the domains of the tractor service stations usually associated with several of such farms. State farms, too, were included. The first expedition was mainly confined to Zaraisk, a district of the Ryazan Government, and the second was called the Ryazan Expedition, though it too was limited to a relatively few collective farms in the Sapozhkovsk locality. Both aimed at providing as much information as possible from the point of view of the potential farmlands, including detailed maps, soil science, climatology, contours and water supply, and also some indication of the measures needed to make the land suitable for cultivation and optimum use. Though students from many other departments in the University took part—physical and economic geographers, geophysicists and cartographers, soil geographers, biogeographers, etc.—it would seem that the services of economic botanists, entomologists, and even zoologists and scientific stock-breeders would be needed to make a complete and really informative study, and these are not mentioned (unless included under biogeographers). Zvorykin and Ignat'ev are firmly convinced that in conformity with the far-reaching and ambitious economic planning for Soviet industry and agriculture, as set forth in some detail at each succeeding plenary session of the Central Committee, geographers must considerably broaden their ideas; they must even extend the range and variety of their work beyond that of agricultural requirements to the industrial field generally, for example, in surveying suitable river sites for hydroelectric stations.

Forest Products Research during 1954

The annual report for 1954 of the Forest Products Research Laboratory, Princes Risborough (pp. 60+8 plates. London: H.M.S.O., 1955; 3*s*. 6*d*. net), shows that the scope and nature of the work undertaken have remained the same; the contact between the Laboratory and the trades and others interested in the utilization of timber and its products have been close; and the number of inquiries reaching the Laboratory is still on the increase. One significant change in the work has been a decrease in the emphasis on the testing and assessment of new Colonial timbers which has formed such an important and valuable part of the work of the Laboratory during past years, more time having been devoted to the examination of various species of home-grown timber in co-operation with the Forestry Commission. Now that the new plantations are reaching a size when thinnings can be made in them, the strength or degree of these thinnings in various species of crops is undergoing sylvicultural experiment. As the work proceeds, with the increase in age and size of the wood, the Laboratory will be able to give valuable assistance in testing the timber quality of the various species being used, the soils on which they are grown and various other locality factors, including the management applied. Tests of timber seasoning and important plywood experiments are under investigation. The Entomology Section reports the discovery of the house longicorn beetle in Surrey a few years ago. It is a menace to softwood structural timbers and is well known on the Continent of Europe. So far, in spite of careful investigation, it has only been found in a comparatively restricted area in Surrey. It is said to attack the hardwood oak in Great Britain. The death-watch beetle has been under study for some time in the Section.

Australian Earthworms

The longest earthworm in the world, *Megascolides australis*, is found in Gippsland, Australia, and grows up to eleven feet in length. Its habit of 'squirting' has been described by Elizabeth C. Pope (*Austral. Mus. Mag.*, 11, No. 12; December 1955). When disturbed, the worm squirts out a series of pairs of jets of fluid from a line of pores opening down each side of the body. The effect can be most spectacular, for these jets rise as high as eighteen inches or two feet into the air. Although there are reports that the fluid has a corrosive action, it is only slightly alkaline and contains some dissolved salts, body wastes like urea and some proteinous materials and cells. The fluid comes from the worm's body cavity and is squirted out by violent contractions of the body-wall which force the fluid out under great pressure through the pores. There is no record of the fluid having anything but a mildly irritating effect on the skin of human beings. The fluid is used for lining or lubricating the burrows of the worms. The article also refers to other 'squirter' earthworms.

Barley Mutants

T. Lawrence (*Canad. J. Bot.*, 33, 6, 515; 1955) has described the production of mutations by irradiating Montcalm barley in different ways. Five radiation sources were used for inducing mutations in barley, all treatments being given at a dosage of 10,000 r. equivalent. The radiation sources with their respective dose-rates in the region of the irradiated seeds were: a betatron (181·8 r./min.), an X-ray machine (201 r./min.), radium–beryllium (5·3 r./min.), and two cobalt-60 sources (4·5 r./min. and 75·75 r./min.). None of the radiation sources used was more effective than the X-ray treatment in producing mutations. The betatron and the high dose-rate treatments from cobalt-60 appear to be somewhat less effective than X-rays. More than thirty different mutant types were produced, including a number of vital mutants, such as stiff-strawed and early-maturing types. These appear promising as new varieties, but require further agronomic evaluation.

University of Birmingham: Appointments

Dr. N. A. Dudley, lecturer in engineering production in the University of Birmingham, has been appointed reader in engineering production and head of the Department of Engineering Production for a period of three years. The following have been appointed to lectureships in the University: T. K. Chaplin (civil engineering), Dr. T. B. Massalski (physical metallurgy), R. B. Hoole (mining) and Dr. J. N. Hawthorne (pharmacology). The following members of staff of the National Vegetable Research Station, Wellesbourne, have been appointed recognized lecturers in the University: D. W. Wright (attached to the Department of Zoology) and Dr. W. G. Keyworth (attached to the Department of Botany).

Royal Institution: Officers

The following have been elected officers of the Royal Institution: *President*, Lord Brabazon of Tara; *Treasurer*, Mr. W. E. Schall; *Secretary*, Mr. S. Robson; *Managers*, Dr. T. E. Allibone, Mr. E. R. Davies, Sir Alfred Egerton, Dr. A. G. Gaydon, Mrs. H. K. Hawkes, Brigadier H. E. Hopthrow, Mr. L. B. W. Jolley, Dr. H. Lowery, Mr. J. A. Oriel, Prof. H. J. Plenderleith, Dr. J. H. Schulman, Mr. P. H. Schwarzschild, Dr. R. Seligman, Dr. C. Keith Simpson and Prof. W. D. Wright; *Visitors*, Lieut.-Colonel S. J. M. Auld, Mr. F. G. Brown, Mr. R. C. Chirnside, Dr. F. H. Cotton, Mr. H. W. Cremer, Miss E. H. Jebens, Dame Kathleen Lonsdale, Mr. G. Parr, Mr. J. D. Peattie, Dr. R. Scott Russell, Miss Daphne Sidebottom, Dr. P. C. Spensley, Mr. W. R. Stevens, Mr. S. A. Stigant and Dr. D. T. A. Townend.

Institute of Petroleum: Officers

The following have been elected officers of the Institute of Petroleum for 1956–57: *President*, Rt. Hon. Lord Geddes; *Past-Presidents*, Lieut.-Colonel S. J. M. Auld, T. Dewhurst, Dr. A. E. Dunstan, E. A. Evans, Prof. F. H. Garner, H. S. Gibson and C. A. P. Southwell; *Vice-Presidents*, Dr. E. B. Evans, A. C. Hartley, E. LeQ. Herbert, R. B. Southall and E. J. Sturgess; *Honorary Treasurer*, G. H. Coxon; *Honorary Secretary*, C. Chilvers; *General Secretary*, D. A. Hough; *Editor*, George Sell; *New Member of Council*, M. E. Hubbard.

Annual Meeting of the Society of Chemical Industry

In addition to the lectures to be given at the seventy-fifth annual meeting of the Society of Chemical Industry during July 9–15 (see *Nature*, March 31, p. 609), a number of visits will be made to factories and research organizations in the London area. They include the Paint Research Station at Teddington, the National Institute for Medical Research, the Central Electricity Authority (Bankside Generating Station), Glaxo Laboratories, the Isle of Grain refinery of Shell-Mex and B.P., and the Atomic Energy Research Establishment at Harwell. The meeting begins with a reception on the Monday evening at Guildhall by the chairman, Sir Charles Dodds, and Lady Dodds, and the annual general meeting will take place the next day. The annual dinner will be held on the Wednesday at the Dorchester Hotel.

South-Eastern Union of Scientific Societies: Congress in Tunbridge Wells

The sixty-first congress of the South-Eastern Union of Scientific Societies will be held during May 24–27 in Tunbridge Wells, the town where the Union first met in 1896. The president-elect is Dr. W. E. Swinton, chief scientific officer of the British Museum (Natural History), whose address, "Nature and the Free Mind", will be given on May 25. In the various sections of the Union, addresses will be given by the following: *Archæology*, Major J. M. T. Burchell (the archæology of the Medway Estuary); *Botany*, Prof. C. T. Ingold (Gasteromycetes or Nature tries again); *Geology*, C. Fagg (swallow holes in the Mole Gap), and Prof. S. W. Wooldridge (geomorphology of the central Weald); and *Zoology*, Prof. H. R. Hewer (the importance of keeping field records). Further information can be obtained from the honorary local secretary, Mrs. H. Vernede, Carlton House, Carlton Road, Tunbridge Wells, Kent.

Tenth International Congress of Entomology, Montreal

The Tenth International Congress of Entomology will be held in Montreal during August 17–25, the meetings being at McGill University and the University of Montreal. The sections of the Congress have been arranged provisionally as follows: systematics, morphology and anatomy, physiology, behaviour, ecology, geographical distribution, genetics and biometrics, palæontology, arachnids and other land arthropods, agricultural entomology, forest entomology, medical and veterinary entomology, entomology of stored products, biological control, and apiculture. A visit to the Science Service Laboratories, Ottawa, and a number of short excursions will be made during the Congress, following which tours to a number of more distant laboratories and excursions for collecting will be arranged. Further information can be obtained from the secretary of the Congress, J. A. Downes, Division of Entomology, Science Service Building, Ottawa, Ontario.

Third International Congress on High-speed Photography

The third international congress on high-speed photography will be held in the Government Offices, Horse Guards Avenue, London, S.W.1, during September 10–15, and is being sponsored by the Department of Scientific and Industrial Research. The following main topics will be considered: flash sources for high-speed photography and high-speed cinematography; mechanical-optical cameras and drum cameras; high-speed shutters, and scanning and image dissection methods; and recent applications of these techniques in research, and particularly in the fields of industrial machine analysis, explosive studies (including atomic research), hydrodynamic and aerodynamic research, and medical and biological research. An exhibition of high-speed photographic and cinematographic equipment and associated instrument aids will be held concurrently with the congress, and admission to this exhibition will be free (tickets being obtainable by post from the congress secretariat). The membership fee for the congress is £6 10*s*. Further information can be obtained from the congress secretariat at the Department of Scientific and Industrial Research, Charles House, 5–11 Regent Street, London, S.W.1.

Announcements

Dr. R. F. Gordon, director of the Houghton Poultry Research Station, has been appointed adviser on poultry research to the Agricultural Research Council. The post of adviser is a part-time one, his function being to keep under review research in progress on poultry and to act as technical secretary to the Council's Committee on Poultry Research.

Mr. A. O Coinneáin, of the Department of Industry and Commerce, Republic of Ireland, has been appointed chairman of the Irish National Committee for Geodesy and Geophysics in succession to Mr. T. O Muireadhaigh.

Mr. Lennart Holm, of the Institute of Systematic Botany of the University of Upsala, has been awarded the 1956–57 Graduate Fellowship of the Mycological Society of America. Mr. Holm, a student of Dr. Nannfeldt, is studying the classification of the Ascoloculares. This is the first time the award has been made to a European student.

The National Physical Laboratory, Teddington, is holding an open day on May 25. Admission is by ticket only, and a limited number of invitations for the afternoon period 1.30–5.30 p.m. are available on application to the Director.

The second Symposium on Condensation Nuclei will be held in Basle and Locarno (Switzerland) during October 1–5, 1956. Those who wish to read papers should write before July 15 to Dr. M. Bider, Astronomisch–Meteorologische Anstalt der Universität, Binningen, Switzerland.

The British Society of Rheology is holding a symposium on "Rheological Research in the Textile Industry" during June 7–8 at the laboratories of the British Rayon Research Association, Manchester. Further information can be obtained from the Secretary, British Society of Rheology, 52 Tavistock Road, Edgware, Middlesex.

The eleventh symposium of the Society for Experimental Biology will be held in the University College of Wales, Aberystwyth, during September 10–14, the subject of the symposium being "The Biological Action of Growth Substances". Non-members of the Society may attend on payment of a registration fee of two guineas. Further information can be obtained from the honorary symposium secretary, Dr. J. F. Sutcliffe, 68 Half Moon Lane, London, S.E.24.

The twenty-first Cold Spring Harbor Symposium on Quantitative Biology will be held during June 4–12, the topic for discussion being "Genetic Mechanisms—Structure and Function". Genetic mechanisms will be considered on the chemical, genic, chromosomal, cellular and developmental levels. The Symposium is open to all on application to the Biological Laboratory, Cold Spring Harbor, New York, whence the full programme and further information can be obtained.

The German Geophysical Association and the German Meteorological Association will be holding a joint meeting in Hamburg during September 25–29. A number of topics of mutual interest will be discussed, and papers are invited (which, together with a summary, should be submitted before June 15). Further information can be obtained from the Deutsche Geophysikalische Gesellschaft, Rothenbaumchaussee 80, Hamburg 13, or the Meteorologische Gesellschaft in Hamburg, Bernhard-Nocht-Strasse 76, Hamburg 4.

A conference on "Heat Treatment Practice", organized by the Metallurgy (General) Division of the British Iron and Steel Research Association, will be held at Ashorne Hill, near Leamington Spa, during June 5–6. There will be three sessions on the following topics: distortion and cracking problems; heating for forging and treatment; and transformations. Application forms and further information can be obtained from the organizer and secretary, Mr. J. R. Powell, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

The title of the quarterly bulletin *Terminological and General Language Review* has been changed to *Reading and Listening Linguistically*, and although the bulletin remains essentially the same in its purpose, namely, the application of the linguistic approach when reading an article so as to pick out the essential features, greater emphasis will be given in the future to the needs of non-academic readers. The bulletin is produced by W. R. Dunlop, 57 Gordon Square, London, W.C.1, from whom further information can be obtained.

The American Physiological Society has given permission to the Johnson Reprint Corporation (125 East 23 Street, New York 10) to reproduce, by the photo-offset process, certain volumes of *Physiological Reviews* and the *American Journal of Physiology*, which are no longer available. The first sets of reprints (*Physiol. Rev.*, 19–29; 1939–49) are expected to be ready before the end of the year at approximately 15 dollars per paper-bound volume. Later, the Corporation hopes to reproduce the following: *Physiol. Rev.*, 31 (1951) and 34 (1954); *Amer. J. Physiol.*, 1–103 (1898–1933) and 114–116, 118–132, 140–145, 147, 152–159 (1935–49).

The Mond Nickel Fellowships Committee is offering up to five travelling fellowships, open to persons of British nationality with degree or similar qualifications, not necessarily in metallurgy, so that they can obtain additional training and experience in industrial establishments at home or abroad (in special circumstances, at a university) in order to make them more suitable for employment in technical and administrative positions in British metallurgical industries. The fellowships will be for one year and will be worth £900–1,200. The awards are seldom made to persons more than thirty-five years of age. Application forms, to be completed by June 1, and further information can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

DIET AND ANÆMIA

THE hundredth meeting of the Nutrition Society, held at the Medical College, London Hospital, on March 10, took the form of a symposium on "Diet and Anæmia", which some 118 members and guests attended. The chair was taken by Sir Stanley Davidson, who in a brief introduction referred to the improvement in the clinical picture which has been effected by better medical education and treatment based on much research, culminating in the discovery of vitamin B_{12}.

The morning session was devoted mainly to the causes of anæmia. The first paper, by Dr. G. R. Wadsworth and Prof. B. S. Platt (London School of Hygiene and Tropical Medicine), was entitled "Zymotic and Other Factors in the Development of Anæmia" and dealt especially with factors affecting the protein economy in its relation to the development of anæmia. About 6 gm. of globin from hæmoglobin is recycled daily, or about a tenth of the estimated total daily protein requirement. If the breakdown products of globin are not returned to the metabolic pool, anæmia may develop if there is deficient protein intake or lack of specific hæmatinic substances such as vitamin B_{12} or folic acid. However, the formation of hæmoglobin takes precedence over that of all other body proteins, even of serum protein; hence deficiency of hæmoglobin may not become evident for a long time, and then will be more readily detected by a fall in the total amount of hæmoglobin in the body rather than by a fall in hæmoglobin concentration in the blood, according to recent findings by Hallgren. Feeding experiments with glycine labelled with nitrogen-15 or with carbon-14 support the view that hæmoglobin may be partly derived from stroma protein and may be synthesized, while the maturing red cell is in circulation, from substances derived from the plasma. Severe anæmia may develop in infections (for example, meningitis) when iron therapy may be of value, in infestations (for example, malaria, hookworm) and following severe burns.

The second paper, by Prof. A. W. Woodruff (London School of Hygiene and Tropical Medicine), dealt with anæmia due to malnutrition in the tropics and mentioned the high maternal mortality-rates in Indian cities. Some nutritional megaloblastic anæmias may be due to deficiency of the Wills factor, which may be distinct from folic acid and vitamin B_{12}. Anæmia due to protein malnutrition may be macronormoblastic, with fibrosis of liver and fatty infiltration, the erythrocytes often being broader and thinner than normal. In the tropics, this type of anæmia can be more serious than megaloblastic and other nutritional anæmias.

The third paper, by Dr. P. B. B. Gatenby, of the Rotunda Hospital, Dublin, dealt with anæmia of pregnancy, which has been investigated there since the beginning of 1953. A special study in 1953 of four hundred cases of severe iron-deficiency anæmia (hæmoglobin less than 9 gm. per 100 ml.) showed half of them to have seldom or never eaten meat or other animal food such as eggs. Iron therapy corrects the anæmia and often prevents relapse to the iron-deficient state before the next pregnancy. In the absence of iron therapy, the incidence of the anæmia increases with the number of pregnancies and with the lowered dietary intakes of iron and vitamin C. In twenty-eight cases of megaloblastic anæmia in which a particular note was taken of the diet, twelve were eating very little meat or eggs, and another eight lacked protein foods, while the remaining eight had an apparently normal diet. Almost all the cases of iron-deficiency anæmia respond to folic acid and some to massive doses of vitamin B_{12}.

In the subsequent discussion, Dr. Lucy Wills expressed the opinion that macronormoblastic anæmia of pregnancy such as was encountered by Prof. Woodruff in Nigeria is an intermediate stage, developing later into megaloblastic anæmia. Prof. Woodruff in his reply suggested that this state of affairs may be due to a deficiency of vitamin B_{12} or of folic acid combined with a protein deficiency.

In the afternoon session, Dr. G. H. Spray (Nuffield Department of Clinical Medicine, Oxford) read a paper on "The Role of Pteroyl Glutamic Acid and Related Compounds in Macrocytic Anæmia". The history of the problem since Wills's work in 1931 was first briefly reviewed. The limited effectiveness of yeast extracts such as 'Marmite' in the treatment of pernicious anæmia may be due to their content of folic acid, although the possible existence of an unidentified 'Wills factor' is not yet entirely ruled out. A normal serum vitamin B_{12} in megaloblastic anæmia is generally taken to indicate a deficiency of folic acid, for which there is no simple test yet available. A hæmopoietic response to folic acid is usually assumed to indicate a disturbance in the metabolism of this factor, which may be due to dietary deficiency (for example, nutritional macrocytic anæmia in India and Africa), defective absorption (in tropical sprue and idiopathic steatorrhœa) or excessive demands, as in pernicious anæmia of pregnancy. In India, Africa and the southern United States, nutritional macrocytic anæmia occurs which is associated with low intakes of fresh fruit and green vegetables and is corrected by oral administration of folic acid. If there is also a very low intake of animal protein, vitamin B_{12} deficiency may be encountered. Anæmia in cases of epilepsy may be due to the use of phenytoin, a possible antagonist to folic acid.

Vilter and his colleagues suggest that folic acid and vitamin B_{12} take part in reactions leading to the synthesis of the nucleoproteins of blood cells from simple precursors. In the absence of vitamin B_{12} there is an excessive demand for folic acid, which keeps the reactions going by 'mass action', and it may eventually become deficient. Large doses of folic acid increase blood formation, using up the remaining small stores of vitamin B_{12} and causing exacerbation of the nervous degeneration. In patients with pernicious anæmia, there may be eventually hæmatological relapse. This useful working hypothesis does not explain completely the role of folic acid in blood formation, its utilization from the diet, its storage and excretion, and the question as to the utilization of folic acid synthesized by intestinal bacteria still remains unanswered.

The second paper in the afternoon session was by Dr. J. R. Evans (Nuffield Department of Clinical Medicine, Oxford) and dealt with the absorption of vitamin B_{12} in the megaloblastic anæmias. Vitamin B_{12} labelled with cobalt-60 was used, and the radioactivity of the fæces was measured after an oral dose of 0·5 μgm., the assumption being made that all radioactivity not recovered in the fæces had been absorbed. In forty-four observations on thirty-five control subjects, the radioactivity in the fæces ranged from 9 to 47 per cent and averaged 27·3 ± 1·6 per ent of that present in the oral dose. In twenty-four pernicious anæmia patients, the corresponding verage percentage was 92·3 ± 1·3. When these patients were given intrinsic factor, most of the esults were within the limits observed in normal subjects. Achylia and atrophy of the gastric mucosa upported these findings in each of nineteen of the atients who were studied. Sterilization of the bowel with chlortetracycline did not increase the uptake of abelled vitamin B_{12} in a patient with untreated ernicious anæmia. Studies on megaloblastic anæmia ollowing gastric surgery showed that, after total astrectomy, little or no labelled vitamin B_{12} is bsorbed unless intrinsic factor is given with it. In ve patients with partial gastrectomy, failure of bsorption was corrected by intrinsic factor, while in nother nine patients in whom no megaloblastic næmia developed after removal of the distal half of he stomach, there was no permanent impairment of itamin B_{12} absorption. In seven patients with liopathic steatorrhœa and megaloblastic anæmia, bsorption was normal in one young patient, slightly npaired in another and negligible in the remaining ve. Intrinsic factor seldom caused improvement, ven when given in very large doses. In another four atients with idiopathic steatorrhœa, but no megaloblastic anæmia, absorption was normal in three, nd only slightly reduced in the fourth. Absorption as unaffected in megaloblastic anæmia of pregnancy r the puerperium and in megaloblastic anæmia ssociated with epilepsy.

The final paper, by Dr. F. Wokes (Ovaltine esearch Laboratories, King's Langley), described næmia associated with dietary deficiency of vitamin $_{12}$ encountered in a group of about a hundred and fty persons termed 'vegans' who consume no animal od whatever. There was no megaloblastic or acrocytic anæmia, but in rather less than half the ıbjects there were low serum B_{12} levels (less than 0 μμgm./ml.) accompanied by neurological manistations ranging from slight paræsthesia to subacute mbined degeneration of the cord. The wide riation in response was probably not due to riations in dietary intake of the vitamin, which as not found in significant amounts in the foods nsumed by the 'vegans'. It was thought to be ore likely to be caused by differences in the degree intestinal synthesis of the vitamin.

Study of the 'vegan' diet showed its vitamin ntent to be satisfactory, apart from B_{12} and ssibly also D. The average protein intake was ther low (9–11 per cent on the calorie basis), and e large amounts of pulses consumed tended to lead a deficiency of methionine, which would be gravated by the deficiency of vitamin B_{12}. This, gether with the unusually high intakes of folic acid m green vegetables, may have been responsible the neurological manifestations.

The part played by vitamin B_{12} in the *de novo* nthesis of labile methyl groups to convert homosteine to methionine, and also in the reduction of sulphide to sulphydryl groups, has led to a study 'vegans' and non-'vegans' of the metabolism of iocyanate, the sulphur-containing detoxification oduct of cyanide, in the metabolism of which amin B_{12} in the form of hydroxo- or aquocobalmin appears to be implicated. A sulphur transfer cycle was described for synthesis of essential sulphur-containing metabolites which might include the methionine deficient in 'vegan' diets. Lack of vitamin B_{12} might also, by inhibition of a sulphydryl system, lead to abnormal metabolism of tryptophan and tyrosine, with accumulation of toxic products, which might be responsible for the neurological manifestations.

In the subsequent discussion, Dr. C. C. Ungley described scotomata occurring in one of the 'vegans', which were cured by prolonged administration of vitamin B_{12}.

VEGETABLE TANNINS

SYMPOSIUM IN CAMBRIDGE

THE Society of Leather Trades' Chemists held a symposium on "Vegetable Tannins" during April 12–13 in the Chemistry Department, University of Cambridge, at which more than a hundred members and guests participated.

After the symposium had been opened by the president of the Society, Dr. R. G. Mitton (British Leather Manufacturers' Research Association), the chairman, Prof. R. D. Haworth (Chemistry Department, University of Sheffield), briefly referred to Emil Fischer's outstanding contribution to the chemistry of the gallotannins and mentioned how the early optimistic attempts of the 1920's to bring order to the untidy field of tannin chemistry was not realized. The reason for this is that those physical methods, which are now used for the isolation of single substances, were unknown. As a result of recent work, much of which, said Prof. Haworth, has been carried out by those present at the symposium, order and interest have been restored. Considerable academic and technical research is now in progress, and we have learned much concerning the units from which the complex tannins are composed.

In an introductory paper, on the scope of vegetable tannin chemistry, Dr T. White (Forestal Central Laboratories) treated historically the chemistry of the tannin and related polyphenol constituents of the principal vegetable tannin extracts. He dealt with the previously proposed classification of tannin extracts, defined a tannin (as opposed to a polyphenol) and directed attention to tannin action. New work on the degradation of the major constituent of commercial gallotannin was outlined. The preliminary results can be interpreted in terms of a trisaccharide formula which is reminiscent of the tetrasaccharide formula proposed this year for sumach gallotannin by Grassmann and co-workers. Dr. White stressed that the condensed tannins cannot now be considered as a single class of compound. His paper included a review of the physical chemistry of gross tannin extracts, and a provocative account of the physiological function of tannins in the intact plant, notably as inactivating agents for vector-transmitted virus proteins.

Mr. H. G. C. King (also of the Forestal Central Laboratories) and Dr. White then gave a paper on quantitative determination of specific nuclei and components of vegetable tannin extracts. In the same way that paper chromatograms may be used for the separation of tannin constituents, they may also form the basis for the estimation of these substances, when used in conjunction with specific reagents and reflectance spectrophotometry. Examples of catechol, monosaccharide, phloroglucinol, pyrogallol and resorcinol estimations were included.

In a paper on gallotannins and ellagitannins, Prof. D. Burton and Dr. H. E. Nursten (University of Leeds) outlined the work of the Leather Industries Department at Leeds under the successive administration of Profs. Atkin and Burton, both of whom had applied electrometric titration methods to gross tannin extracts and their dialysates, plant acids and their salts being found in the dialysate. By means of cation-exchangers, the salt content was estimated before and after dialysis. Application of these methods to the types of extract under consideration has afforded analyses of use to the industry.

Prof. O. Th. Schmidt (Chemical Institute of the University of Heidelberg) then gave a paper on the constitution of chebulinic acid. A Diels–Alder adduct of dimethyl fumarate and 1-acetoxybutadiene was formed, and the configuration of the separate racemates was unambiguously determined. Treatment of the *trans-trans*-tetrahydrophthalic acid dimethyl ester with ozone and hydrogen peroxide successively gave a cleavage product, the antipodes of which were resolved with brucine. One antipode was identical with the butanol tetracarboxylic acid lactone, derived from chebulic acid. Hence, both these substances have the racemoido-racemoido-configuration. Addition of the elements of water to chebulinic acid gave *neo*chebulinic acid, which afforded chebulic acid and a trigalloylglucose on hydrolysis. The latter proved to be identical with 1β : 3 : 6-trigalloyl-D-glucose, which was synthesized from triacetyl-L-glucosan. Application of the new results suggests a constitutional formula for chebulinic acid.

In his exploratory study of the polyphenols and polyphenolase of tobacco, Mr. W. W. Reid (Research Department, Carreras, Ltd.) fractionated tobacco extracts by lead acetate precipitation and solvent extraction. These fractions were further subdivided as band chromatograms on thick paper, and homogeneous fractions were estimated by modern scanning techniques. Cellulose columns were also employed, and the enzymic oxidation of the resulting polyphenols by tobacco polyphenolase was studied.

In a contribution on paper chromatography as an aid to the elucidation of the structure of polyphenols occurring in tea, Dr. E. A. H. Roberts (Indian Tea Association Chemical Laboratory) exemplified the technique by the separation of (+)- and (−)-catechin and of *cis*- and *trans*-cinnamic acids. Accordingly, (+)-catechin, (−)-*epi*catechin, (+)-gallocatechin, (−)-*epi*gallocatechin, and *cis*- and *trans*-chlorogenic and *neo*chlorogenic acids were identified, theogallin was shown to be a galloyl ester of quinic acid, and chromatographic evidence for the occurrence of both *p*-coumarylquinic acids and myricetin glycosides was advanced. The possibility of the production of benztropolones in tea fermentation was tentatively considered.

Dr. D. E. Hathway (British Leather Manufacturers' Research Association), in a communication on some approaches to aromatic biosynthesis leading to polyphenols and tannins, described the separation and identification of ellagic acid in plant extracts, and the separation of a plant acid fraction from myrobalans by means of ion-exchange chromatography. Related *cyclo*hexanecarboxylic acids were identified by paper chromatography, and they were separated by extended ion-exchange methods. The chromatogram of the polyphenols and tannins of myrobalan was elucidated. On account of Davis's microbia studies, and the presence of *cyclo*hexanecarboxyli acids concomitant with simple polyphenols an tannins in myrobalans, Hathway suggested that the may also be precursors of aromatic amino-acid polyphenols and tannins in the plant. The occurrenc of *cyclo*hexanecarboxylic acids in other plants wa mentioned, and the question of the ubiquity shikimic acid was raised. The use of radioactiv tracers in lignin biosynthesis was cited, and th emergence of C_7—C_9 plant compounds, includin gallic acid, from the *cyclo*hexanecarboxylic aci sequence was discussed.

On the second day the conference was continue under the chairmanship of Dr. F. E. King (Researc Department, British Celanese, Ltd.). In their revie of the leuco-anthocyanins, Drs. T. Swain and E. Bate-Smith (Low Temperature Research Statio Cambridge) have divided these substances into category requiring oxygen for the transformatio into anthocyanidin, and a category which does n require it. Little is known of the chemical structure many of these substances. King and Bottomley (195 isolated a leuco-anthocyanin, however, which the proved had a flavan-3 : 4-diol structure (7 : 8 : 3′ : 4 tetrahydroxyflavan-3 : 4-diol), the tetramethyl eth of which was afterwards synthesized by King an Clark-Lewis. Meanwhile, Swain had synthesized t 5 : 7 : 3′ : 4′-isomer by hydride reduction of taxifoli This new leuco-anthocyanin does not occur in Natur it being different from that in apple and cacao. Tw decades earlier, Robinson and co-workers provid considerable evidence for the structure of cyan maclurin and peltogynol, neither of which belongs the flavan-3 : 4-diol type. Leuco-anthocyanins a sometimes mobile on paper chromatograms, and th is a behaviour consistent with comparatively simp structures. A stationary class may be due chemically unidentified polymers.

Mr. W. E. Hillis (Division of Forest Produc Commonwealth Scientific and Industrial Resear Organization, Australia), in a communication leuco-anthocyanins as the possible precursors tannins, showed that the leuco-anthocyanin conte of vegetable tannin materials follows the intensity red colour imparted to leather. In regions of acti growth, such as the leaf tips and cambium duri spring, there is a relatively high accumulation leuco-anthocyanins. Mr. Hillis presented eviden that in eucalypts these substances originate in t leaves and move down the phloem across the ca bium into the wood. Leuco-anthocyanins may transformed into 'tannins' at the sapwood–heartwo boundary.

Dr. W. Mayer (Chemical Institute of the Univers of Heidelberg), in a paper on catechins from the ba of oak and sweet chestnut, described the isolation (+)-catechin and (+)-gallocatechin from these pla tissues. (+)-Gallocatechin proved identical w Oshima's casuarin. Reduction of the pentamet ether with sodium and alcohol invoked desmethox ation, and the resulting diphenylpropane was a obtained from pentamethyl (−)-*epi*gallocatechin a was synthesized via the chalcone. The simi desmethoxylation of O-trimethylpyrogallol w encountered by Kostanecki.

In a communication on the occurrence and pr erties of dihydroflavonols (4-oxocatechins), Dr. J. Gowan, Mrs. E. M. Philbin and Prof. T. S. Whee (Chemistry Department, University College, Dubl reviewed the occurrence of the eight dihydroflavonols in the plant kingdom: dihydro-kæmpferol and -myricetin occur most frequently. Dihydroflavonols have been synthesized by six methods: oxidation of 2′-hydroxychalcones and flavanones; bromination of flavanone, followed by nucleophilic replacement of halogen; ring-closure of 2′-hydroxy-α-methoxychalcones; treatment of 2′-acetoxychalcone dibromides with silver acetate or alkali; dithionite reduction of flavonols; and reaction of aromatic aldehydes with 2-hydroxyphenacyl chlorides. Under the influence of alkali, dihydroflavonol disproportionates into the flavonol and flavanone, or affords the corresponding 2-benzyl-2-hydroxycoumarân-3-one.

Dr. W. B. Whalley (Organic Chemistry Department, University of Liverpool), discussing the stereochemistry of the chromans and related compounds, dealt with a stimulating application of conformational analysis. In common with King, Dr. Whalley agrees with the assignment to catechin and *epi*catechin of *trans*- and *cis*-structures, respectively, but he produced evidence in favour of fresh conformations with 3(*a*)-hydroxyl groups for both substances. Conformational analysis has been extended to the 3-hydroxyflavanones, 2-hydroxy*iso*flavanones and flavan-3 : 4-diols, and it is evident that Dr. Whalley will elucidate the conformation of the complicated O-ring heterocyclics by application of stereo-specific reactions.

The Society will publish the symposium lectures and discussions in book form, and this should interest all those whose work brings them into contact with polyphenols, tannins and vegetable tannin materials.

D. E. Hathway

EAST AFRICAN INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR 1954–55

The East African Industrial Research Organization, which incorporates the East African Industrial Research Board, came into existence on April 1, 1955, and its first annual report* is a progress report covering the period January 1, 1954–June 30, 1955. The new Organization absorbs the staff of the previous Board, and provision is made for a 60 per cent increase during the next two years. The British Government is contributing, from Colonial Development and Welfare Funds, 75 per cent of the apital expenditure for offices and laboratories and housing, and half the recurrent expenditure during the next two years. The Organization will be responsible to a board, on which the East African Government and the East African High Commission are represented.

The present report summarizes the work in the production of hecogenin from sisal waste, the plant or which has operated successfully since it was fficially opened in June 1954. A preliminary report as been issued on the investigation of coffee processing which indicates that there are three stages in rying fermented coffee and that it is desirable to ry-wash the fermented coffee initially as quickly as possible, without using too high a temperature. When the coffee is dry enough to be safe from eterioration, the remaining process may be a slower removal of moisture in a conditioning bin. Work with dual-fuel engines, using oil and indigenous wood, has shown that producer gas can replace diesel oil in a diesel engine and is utilized as efficiently thermally as the oil. Satisfactory ignition of the gas–air mixture can be achieved with a low proportion of the full-load consumption of oil; at least 70 per cent of the full-load rating of a coupled diesel engine and alternator can be carried on gas, while the governor retains full control of speed, and existing engines can be modified economically on the site.

Chemical engineering research has been concerned with the utilization of natural steam, the production of salt and lime burning; in ceramics a refractory grog has been produced by calcining fine kyanite, bonded into pellets with molasses in a rotary kiln, and also a porous grog by grinding raw kyanite with charcoal, pelleting with molasses and calcining in the laboratory at 1650° C. Other work has been concerned with the production of phosphatic fertilizers and the pelletizing of cetyl alcohol for use in retarding the evaporation of water from dams. For this latter purpose, following work by A. F. C. Cole, who died during the period, apparatus has been devised by which an output of 20 lb. a day has been achieved. The apparatus is described and illustrated in the report.

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* East African High Commission. East African Industrial Research rganization: Annual Report 1954–55. Pp ii+17. (Nairobi: East frican Industrial Research Organization, 1955.)

CURRENTS THROUGH THE STRAITS OF DOVER

Nearly a hundred and twenty-five years ago Faraday predicted that electrical potential differences would be set up in sea water, a conducting fluid, by its motion in the Earth's magnetic field. His predictions were verified by measurement of voltages induced on submarine cables. During recent years, oceanographers have begun to use measurements of the voltage differences in sea water as a useful method of studying water transport. In a recent paper (*Phil. Trans. Roy. Soc.*, A, **248**, 953; 1956) K. F. Bowden has demonstrated the value of the method in his study of the flow through the Straits of Dover. He has taken as his raw material fifteen months of continuous observations of the voltage fluctuations induced on a cable crossing the Straits of Dover, together with four months of similar observations on a cable crossing the southwestern portion of the North Sea. Regular voltage fluctuations, about one volt in amplitude, produced by the tidal currents are a dominant feature of his records. These fluctuations, while serving a useful purpose for calibrating the voltage in terms of the mean flow through the Straits, have to be eliminated to study the more interesting residual currents. The calibration, which depends on the conductivity of the sea bed as well as the sea water, is done empirically. Shorter-period fluctuations produced by magnetic disturbances are eliminated by filters in the measuring equipment and by smoothing of the graphical records.

Prof. Bowden shows that the residual currents, which sometimes run with speeds as high as one and a half knots in either direction, are highly correlated with the local winds and the slope of the sea surface along the Straits. The correlation is also high with the wind system over the southern part of the North Sea and the English Channel, indicating that the surface slope along the Straits is largely a consequence of the regional wind system, though influenced as well by other factors. Prof. Bowden's measurements enabled him to make estimates of the coefficients of wind stress and of bottom friction. These estimates, though somewhat high, agree in magnitude with other independent estimates and strengthen the probability that further development of the dynamics of the air–sea interactions can be made through similar studies. Such studies are at present being made of the Gulf Stream through the Florida Straits and of currents in the Cook Straits of New Zealand, and others are being planned.

Prof. Bowden was perhaps fortunate in studying a region that has been extensively surveyed in the past and he had access to detailed meteorological and tidal information in carrying out his analysis. The method he has employed has emerged as a powerful supplement to the usual techniques of oceanographic survey and is, at present, the only practical way in which large-scale currents can be continuously monitored. N. P. FOFONOFF

AMPHITHALLISM IN FUNGI

By M. EILEEN KENNEDY and PROF. J. H. BURNETT

University of St. Andrews

IT has generally been found that the mating systems of fungi are very constant features and that if, for example, a species is heterothallic, it regularly produces spores which are homocaryotic in respect of mating type. However, exceptional fungi are known which produce spores both homocaryotic and heterocaryotic for mating-type factors on the same fruit body. Lange[1] introduced the term 'amphithallism' to describe this condition in species of *Coprinus*.

Recently we have investigated an amphithallic condition in some strains of bipolar gasteromycetes of the *Nidularia denudata* 'complex', and it is now evident that confusion has arisen in the application of Lange's term. This is because, first, different mechanisms give rise to the condition and, secondly, because the term has been applied to quite different phenomena.

At least four mechanisms are known which can result in the production of spores both homocaryotic and heterocaryotic for mating-type by a single fruit body, namely:

(1) In certain Basidiomycetes with four-spored basidia, an additional mitosis after meiosis results in the occurrence of eight-nucleate basidia. Two nuclei migrate into each basidiospore and they may carry the same or different mating-type factors, that is, the basidiospores will be homocaryotic or heterocaryotic for mating type, respectively. Unequivocal cytological and breeding evidence for this situation has been obtained in strains of *Nidularia denudata* by one of us (M. E. K.), details of which will be published elsewhere. Circumstantial evidence for a similar mechanism is available in *Omphalia flavida*[2], *Coprinus plagioporus* and *C. subpurpureus*[1].

(2) In certain Basidiomycetes with two-spored basidia, meiosis occurs in the basidium and two nuclei migrate into each basidiospore. Single basidiospore isolates usually germinate to give a mycelium bearing clamp-connexions. Exceptions have been recorded in *Coprinus sassii* (= *C. ephemerus* f. *bisporus*)[1,3], *Galera tenera* f. *bispora*[3], *Aleurodiscus canadensis*[4] and *Mycena rubromarginata*[5]. In these fungi some single-spore isolates failed to form clamp connexions, and appropriate matings demonstrated that such isolates, of the same species, carried complementary mating-type factors, that is, the basidiospores from which these isolates originated were homocaryotic for mating-type factors. Recently, Terra[6] has demonstrated that this interpretation is correct in *Stropharia umbonatescens* and has also demonstrated, by mechanical separation, the heterocaryotic nature in respect of mating type of the rest of the basidiospore isolates. It is not known at present why basidiospores of such fungi are normally heterocaryotic in this respect, although an association between nuclei of complementary mating type during migration into the spore has been suggested[3].

Basidiomycetes have been described which, in addition to two- and four-spored basidia, possess a variable but usually small number of basidia which bear three, five or more spores. It has been suggested[7,8] that unequal distribution of the four nuclei derived from meiosis to these basidiospores would result in spores homo- and hetero-caryotic in respect of mating type. No acceptable experimental evidence has been presented, as yet, in support of this claim.

(3) Most Ascomycetes regularly produce eight, initially uninucleate, ascospores; but occasionally some of them are replaced by 'giant' binucleate spores, some of which may be heterocaryotic for mating-type factors, for example, *Neurospora crassa*[9]. In other Ascomycetes four, initially binucleate, spores, each heterocaryotic for mating type, are formed regularly in each ascus. But in these fungi uninucleate ascospores, which are necessarily homocaryotic for mating-type, are formed exceptionally with variable frequencies, for example, in *Neurospora tetrasperma*[10], *Podospora anserina*[11]. The mechanism common to both these exceptional conditions is the irregular delimitation of the cytoplasm at spore formation, but the causes of such irregularities have not been fully investigated. A similar kind of irregularity is presumably responsible for the occasional heterocaryotic meiospores produced by the Phycomycete, *Phycomyces blakesleeanus*[12].

(4) Heterocaryosis for mating-type factors in the ascospores of the four-spored Ascomycetes such as *N. tetrasperma* is a consequence, not only of the mode of spore delimitation, but also of the orientation o the spindles during nuclear divisions in the ascus and the time of segregation of the mating-type factors during meiosis[13]. However, the occurrence of asc with initially binucleate ascospores, which are homocaryotic for mating type, has been reported[14,15]. In *N. tetrasperma* it has been suggested[16] that this may come about as a result of irregularities in spindle orientation; but a different mechanism, the intervention of crossing-over between the mating-typ locus and the centromere, which alters the spatial segregation pattern of the mating-type factors in the ascus, has been described[15] for *P. anserina*. Completely acceptable cytological and genetical evidenc for these hypotheses is not available.

Amphithallism can be applied to the results of th four types of behaviour described, since they all lead to the production of spores, homocaryotic and heterocaryotic for mating type, by a single fru body. But amphithallism will affect the matin systems of different fungi in quite different ways For example, in an outbreeding form such as *Coprinus subpurpureus*, amphithallism restricts the degree o potential outbreeding, but in an inbreeding fungu such as *Neurospora tetrasperma* it will introduce a measure of potential outbreeding.

The other point to which we direct attention is the suggested application by Olive[17] of amphithallism to an altogether different mode of behaviour. He has shown that single-ascospore isolates of *Sordaria fimicola* will produce fertile perithecia in culture, but if such isolates are grown in pairs, fertile perithecia are formed preferentially in the zone of contact between them. He suggests that the definition of amphithallism be extended to include this condition, which he describes as the tendency in a homothallic organism towards heterothallism. Such usage seems to us to be a misapplication of the term. Olive's situation is reminiscent of that described as "relative heterothallism" in *Aspergillus nidulans*[18], and the mechanisms responsible for these phenomena are not yet understood. But the causes and consequences of these phenomena must be entirely different from those responsible for the amphithallic condition as described earlier. [Feb. 4

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EFFECT OF SOLUTE CONCENTRATION IN THE IRRADIATION OF AQUEOUS SOLUTIONS BY IONIZING RADIATIONS

By Drs. G. R. A. JOHNSON, G. SCHOLES and J. WEISS
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DURING recent years, considerable attention has been paid to the chemical action of ionizing radiations on aqueous solutions, largely due to the possible significance from a radiobiological point of view. Most of the work hitherto reported in the literature has been concerned with very dilute solutions; but it is clear that, with regard to the elucidation of the reaction mechanisms as well as to the biological aspects, the behaviour of more concentrated solutions and altogether a much wider range of concentrations should be considered.

For dilute aqueous solutions, it is generally accepted that the chemical action of ionizing radiations on the olute is an indirect one, that is, via the free radicals OH and H) produced from the water[1]. On this basis, the chemical yield should be independent of concentration of solute over a fairly wide range, provided that sufficient solute is present to utilize all the available radicals produced from the solvent. It has been usually supposed that this, in fact, holds in all cases. With organic solutes, however, no clear xperimental evidence has been presented to prove uch a generalization.

In the course of some recent work on the mechanism f the chemical action of X-rays on several organic ompounds in dilute aqueous solutions, detailed tudies have been made of the effects of concentration of solute on the yields of radiation products. It has een found that in none of the cases so far investiated does the yield actually become independent of the solute concentration up to concentrations of bout 1 *M*. Fig. 1 shows the dependence of the nitial yields of acetaldehyde from aqueous ethanol solutions[2] and of pyruvic acid from lactic acid olutions, as a function of solute concentration; radiations were carried out in the presence of dissolved oxygen, at room temperature. These experinents show that within the range 10^{-5}–$1\cdot0$ *M*, the ield of the product never becomes independent of the solute concentration. The relative increase in oxidation yield is greatest in the lower region, that is, up to 10^{-3} *M*. However, at higher concentrations the yield still continues to increase and, in these systems, can eventually attain values which are considerably greater than the maximum that could arise from the yield of hydroxyl radicals resulting from the decomposition of water by the radiation, normally supposed to correspond to $G \simeq 3\cdot0$–$3\cdot5$ (molecules/100 eV.). Over the concentration-range considered here, 'direct effects', that is, changes due to the absorption of the radiation energy by the solute, even at the highest concentration employed, cannot amount to more than about 10 per cent.

In several other reactions induced by radiation in aqueous systems, for example, the formation of

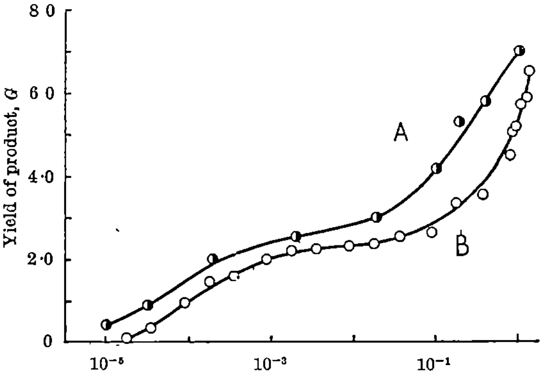

Fig. 1. Irradiation of aqueous solutions with X-rays (200 kV) in the presence of oxygen (1 atm.). pH = 1·2. Dose-rate = 2×10^{17} eV./ml./min. [$G(Fe^{3+}) = 15\cdot5$]
Dependence of the initial yields on the solute concentration. Curve *A*: pyruvic acid from lactic acid solutions; curve *B*: acetaldehyde from ethanol solutions

ammonia from α-alanine[3], of inorganic phosphate from the α- and β-glycerophosphates (Taylor, Scholes and Weiss, unpublished results) and from ethyl phosphate (Wheeler, Scholes and Weiss, unpublished results) and of acetaldehyde from ethylamine[2], it has been found that, over the range of solute concentrations studied, the yield of the product does not attain a constant value. All these experiments were carried out with X-rays (200 kV.) in the presence of dissolved oxygen. Some preliminary experiments, using cobalt-60 γ-rays, which have been carried out with the ethanol and lactic acid systems, have shown that the dependence of the yield on solute concentration is essentially similar to that observed with X-rays. Although in a given system the pH of the solution is sometimes a determining factor for the yield of the products, it does not, in general, appear to influence the overall dependence of yield on concentration.

A few cases have previously been reported in which the effects of solute concentration have been studied. It has been emphasized that there is a marked dependence on concentration of the yield of ammonia from glycine[4]; reference may also be made to the irradiation, with γ-rays, of solutions of formic acid[5] and of ethanol[6], where somewhat similar effects have been noted. It should be pointed out that in the early experiments of Fricke *et al.*[7], Kinsey[8], and Stenström and Lohmann[9], the yield of the product did not become independent of concentration over the range investigated.

Hydrogen peroxide is produced in all these solutions irradiated in the presence of oxygen, and the yield of this has been determined, in several systems, as a function of solute concentration. Some of the results obtained are recorded in Fig. 2. The rather striking fact emerges that the initial yield of hydrogen peroxide ($G(H_2O_2)$), in contrast to that of the organic product, is, in these cases, more or less independent of solute concentration over a relatively wide range; the value of $G(H_2O_2)$, however, varies according to the solute and must, therefore, be related to the mechanism of the oxidation processes involved. It is of some interest to note that in all the cases examined (cf. Fig. 2) the yield of hydrogen peroxide becomes practically independent of solute concentration when the latter exceeds about 10^{-3} M, that is, the concentration at which the rate of increase of the yield of the organic product changes markedly.

It is difficult to reconcile these observations with some of the simple views on the action of ionizing radiations in aqueous systems. The observed increase in the yield of organic product with increasing concentration of solute could possibly be explained, for example, by (*a*) reactions of the solute with hydrogen atoms when the concentration of the former is sufficiently high to compete with oxygen in the reaction $H + O_2 \rightarrow HO_2$; (*b*) electronic excitation of the solute molecules by the slow electrons produced by the ionizing radiations[10]; (*c*) further reactions of the solute with those active species (for example, free radicals) which may only become available at higher concentrations of solute. (It should be borne in mind that we have no independent knowledge of the extent of the primary decomposition of the water into free radicals, and there could be, in the more dilute solutions, an appreciable amount of recombination or deactivation of the active species.)

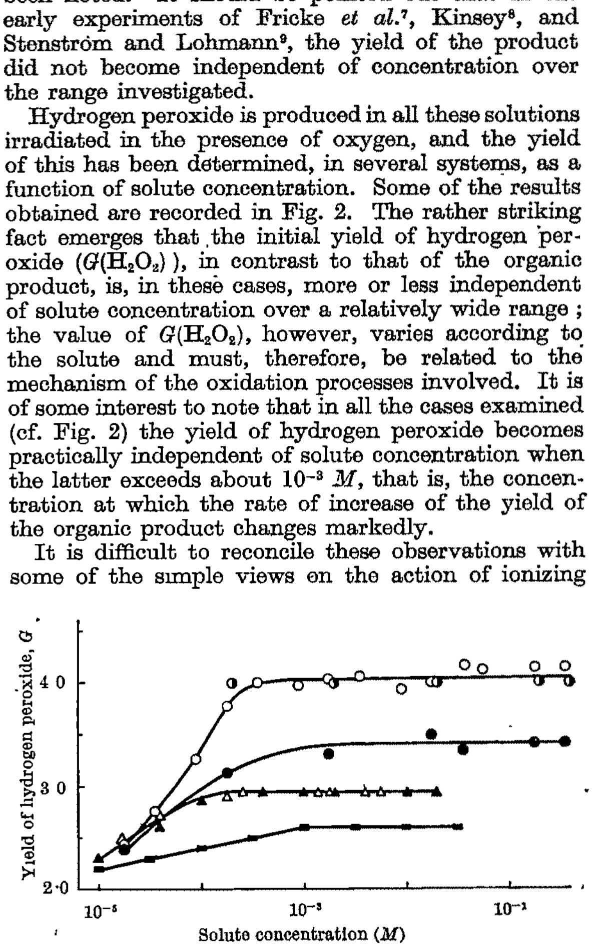

Fig. 2. Dependence of the initial yields of hydrogen peroxide on the solute concentration in different aqueous solutions irradiated with X-rays (200 kV.) in the presence of oxygen (1 atm.). Dose-rate = 2 × 10^{17} eV./ml /min. [$G(Fe^{3+})$ = 15 5]
○, Ethanol, pH = 1 2; ●, ethanol, pH = 5·5; ◑, lactic acid, pH = 1 2; ▲, α-glycerophosphate, pH = 1·2; △, β-glycerophosphate, pH = 1·2; ■, monoethyl phosphate, pH = 1·5

The dependence of the overall yield on the concentration of the solute ([c]) should be, in each of the cases discussed above, given to a first approximation, by an expression of the type:

$$\text{Yield} \simeq \frac{k_1 [c]}{k_2 + k_3 [c]}$$

where, in general, k_1, k_2, k_3 are functions of the various parameters such as the initial local concentration of the free radicals in the tracks of the ionizing particles, the concentration of molecular oxygen, etc.; the experimental results (cf. Fig. 1) do, in fact, appear to conform with such an expression. (It should be pointed out also that the nature of the yield-concentration plots does not support the occurrence of chain reactions in the systems under consideration.)

It is clear, from the above remarks, that in studies o the effects of ionizing radiations on organic compounds in aqueous systems, much more attention should be paid to the influence of concentration of solute , selection of any arbitrary concentration for the elucidation of the reaction mechanism may lead to erroneous conclusions. In particular, caution must be exercised in deriving values for the yields o primary radicals from the results obtained in any system at any one concentration of solute. Never theless, the study of aqueous systems of organic compounds, rather than of some simple inorganic systems, appears to be capable of yielding more complete information about the various primary processes following absorption of radiation, since i is possible that some important features may not b revealed in simple inorganic systems where the sam product is often formed via different routes.

Some of the experiments reported here were carrie out by Mrs. Freda Hope, to whom our thanks ar due. We wish to acknowledge, with thanks, th financial assistance of the North of England Counc of the British Empire Cancer Campaign and of th Rockefeller Foundation. [Feb. 27

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Azulene

Previous work on the crystal structure of azulene[1] was shown that the apparent space group is $P2_1/a$ C^5_{2h}) with two molecules in the unit cell. This implies centrosymmetric molecule, which is in conflict with he chemical evidence. The two most likely explanaons of this discrepancy are : (*a*) that the implied centre of symmetry is only statistically true, and is ue to rotating molecules or a disordered structure ; or (*b*) that the absent spectra leading to the deduction of the space group $P2_1/a$ are accidental, and that the rue space group is really of lower symmetry. Günthard[2] has discussed these possibilities, and in ecent work[3] has shown that a comparison of the ntropies of azulene and naphthalene (which has milar lattice dimensions) appears to confirm the resence of some disorder in the azulene crystal.

We have now made a further examination of the crystal structure of azulene and have obtained the ell dimensions $a = 7{\cdot}91 \pm 0{\cdot}02$, $b = 6{\cdot}00 \pm 0{\cdot}02$, $= 7{\cdot}84 \pm 0{\cdot}02$ A., $\beta = 101°\ 30'$. This unit cell contains two molecules of $C_{10}H_8$ and the ($h0l$) eflexions are absent when h is odd. We have looked or the ($0k0$) spectra carefully up to the seventh order, iving long exposures on oscillation photographs, but have only been able to find (020) with F about 15·5 and (060) with F about 1·7. What appeared to be a peak (010) was observed with copper radiation, but his is probably spurious and could not be repeated with iron radiation.

So far our work is in good agreement with previous esults and suggests the space group $P2_1/a$, although only two ($0k0$) reflexions can be recorded. To obtain urther evidence we have applied the statistical tests of Wilson[4] and Howells[5] to the ($h0l$) spectra, and he results indicate quite strongly that the projection of the structure on (010) is non-centroymmetrical. If this conclusion is accepted, it means hat the ($0k0$) absences are accidental and that the pace group is probably Pa (C^2_s) with two asymmetric molecules in the unit cell.

Proceeding on this assumption, a trial structure based on the chemical formula was postulated and efined by the method of difference syntheses. Good greements were soon obtained for all the ($h0l$) pectra, and an electron-density projection of the tructure on (010) is shown in Fig. 1 At this stage he average discrepancy between observed and calulated structure factors in the ($h0l$) zone is 11 per cent. The other zones also give substantial agreements and are being further refined.

The positions of the molecules in the unit cell are milar to those of the naphthalene structure[6], lthough the azulene molecules have a rather different rientation. Their position with respect to the glide plane is such as to create an almost exact halving of the ($0k0$) spectra ; but this halving is, of course, ccidental in the sense that it is not necessarily mposed by the symmetry elements of the space roup. From Fig. 1 it is seen that the molecular lane is steeply inclined to (010), as in the corresponding naphthalene structure, and this prevents clear esolution of all the atoms. Nevertheless, the form of the molecule, consisting of a fused five- and seven-membered ring system, can be clearly seen. Although some disorder may be present in the structure, it does not seem to be enough to prevent a full determination of the molecular structure by the X-ray method.

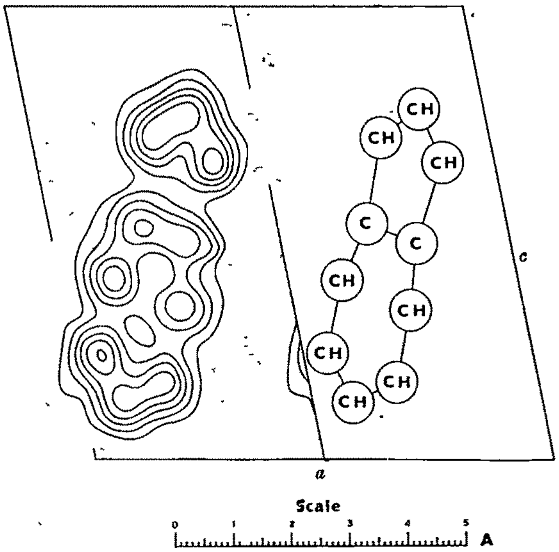

Fig. 1. Projection of the azulene structure on (010)

The peak values of the electron density are seen to vary in an interesting manner on the different atoms ; but neither these variations nor the variations of bond-length which can be obtained after allowing for the orientation are significant at the present stage of refinement. As the structure is non-centrosymmetric, it is expected that this refinement process will have to be carried quite far, probably with the use of full three-dimensional data, before really significant and chemically interesting results are obtained. This work is now proceeding.

We are indebted to Prof. Wilson Baker and to Dr. E. Clar for supplies of pure azulene.

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Radioactivity of Iron Meteorites by the Photographic Method

We wish to present the preliminary results of a study of the α-radioactivity of iron meteorites by the method of nuclear emulsions.

The important work of Paneth's group[1] on the helium ages of iron meteorites shows uranium and thorium contents of 0·1–1 × 10^{-8} gm./gm. Davis's radium determinations on seven iron meteorites gave uranium equivalents of the same order of magnitude[2].

The meaning of the helium ages has been discussed by Urey[3,4]. He states that on thermodynamical grounds[3,5] one would expect in the metallic phase of meteorites concentrations of uranium and thorium considerably lower than 10^{-9} gm./gm. On the other hand, Urey[3] and Singer[6] have suggested that radiogenic helium could be preferentially lost as a result of a localization of radioactive elements in the boundaries between crystals. In such an event, ages by the helium method would be too low.

Recently, Reed and Turkevitch[7] have used activation methods to determine the uranium content of two iron meteorites. Their results are lower than those of Paneth's group by at least one order of magnitude.

The nuclear emulsion method appears particularly appropriate for such measurements of very low radioactivity, especially when one deals with the localization of radioactive elements. In spite of the fact that definite conclusions cannot, as yet, be drawn, we think it worth while to give a progress report on our work on this problem, pointing out, in particular, the technical difficulties and the limitations of the method. A detailed account will be published elsewhere.

We have studied so far two iron meteorites: Toluca (Hamburg) and Carbo. Uranium and thorium contents have been determined by Dalton *et al.* on other samples of these octahedrites[8]. We have counted and localized two thousand α-particle tracks, on an area of 32 cm.^{2} of plates (Ilford *C*2, exposure time 140 days). Range-distribution analysis indicates that more than 85 per cent of the α-particles counted must result from surface contamination of the samples by polonium, in spite of many precautions to prevent it. However, this contamination corresponds to no more than 100 polonium atoms (10^{-16} curie) per sq. cm.

To reduce as much as possible the effect of the surface contamination in determining the uranium and thorium content, only tracks with a residual range in the emulsion of less than 15 microns were taken into account. This being the shortest range in the uranium and thorium families, tracks of less than 15 microns must have originated within the sample. Uranium and thorium contents, calculated in this way, are given in Table 1; it must be kept in mind that these are maximum values.

We have also determined a maximum value of 10^{-7} gm./gm. for the uranium and thorium concentration in the troilite phase of Toluca. We conclude that the uranium and thorium found by Paneth's group in Toluca (Hamburg) is not all localized in the troilite phase, since the resulting specific activity should have been easily detected under our experimental conditions. The relatively important degree of contamination has prevented us so far from deciding if the activity is concentrated in the inter-crystal boundaries.

Our upper limit of $0{\cdot}6 \times 10^{-8}$ gm. uranium/gm. agrees with the results of Paneth and co-workers, but, of course, does not contradict those of Reed and Turkevitch. We hope in further experiments to lower our level of contamination by a factor of ten, which should clearly throw our findings in favour of one or the other of these contradictory results, and further our knowledge on the distribution of radioacti
elements in meteorites.

We wish finally to point out that a lower limit
the uranium and thorium concentrations in Tolu
(Hamburg) can be obtained from its minimum rad
genic helium content[1], if we assume for it an a
of $4{\cdot}5 \times 10^9$ years[9] and if we suppose that
radiogenic helium was lost. This comes out a
$U > 1{\cdot}5 \times 10^{-11}$ gm./gm.; $Th > 2 \times 10^{-10}$ gm./g

Table 1. URANIUM AND THORIUM CONTENT (in 10^{-8} gm./gm.)

	Toluca (Hamburg)	Carbo
This work	$U < 0{\cdot}6$ $Th < 2$	$U < 0{\cdot}6$ $Th < 2$
Paneth's group results (ref. 1)	$0{\cdot}18 < U < 0{\cdot}22$ $2{\cdot}11 < Th < 2{\cdot}65$	$0{\cdot}54 < U < 0{\cdot}60$ $0{\cdot}49 < Th < 0{\cdot}87$

We are indebted to Prof. F. A. Paneth for supplyi
the sample of Carbo, and we wish to thank him a
Prof. H. C. Urey for stimulating discussions.
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Electric-breakdown Tracks in 'Perspex'

MASON[1] has shown that the short-time elect
strength of polythene and other solid insulati
materials may have an average value many times l
than the intrinsic breakdown stress, because of t
distortion of the field and the high local stress at t
ends of discharges. Still to be explained, howev
is the steepness of the breakdown voltage/ti
characteristic for 50 c./s. stresses of a few seco
duration.

In order to investigate this problem, polythe
'Perspex', and polystyrene specimens have b
broken down between needle-point electrodes in hi
quality transformer oil at room temperature, p
vision being made to short-circuit the breakdo
path in the specimen within a few micro-seconds
the breakdown. In this way, the nature of the bre
down channels may be observed in the absence
damage resulting from the passage of fault curr
(Fig. 1). A similarity, most pronounced in
'Perspex' specimens, has been noted between
nature of the breakdown propagation and that
the streamer breakdown of air.

A ciné-film has been made of a breakdown
'Perspex' sheet, ½ in. thick, disposed as shown
Fig. 2, at 50 kV. r.m.s., 50 c./s., and the last sect
of this film is reproduced in Fig. 3. Each fra
corresponds to successive third half-cycles, and
time taken for the breakdown to be propaga
through the specimen was about 15 sec. When
film is projected at two frames per second (⅛ of nor
speed) a step-by-step erosion from alternate poi
(probably as each becomes positive) may be seen

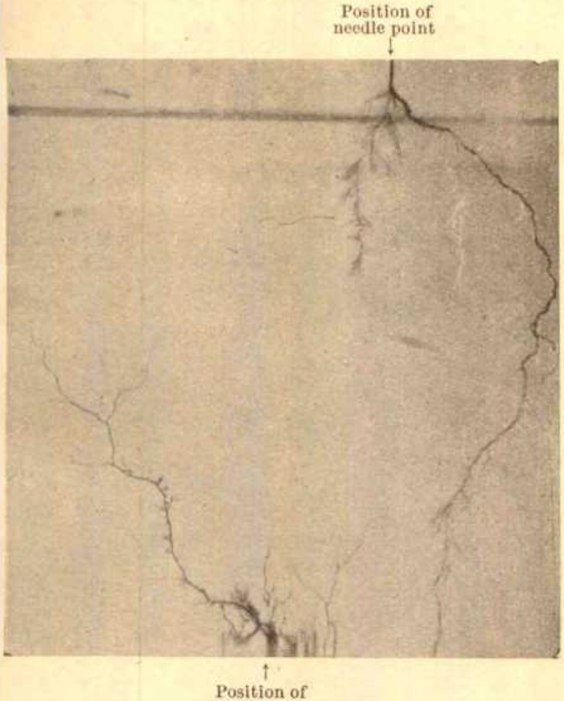

Fig. 1. Breakdown tracks in 'Perspex' undamaged by fault current

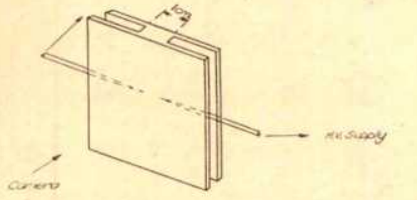

Fig. 2. Arrangement of specimen for ciné film of 50 c./s. breakdown in 'Perspex'

The evidence suggests that a possible mechanism f breakdown propagation from pointed electrodes that is, needles or the ends of discharge streamers) s the flow of free electrons towards the positive lectrode, permanent damage to the material occurring ear to the ends of the channels where the current lensity is sufficiently high. The electrons may be xcited from imperfection levels, possibly by radiation rom discharges. This suggested mechanism would ccount for the random nature of many of the channels nd for the fact that channels from opposite electrodes ollow separate paths.

The breakdown mechanism described is observed o be a step-by-step process, cycle by cycle. The umber of cycles to breakdown depends on the current lensity in the discharge channel, which itself depends upon the excitation and subsequent acceleration of initially trapped electrons. Because the current would depend strongly on the stress, the time to breakdown falls rapidly as the stress is increased.

Since this communication was prepared, my attention has been directed to some similar work which has just been published in Germany[2].

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Damping of the Earth's Free Nutation

The 'free nutation' of the Earth is a motion of the Earth's instantaneous axis of rotation around its mean position. The poles (intersections of the axis with the Earth's surface) describe changing orbits with the 'Chandler period' of about fourteen months. Every six or seven years the amplitude of these orbits reaches a maximum of up to ten metres and then decreases almost to zero. Following Jeffreys[1], Bondi and Gold[2] have considered that the free nutation has a characteristic damping time of the order of ten periods. They find that such heavy damping cannot arise from internal motion of the core or from relative motion between core and mantle, and conclude that it results from non-elastic behaviour of the mantle.

However, I doubt that the damping is as heavy as they suppose. Schweydar[3] has shown that the form and amplitudes of the observed complicated motion of the poles can be explained with a good approximation as a beat phenomenon between the free Chandler period of the Earth of about fourteen months and a periodic annual displacement of the Earth's axis of inertia. He found that the average annual movements of air masses from one hemisphere to the other alone should produce displacements of the poles of inertia with an average annual range of roughly three metres, which is enough to explain the amplitude of the nutation; there are appreciable variations from year to year due to changes in the meteorological conditions. On the other hand, observations of the uplift in formerly glaciated areas and the existence of deep-focus earthquakes indicate[4] that the mean time of viscous relaxation in the upper 700 km. of the Earth's mantle is at least of the order of a hundred years. From this a coefficient of viscosity of the order of at least 10^{21} poises may be derived. The period of only about seven years with which the amplitudes of the free nutation increase and decrease is probably short compared with the damping time of the nutation. Moreover, the energy transfer from atmospheric and other processes to the Chandler motion is unknown. Con-

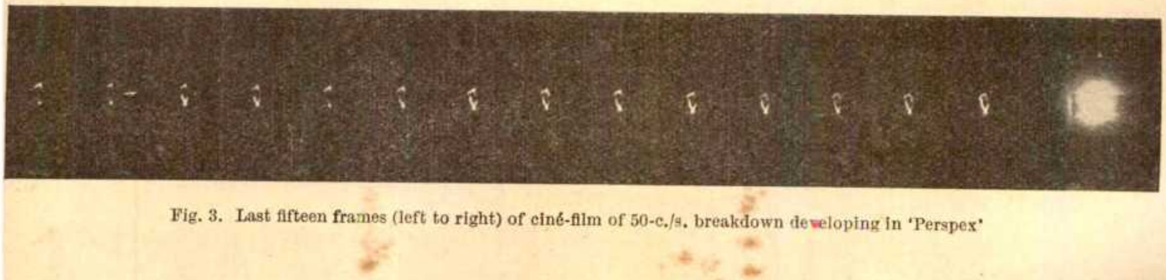

Fig. 3. Last fifteen frames (left to right) of ciné-film of 50-c./s. breakdown developing in 'Perspex'

sequently, it does not seem possible to interpret the decay curve of the nutation and to discriminate the effect of damping from the beat phenomenon.

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A New Theorem in Electrostatics and its Application to Calculable Standards of Capacitance

Although capacitance has the dimensions of length only, usually two or more separate lengths are needed to compute the capacitance of the various forms that have been used as standards. In seeking a form of calculable capacitor involving a minimum number of determinations of length, we have investigated cylindrical systems and have discovered a particular class of capacitor in which the capacitance depends on one length only to the first order. For example, if a square cylinder is constructed from four conducting planes which are insulated from each other at the corners, then the direct capacitances per unit length of cylinder, between each pair of opposing inside faces, are equal and independent of the size of the square. This direct capacitance was calculated as $\frac{\ln 2}{4\pi^2}$ cm./cm., and it was also calculated that if the cross-section was rectangular with a ratio of sides of $1 + \delta$, $\delta \ll 1$, then the mean of the two cross-capacitances was $\frac{\ln 2}{4\pi^2}\{1 + 3{\cdot}45\,\delta^2 + \ldots\}$ cm./cm. These calculations confirmed that, providing the asymmetry was not too great, a standard capacitor could be constructed which required only one length measurement for the computation of its capacitance. The length of the capacitor may be defined by insulating a length of one face from the remainder of that face, which remainder functions as a guard.

The capacitance per unit length and asymmetry effects were calculated for a number of other symmetrical cross-sections. These calculations all gave the same value, namely, $\frac{\ln 2}{4\pi^2}$ e.s.u., as the capacitance per unit length, and this result led one of us (D. G. L.) to propose and prove the following theorem:

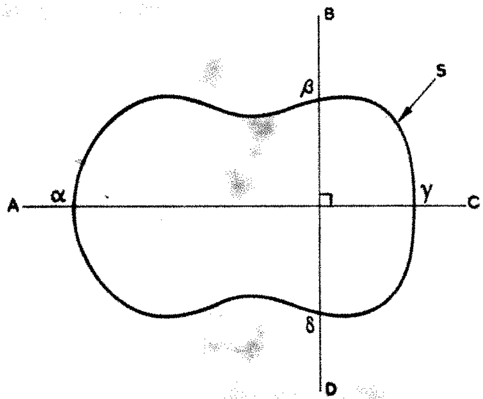

Fig. 1. Cross-section of cylindrical shell

Let the closed curve S (see Fig. 1) be the cross-section of a conducting cylindrical shell, which cross-section has one axis of symmetry AC but is otherwise arbitrary. Further, let this shell be divided into four parts by two planes at right angles, the line of intersection of the planes being parallel to the generators of the cylinder, and one of the planes containing the symmetry axis AC. Then the direct capacitance, per unit length of the cylinder, between opposing parts of the shell (for example, $\alpha\beta$ to $\gamma\delta$), due to the field inside (or outside) the shell, is a constant:

$$C_0 = \frac{\ln 2}{4\pi^2}\ \text{e.s.u.} = 0{\cdot}0175576\ \text{e.s.u.}$$

As a consequence of this theorem, it is clear that the choice of the cross-section, for a cylindrical standard capacitor, is limited only by the requirements that the cross-section have one axis of symmetry and that it be a closed curve.

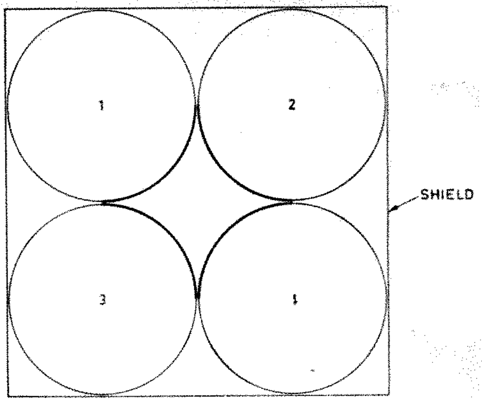

Fig. 2. Cross-section of experimental capacitor

A cross-section which satisfies these requirements and at the same time is easy to realize in practice is that of the space between four circular cylinders the axes of which are arranged to lie at the corners of a square (see Fig. 2). Accordingly, a capacitor of nominal capacitance 1 pF (equivalent length, 20·151 in.) was constructed, using four pieces of stock silver-steel rod (nominal diameter, 15/16 in.) for the cylinders and suitably shielded externally so that only the inside field contributes to the capacitance. Two of the rods (2 and 4) were provided with end-guards to define their lengths and the rods were insulated from each other by mica spacers (0·004 in. thick) placed in the end guard region.

The cross-capacitances (1–4 and 2–3) were measured, and although they differed from the mean capacitance by as much as 0·3 per cent, this mean agreed to within one part in ten thousand with the capacitance calculated from the measured lengths of the guarded rods, due allowance being made for the dielectric constant of the air. It is proposed to construct a precision capacitor based on this design.

Full details of these investigations will be published elsewhere.

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Oxidation as a Source of 'Anomalies' in Amylose

Peat and his collaborators[1-3] have found that amylose prepared from potato, sago, maize and apioca starch cannot be degraded by purified β-amylase or phosphorylase to an extent greater than about 70 per cent. Retrogradation of the amylose, which might have accounted for this, has been ruled out[2], leaving the implication that a proportion of the molecules of amylose have either an anomalous non-educing end-group, or an anomalous group at some point along the chain. Peat, Thomas and Whelan[4,5] ind that the anomaly can be removed by treating amylose with a β-glucosidase, termed *Z*-enzyme, and herefore suggest that it may result from the presence f a single glucose residue attached to the main hain by a link of β-configuration.

An alternative possibility is that the anomaly is an artefact introduced during the preparation of the amylose. This might happen through air-oxidation[6] during the isolation of the amylose, or, if the starch s a commercial sample, during the industrial processing of the starch.

To test this possibility, starch, freshly prepared from potatoes, was dispersed in neutral 1 per cent odium chloride solution in the absence of oxygen, nd fractionated as described previously[7]. Samples f the amylose fraction ('blue value' 1·3) were then reated with oxygen and their susceptibility to rystallized potato phosphorylase[8] compared with hat of the untreated amylose.

The oxidized samples were prepared by blowing xygen at 95° C. through portions of the amylose issolved in (*a*) 0·5 *M* sodium hydroxide and (*b*) 0·01 *M* phosphate buffer, *p*H 7·1. The intrinsic viscosity f the amylose (measured in 0·5 *M* sodium hydroxide t 20° C.) fell in (*a*) from 3·09 to 1·13 in a treatment asting 20 min., and in (*b*) to 0·98 in 8·75 hr. To nable a strict comparison to be made, a sample f the parent amylose was hydrolysed to an intrinsic iscosity of 1·02 by treatment with 0·1 *M* hydrohloric acid at 60° C. for 75 min. in an atmosphere f nitrogen. The three samples of degraded amylose ere precipitated from neutral solution with butanol, nd solutions prepared from the precipitates by team-distillation under nitrogen.

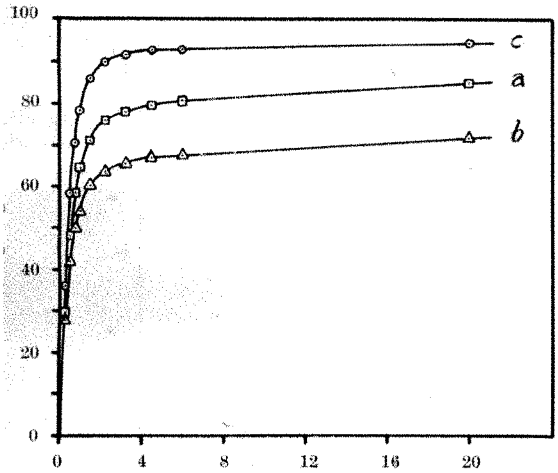

Fig. 1. Phosphorolysis of amylose. Curve (*a*), amylose previously oxidized in 0·5 *M* sodium hydroxide to $[\eta] = 1 \cdot 13$; (*b*) amylose previously oxidized at *p*H 7·1 to $[\eta] = 0 \cdot 98$; (*c*) amylose previously hydrolysed to $[\eta] = 1 \cdot 02$

When incubated with phosphorylase in 0·2 *M* phosphate buffer, *p*H 6·6, at 38° C., the parent amylose was degraded smoothly to 90 per cent of theoretical. Degradation was measured by staining samples with iodine and measuring the optical density at 680 mμ. In a control to which phosphate was not added, there was no change in 24 hr. in intrinsic viscosity or in the optical density of the iodine stain. The phosphorylase was therefore free from α-amylase and *Q*-enzyme.

The three samples of degraded amylose were incubated simultaneously with phosphorylase under identical conditions. The results are shown in Fig. 1, in which degradation, expressed as the percentage fall in optical density of the iodine stain, is plotted as a function of time. It can be seen that a limit was quickly approached in all three cases, and from the values at 6 hr. the limit approximated for the hydrolysed sample to 92·8 per cent, for the sample oxidized in alkaline solution to 80·7 per cent and for the sample oxidized in neutral solution to 67·4 per cent of theoretical.

These results have been confirmed by duplicate experiments, and it is therefore clear that anomalies which limit phosphorolysis can be introduced into amylose by molecular oxygen, and also that such anomalies are not present to any appreciable extent in native amylose.

Two of us (H. B. and N. D. S.) are grateful to the Department of Scientific and Industrial Research for maintenance awards.

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Photochemical Oxidation of Alcohols by Dichromate

In a recent communication in *Nature*[1] a table is presented of the reactivities per —OH group of a series of alcohols towards hydrogen-atom abstraction by photo-excited quinones. These values are very close to the relative reactivities of the alcohols to photo-excited dichromate solutions, for which approximate figures are available (Table 1)[2].

Table 1

Alcohol	Reactivity to	
	Quinone	Dichromate
Methanol	0·12	0·3
Ethanol	1·0	1·0
n-Propanol	1·53	1·5
iso-Propanol	2·14	2·0
Glycerol	0·28	0·5

It might be concluded from this that the first reaction in photochemical oxidation by the dichromate ion is hydrogen atom abstraction from the organic molecule.

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Mechanism of Inactivation of Tobacco Mosaic Virus by X-rays

INACTIVATION of tobacco mosaic virus by X-rays has been studied by Gowen and Price, by Lea and associates[1] and by us[2]. The fraction surviving is an exponential function of dose with D_0 about $2 \cdot 3 \times 10^5$ r. This value corresponds to a target 3000 A. long and about 40 A. in diameter[2].

If the nucleic acid is the target, as proposed by Epstein[3], then it is possible that X-rays produce their lethal effect by breaking a nucleic acid chain. If this is true, then nucleic acid isolated from heavily irradiated tobacco mosaic virus ought to have a lower average particle-length than nucleic acid from unirradiated virus.

Since nucleic acid isolated from tobacco mosaic virus is a long, thin, fairly rigid rod[4,5], this theory can be put to test by measuring the intrinsic viscosity of isolated nucleic acid. To this end, 2 per cent solutions of tobacco mosaic virus were subjected to various doses of X-rays, and the nucleic acid was isolated by the method of heat denaturation[5]. The concentration of nucleic acid was determined from the height of the absorption maximum at 2570 A. The freedom from protein was verified by noting that the ratio of the extinction coefficients at 2600 and 2800 A. agreed closely with that of tobacco mosaic virus nucleic acid and differed greatly from that of the virus protein[6]. Results are shown in Table 1.

Table 1. INTRINSIC VISCOSITY OF TOBACCO MOSAIC VIRUS NUCLEIC ACID FOLLOWING X-IRRADIATION

Intrinsic viscosity (ml./gm.)	Radiation dose (10^6 r.)	Intrinsic viscosity (ml./gm.)	Radiation dose (10^6 r.)
84	0	65	0·46
77	0	37	1·85
74	0	40	1·85

Nucleic acid isolated from X-irradiated virus has a lower intrinsic viscosity and, therefore, a lower average particle-length than that isolated from unirradiated virus. Therefore, the action of X-irradiation is to break the nucleic acid rods. That this breakage occurs as a result of damage inside the virus particle is indicated by the observations that heavily irradiated tobacco mosaic virus possesses essentially the same sedimentation-rate, intrinsic viscosity and electron image size as unirradiated virus. One can show, on the basis of simplified Simha theory, that the effect of breaking once each particle in an initially uniform distribution of rods, with the position of the break being equally likely at any point along the rod, would be to reduce the intrinsic viscosity to exactly one-half of its initial value. This calculation indicates that the order of magnitude is 1 for the number of breaks per rod associated with irradiation doses of about eight times the value of D_0 for inactivation.

This result is consistent with the view that the lethal action of X-rays on tobacco mosaic virus is the breaking of a single molecular chain anywhere in the nucleic acid. A possible reason for the discrepancy between the lethal dose and the dose required to break the rod is that the structure of ribose nucleic acid may be a coil of several strands.

An important deduction from these findings is that the biological activity of tobacco mosaic virus depends on the physical intactness of the nucleic acid. That a comparable degree of intactness of the protein is not required is indicated by the results reported by Schramm[4], to the effect that tobacco mosaic virus which has lost considerable protein still shows full biological activity.

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A New Unidentified Indole Hormone in Maryland Mammoth Tobacco

IT has been reported previously[1] that the short-day plant, Maryland Mammoth tobacco, will flower under long day-lengths (14½–15½ hr.) if exposed to varying dosages of γ-rays. Recently, we have been investigating the effect of γ-radiation on the endogenous level of the indole compounds occurring naturally in leaf, stem, root and apical tissues of γ-irradiated and normal Maryland Mammoth tobacco. Large quantities of these tissues (300–1,000 gm.) have been extracted with absolute ethanol, employing a technique for extraction and paper chromatography as described previously[2]. Microlitre quantities of the extracts, after acidification and extraction with ethyl ether, were spotted on Whatman No. 1 filter paper and chromatographed in seventeen different solvents. Colours were developed with *p*-dimethylaminobenzaldehyde. 3-Indoleacetic acid was not detected in any of more than thirty-five individual extractions of leaf, stem, root or apical tissues of normal or γ-irradiated Maryland Mammoth tobacco. However, an unidentified indole compound was found in the leaf and apical extracts with R_F values as shown in Table 1.

Eluates of chromatograms containing the unknown have been assayed for activity in the split-pea curvature and tomato-petiole epinasty test. The compound was found to possess activity in both these biological assays. In addition, through the courtesy of Dr. K. V. Thimann and Dr. B. Stowe, of Harvard University, eluates of chromatograms containing the substance were tested and found to

Table 1. R_F Values in Six Solvents for Various Known Indole Derivatives occurring naturally and for an Unidentified Indole Hormone in Normal and γ-Irradiated Maryland Mammoth Tobacco

Compound	2-Propanol/ ammon./water (80 : 5 : 15)	2-Propanol/ ammon./water (10 : 1 : 1)	Ethanol (70 per cent)	Water	Water (chamber equilibrated with hydrochloric acid)	Water (chamber equilibrated with ammon. hydrox.)
Unidentified indole compound of tobacco	0·98	0·98	0·97	0·67	0·61	0·82
3-Indoleacetic acid (Eastman Kodak)	0·52	0·50	0·78	0·80	0·65	0·98
3-Indoleacetonitrile (Carbide and Carbon Chemicals Co.)	0·98	0·98	0·95	0·40	0·65	0·60
Ethyl ester of 3-indoleacetic acid	0·98	0·98	0·94	0·69	0·78	0·87

be active in the *Avena* curvature and straight-growth tests.

The compound is stable to alkaline treatment, labile to acids, possesses an ultra-violet absorption spectrum indicative of an indole ring system, and gives positive colours with Salkowski, Ehrlich's or Hopkins–Cole reagents.

In view of the absence of 3-indoleacetic acid in Maryland Mammoth tobacco leaf and apical tissue, and the presence of this physiologically active indole compound, it appears that we are dealing with a hitherto undescribed naturally occurring plant-growth hormone. The compound is not 3-indoleacetonitrile, which lacks activity in the pea-curvature test, and it does not appear to be the ethyl ester of 3-indoleacetic acid which, unlike the unknown, is hydrolysed by alkalis.

With the recent report of Luckwill and Powell[3] on he absence of 3-indoleacetic acid in the apple, vidence is accumulating that the hormonal regulaion of growth in plants may not be restricted solely o the influence of 3-indoleacetic acid.

Details of this investigation will appear in the April–June issue of the *Contributions from Boyce Thompson Institute*.

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Inhibitory Action of Chlorpromazine on the Oxidation of D-Amino-Acid in the Diencephalon Part of the Brain

AMONG several substances examined in our laboratory for their influence on the activity of D-amino-cid oxidase, chlorpromazine (N-(3′-dimethylamino-ropyl)-3-chlorophenothiazine hydrochloride) was und to be a powerful inhibitor of this enzyme. The inhibitory mechanism was investigated using a urified oxidase enzyme system and Warburg manoeter, and the kinetic study carried out. D-Amino-id oxidase protein was prepared from hog kidney y the method of Negelein and Brömel[1]. Each zyme system consisted of apo-enzyme (protein *E*), 6×10^{-7} mole of flavin adenine dinucleotide repared by the method of Yagi *et al.*[2], $6 \cdot 25 \times 10^{-2}$ ole of D-alanine. Amounts of chlorpromazine upplied by Rhône-Poulenc-Specia) ranging from $\times 10^{-5}$ to 4×10^{-6} mole were added to these zyme systems.

The relation between D-amino-acid oxidase activity and flavin adenine dinucleotide concentration is

$$v = \frac{Vf}{K_F + f} \qquad (1)$$

where v is the reaction velocity in the presence of a concentration f of flavin adenine dinucleotide, V is the maximum velocity obtained by increasing the concentration of flavin adenine dinucleotide, and K_F is independent of f and V. Using this formula, the dissociation constant of flavin adenine dinucleotide with oxidase protein was calculated as $1 \cdot 1 \times 10^{-7}$ *M*.

If an inhibitor acts by combining with oxidase protein competitively with flavin adenine dinucleotide or by forming a complex with flavin adenine dinucleotide, and $K \gg K_F$, the activity of the enzyme can be represented by the following formula, as described by Burton[3]:

$$v = \frac{Vf}{K_F\,(1 + i/K) + f} \qquad (2)$$

where i is the concentration of inhibitor and K is its dissociation constant from its complex with oxidase protein or with flavin adenine dinucleotide.

If v_0 is the reaction velocity in the absence of inhibitor, from equation (2)

$$\frac{v_0}{v} = 1 + \left\{1 - \frac{v_0}{V}\right\}\frac{i}{K} \qquad (3)$$

and K can be evaluated.

In an experiment, the values of v_0/v plotted against the concentration of chlorpromazine (i) gave the straight line, the slope of which was $1 \cdot 8 \times 10^4$ l./mol.; and the values of v_0 and V were 41·5 µl. and 70·5 µl. of oxygen uptake in 30 min. respectively. From these values, K was calculated as $2 \cdot 3 \times 10^{-5}$ mol./l. The possibility of a complex forming between chlorpromazine and flavin adenine dinucleotide was excluded by measuring extinction and fluorescence.

It is therefore concluded that the inhibitory mechanism of chlorpromazine on D-amino-acid oxidase can be attributed to competition with flavin adenine dinucleotide.

These observations suggested that chlorpromazine inhibits the flavin enzymes in brain tissue. As chlorpromazine is believed to have an influence on the diencephalon, the inhibitory action of chlorpromazine on enzymes with which flavin is concerned has been investigated. The activity of a homogenate of the diencephalon (comprising the thalamus, metathalamus epithalamus and posterior part of hypothalamus) was therefore investigated. The oxygen uptake of a homogenate of the diencephalon freshly excised from a dog was measured manometrically. The endogenous respiration of the homogenate was inhibited by cyanide. In the presence of cyanide, it was able to catalyse the oxidation of D-alanine, and was activated by the addition of flavin adenine dinucleotide. It was markedly

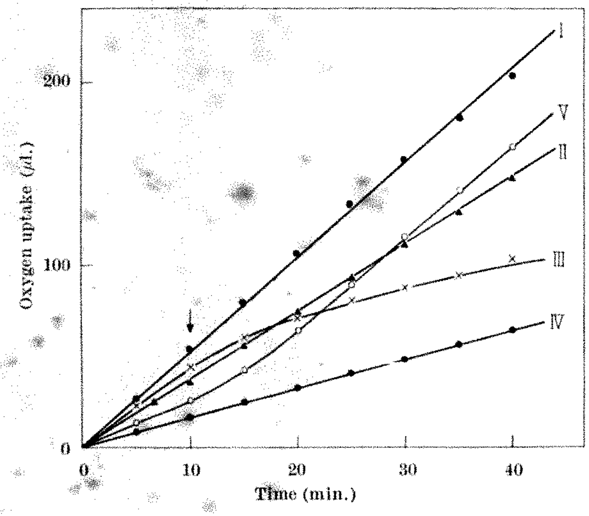

Fig. 1. Inhibitory action of chlorpromazine on the oxidation of D-alanine by a homogenate of diencephalon. Curves I–V show the oxygen uptake of the following reaction mixtures in a total volume 1·8 ml. in each cup: Curve IV, pyrophosphate homogenate (pH 8·3) of 500 mgm. of wet diencephalon and M/900 potassium cyanide (final concentration). Curve II, same as IV + D-alanine (final concentration, $5 \cdot 5 \times 10^{-2}$ M). Curve I, same as II + flavin adenine dinucleotide (final concentration, $1 \cdot 4 \times 10^{-5}$ M). Curve III, same as II + flavin adenine dinucleotide (final concentration $1 \cdot 4 \times 10^{-7}$ M) + chlorpromazine (final concentration 2×10^{-5} M) after 10 min. Curve V, same as II + chlorpromazine (final concentration, 2×10^{-5} M) + flavin adenine dinucleotide (final concentration, $1 \cdot 4 \times 10^{-5}$ M) after 10 min.

inhibited by the presence of chlorpromazine, and was recovered by the addition of flavin adenine dinucleotide, as shown in Fig. 1. The activity in this reaction mixture can be attributed to D-amino-acid oxidase in this tissue.

From these results, it is considered that chlorpromazine will decrease the oxidation of the diencephalon by inhibiting its flavin enzymes in competition with flavin adenine dinucleotide. These results may have some connexion with the pharmacological action of chlorpromazine.

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Glucagon and the Regulation of Carbohydrate Metabolism

THERE is considerable experimental evidence that glucagon (hyperglycæmic factor of the pancreas) is a true hormone which originates in the α-cells of the islets of Langerhans[1]. Its isolation and crystallization were reported in 1953 [2]. The crystalline material appears to be a simple protein with a molecular weight of approximately 4,200 and an amino-acid content which differs significantly from that of insulin[3]. Minute doses of crystalline glucagon (0·1γ in the cat) cause a significant rise in blood sugar[3]. This effect is probably brought about by a stimulation of liver glycogenolysis, since glucagon has been shown to increase the net synthesis of liver phosphorylase[4]. Further than this, little is known abo the action or physiological role of glucagon. Curre speculation revolves about three possibilities: (*a*) th glucagon is an anti-insulin hormone[1], (*b*) that it is insulin synergist[5], or (*c*) that it has no significa function in the control of carbohydrate metabolism

I wish to report briefly some experiments on t effect of glucagon and insulin alone and in combin tion on the utilization of peripheral glucose, and propose a theory of the role of glucagon in the regul tion of carbohydrate metabolism. Detailed expe mental results are being published elsewhere[7].

Fifty-six men (ages twenty-one to forty-seve considered normal with respect to carbohydra metabolism, and in good general health, were studi under controlled basal conditions. All subjects we kept under hospital conditions and on a high carb hydrate diet for several days before the experiment which were done in the morning after a 14-hr. fa and 30–60 min. of bed rest in a special room. T effects of glucagon and/or insulin on arterial (capillar and venous blood-sugar levels were studied for 6 110 min. following a control period of 30–60 mi during which glucose alone was infused. (Glucag and glucagon-free insulin were kindly supplied Drs. Behrens and Kirtley, of the Eli Lilly C Frequent blood samples (30–40 per subject) we drawn without stasis and analysed for glucose the Nelson–Somogyi method[8].

The results showed that glucagon causes a high significant increase ($P = 0 \cdot 001$) in the differen between arterial and venous glucose. These findin confirm results previously reported from this la oratory using a different experimental procedur Insulin also increased the difference between arteri and venous glucose significantly ($P = 0 \cdot 01$), as wou be expected. When both insulin and glucagon we administered together, the differences between arteri and venous glucose were significantly great ($P = 0 \cdot 001$) than those with either glucagon insulin alone. Fig. 1 summarizes the results fro the three experimental groups with respect to valu for the ratio of the difference between arterial a venous glucose to the concentration of arteri glucose, which have been shown to be proportion to the specific rate constant of peripheral gluco utilization under the special conditions of t experiments[7b].

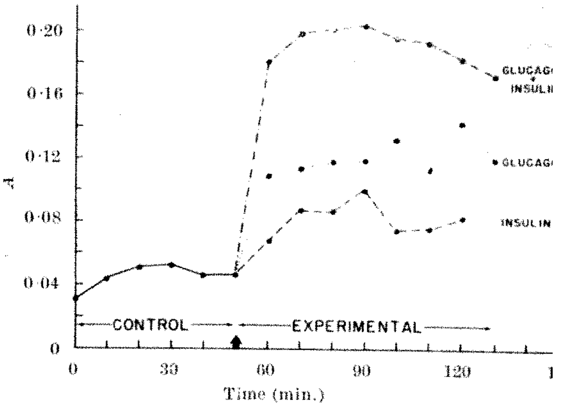

Fig. 1. Each point of control period represents the median value of 54 subjects, whereas each point of the three experimental groups represents the median of 12 subjects. The ratio of the differences between arterial and venous glucose to the concentration of arterial glucose is proportional to the specific rate constant of utilization of peripheral glucose. *A*, arterial glucose concentration; *V*, venous glucose concentration

These findings suggest that (*a*) glucagon has a dual, integrated action, namely, the release of liver glycogen and the enhancement of peripheral glucose utilization, and that (*b*) glucagon and insulin may function jointly to accelerate the peripheral utilization of glucose. Since the two hormones have opposing actions on blood glucose and the levels of liver glycogen, each is well suited to complement the effect of the other in the task of maintaining these two reservoirs of body glucose constant in the face of an accelerated rate of utilization of peripheral glucose.

This mechanism remains to be clarified. Studies in the depancreatized dog[7a] indicate that the effects are not due to a secondary release of insulin. Furthermore, the increases in the ratio of the difference between arterial and venous glucose to concentration of arterial glucose values with glucagon were significantly greater ($P = 0{\cdot}001$) than those observed with comparably high blood-glucose levels obtained by glucose alone[7a]. Hence the hyperglycæmic action *per se* of glucagon is not an adequate explanation for the results observed. Preliminary experiments in the hepatectomized dog (Elrick, H., Rachiele, F., Stoll, F., and Arai, Y., unpublished observations) suggest that the liver is necessary for the enhancing effect of glucagon on peripheral glucose utilization.

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Spasmolytic Effect of Cerebral Tissue Extracts

USING isolated segments of the guinea pig ntestine suspended in oxygenated Tyrode solution t 35° C., strong contractions inuced by acetylcholine and adenoine triphosphate were relaxed by introducing concentrated extracts of at brain in Tyrode solution[1].

When dried red-cell stroma extracted with Tyrode solution was imilarly tried, relaxation of acetylholine contractions occurred immediately, but adenosine triphoshate contractions were not afected. Investigation was then arried out into the possible presence of a relaxing agent other han choline esterase in brain xtracts.

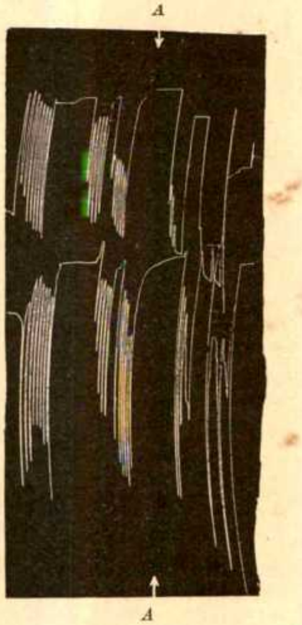

Fig. 1. Trendelenburg's preparation. Intraluminar pressure = 3 cm. water. Upper tracing: peristalsis. Lower tracing: longitudinal movement. At *A*, 0·4 μgm./ml. crude sphingosine (*p*H 7·4). Duration of tracing, 6 min.

A special extract was prepared from cow brain consisting of crude sphingosine bases[2,3] in Tyrode solution, and this, when added to the guinea pig intestine in an organ-bath to make a final concentration of 0·4 μgm./ml., abolished contractions induced by adenosine triphosphate as well as by acetylcholine in a manner similar to whole brain extracts[1].

Using Trendelenburg's preparation[4], it was shown that peristalsis in the guinea pig intestine was abolished by the extract at a concentration of 0·4 μgm./ml. There was a concomitant loss of tone (Fig. 1). Pendular motility in the isolated rabbit intestine was abolished, in some cases after an initial transient spasm. This preparation also showed reduction in tone (Fig. 2).

A more purified fraction (triacetylsphingosine[2]) showed qualitatively similar effects when tested on the isolated rabbit intestine. Larger amounts of this substance were required to demonstrate a definite effect (16 μgm./ml.) and pendular motility and tone only gradually diminished.

These effects of sphingosine were not reversed in any of the tests by washing away the bases. They

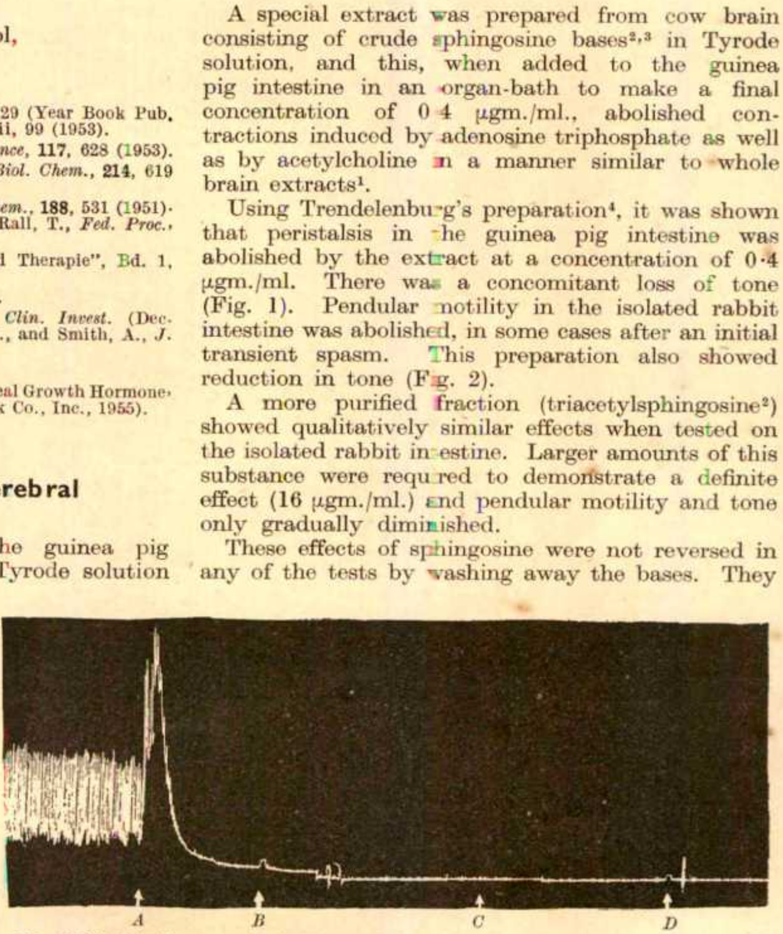

Fig. 2. Rabbit jejunum. At *A*, 0·4 μgm./ml. crude sphingosine (*p*H 7·4). Washing at *B*, *C* and *D*. Duration of tracing, 40 min.

showed the irreversible character observed when atropine is used as an antagonist of acetylcholine in concentrations greater than 0·05 μgm./ml.

It appears, therefore, that sphingosine and allied bases in cerebral tissue may exert a powerful spasmolytic action *in vitro*.

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Lipæmia Clearing Action of Sulphated Animal Hyaluronate

Heparin has now been shown to exert a lipæmia clearing action *in vivo*, and is believed to operate primarily by liberating a lipase which catalyses the lipolysis of chylomicrons and low-density lipoproteins[1].

Constantinides and co-workers[2] have shown that several sulphated synthetic polysaccharides, all of which react metachromatically with toluidine blue, may also exert lipæmia clearing activity, apparently operating in the same manner as heparin. Later, Gutmann and Constantinides[3] demonstrated that sulphated alginic acid may even inhibit experimental atherosclerosis in the rabbit. The work of Constantinides and collaborators indicated further that, at least for synthetic polysaccharides, sulphation is an essential for providing these synthetic agents with both their metachromatic staining capacities and their lipæmia clearing activities.

Since heparin is itself a sulphated uronic acid derivative, it was therefore considered possible that other naturally occurring metachromatic staining mucopolysaccharides, and especially those widely distributed in the connective tissues generally and in arterial ground substance in particular, may also exert lipæmia clearing activity. This possibility was tested, in part, by the following experiments.

Twenty-eight male albino Wistar-strain rats weighing 300–400 gm. were used. All animals were starved for 20 hr. before beginning an experiment. Three and a half hours before bleeding by cardiac puncture, they were given 3 ml. of maize oil intragastrically; twenty minutes before bleeding, they were anæsthetized lightly with intraperitoneal pentobarbitone. Immediately before bleeding, they were given a light supplementary ether anæsthesia; the thoracic cavity was then rapidly opened and 3 ml. of right ventricular blood was withdrawn and transferred to chilled heparinized tubes. After centrifuging, an independent observer graded each specimen of plasma, macroscopically, as 0–5 degrees of turbidity.

The preparations tested for anti-lipæmic (or rather anti-chylomicron) action were given in the dosages, by the routes, and at the times before bleeding indicated in Table 1. In addition to this, cortisone, hyaluronidase and toluidine blue were tested for lipæmia clearing activity on a further twenty-seven rats. Details relating to the latter group of substances are not given here, since they all failed both to clear the plasma of macroscopically visible chylomicrons and to prevent the lipæmia clearing activity of intravenous heparin when administered after these preparations. From Table 1 it seems that: (*a*) heparin acts as a lipæmia clearing agent when injected 15 min. prior to death; this confirms previous findings in this regard; (*b*) hyaluronidase fails to inhibit chylomicronæmia when injected intramuscularly prior to fat feeding or intravenously after fat feeding, despite its known effects in mobilizing tissue endogenous mucopolysaccharide; (*c*) non-sulphated, animal umbilical cord hyaluronic acid is apparently erratic in its lipæmia clearing action when given before or after lipæmia has been induced; the sulphated animal umbilical cord hyaluronate is active in the rat when injected both 24 hr. and 1 hr. prior to fat feeding or, alternatively, 3 hr. after fat feeding.

Table 1. Anti-chylomicronæmic Action of Substances tested on Rats given 3 ml. Maize Oil Intragastrically

Preparation	Dosage	Route	Time before bleeding	No. of rats in group	No. of rats with degrees of lipæmia indicated		
					0–1	2–3	4–5*
Nil (controls)	—	—	—	5	1	3	1
Heparin	400 units	Intraven.	¼ hr.	3	3	0	0
Hyaluronic acid	5 mgm.	Intraven.	¼ hr.	6	3	0	3
SO_4-Hyaluronate	2 mgm. + 2 mgm.	Intraperit. Intraperit.	24 hr. 3½ hr.	8	8	0	0
SO_4-Hyaluronate	2 mgm.	Intraven.	¼ hr.	3	3	0	0

* 4–5 indicates marked opalescence of plasma at 3½ hr. after feeding oil.

Preliminary studies on monkeys indicate that plasma, drawn from a fasted animal 15 min. after an intravenous injection of sulphated hyaluronate exerts a lipæmia clearing action when incubated with lipæmic plasma from a control monkey fed with fat. Thus, sulphated hyaluronate also has a lipæmia clearing action *in vivo* in monkeys and probably operates, at least in part, through a similar mechanism to heparin, the sulphated synthetic polysaccharides tested by Constantinides *et al.*[2] and the inorganic salts used by Bragdon and Havel[4].

These findings strongly suggest that heparin is not unique, as a naturally occurring sulphated mucopolysaccharide, in showing lipæmia clearing activity but that other sulphated tissue mucopolysaccharide may have a similar action.

It is tentatively suggested that the deposition of lipid in connective tissue generally, and in arteries in particular, may be a function of the sulphated mucopolysaccharide metabolism throughout the organism. The possibilities of naturally occurring sulphated mucopolysaccharides taking a critical rol in fat deposition in depots and in arteries, normally and in disease processes, and that they may even be capable of promoting the absorption of pathologically deposited lipid in arteries, are being actively investigated in our laboratories.

The expenses of this investigation were defrayed by a generous grant from the Schlesinger Organization, South Africa. We also wish to thank Dr. Robert L Craig, of Messrs. D. G. Searle and Co., Chicago, for providing the sulphated hyaluronate used and Mr. R. N. Tuck and Mr. H. F. Sadler, of Wyeth (Pty.

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Di- and Mono-Taurobilirubin similar to a Directly Reacting Form of Bilirubin in Serum

IN the course of investigations into the colloidal operties of bilirubin, it was found that inhibition the diazo-reaction in acid solution is caused by e association of bilirubin with the formation of lloidal solutions of bilirubin. The diazo-reaction acid *p*H occurs only if bilirubin remains in the onomolecular state[1].

Bile acids become more soluble after combination ith taurin and glycine. The aim of our work was cause a similar change in the chemical constitution bilirubin and to combine both free carboxyls of lirubin with taurin. We used the method described cently for the synthesis of peptides by Boissonnas, ughan and Osato[2]. The same method has been ed in the synthesis of conjugated bile acids by rgström and Norman[3]. In preparing conjugated lirubin the experimental conditions were the same described in that method. We obtained a chemical mpound, ditaurobilirubin, which differed from free lirubin by its solubility in acid solutions. The azo-reaction at an acid *p*H was direct. The spectrum the new compound in dioxan and water was entical with that of free bilirubin. The new pig- ent gave a positive Gmelin reaction, which is, cording to Fischer, typical for bilirubin and other tra-pyrrolic pigments[4]. The infra-red spectrum of e new pigment confirmed the disappearance of free rboxyl groups as compared with bilirubin. The nthetic pigment changed in water medium, pecially when acidified with strong acids, and the llow colour of the solutions changed into green ossibly taurobiliverdin).

When the experimental conditions for the prepara- n were slightly changed, two pigments were tained, one of which, possibly monotaurobilirubin, grated on paper electrophoresis with half the speed the other (possibly ditaurobilirubin). The slowly grating pigment gave a slightly delayed diazo- action as compared with the other.

The pigments were separated by paper chromato- aphy with a chloroform/methanol/acetic acid stem, and in the same way two pigments in addition bilirubin were isolated from the serum of a patient th hepato-dystrophy, and also from various speci- ns of duodenal bile.

In all experiments (using synthetic and natural aterial) the more polar pigment remained at the arting point and gave a direct diazo-reaction. The less polar synthetic pigment migrated with a slightly lower R_F than the natural pigment, free bilirubin migrating with the solvent front. As with direct chromatography of serum bilirubin, reversed phase chromatography of synthetic products, according to Cole, Lathe and Billing[5], yields two pigments besides bilirubin.

The preparation of other similarly substituted bilirubin derivatives has been undertaken. Their chemical properties and elemental analyses will be described elsewhere.

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Production of Opacity on Serum Agar Plates by Some Strains of *Staphylococcus aureus*

IN 1941, one of us (A. J. H. T.) observed that about half the strains of *Staphylococcus aureus* isolated from the skin lesions of impetigo contagiosa had two properties not often seen in strains from other sources, namely, the ability (*a*) to inhibit the growth of corynebacteria on solid media, and (*b*) to produce zones of opacity on serum agar plates. In a recent investigation of impetigo in south-east Lancashire, it was found that 80 per cent of strains of *Staph. aureus* belonged to one phage type (Type 71), most members of which inhibited the growth of corynebacteria and were resistant to penicillin[1]. More than 95 per cent of the Type 71 strains also produced opacity zones on serum agar plates.

The production of opacity on serum media by *Staph. aureus* has been little investigated, though its occurrence was noted by Woods and Parkin[2]. The zone of opacity extends for 1·0–1·5 mm. beyond the growth and is best seen after 15–18 hr. incubation aerobically at 37° C. The reaction is best demonstrated on infusion broth agar containing 5 per cent fresh horse serum. Substantially the same results are obtained with human serum ; but reactions with rabbit serum are rather less frequent and intense. No opacity occurs when the plates are incubated anaerobically or when the infusion agar base is replaced by 'Lemco' broth agar or by 'Oxoid' nutrient agar.

The ability to produce opacity is unevenly distributed among *Staph. aureus* strains. It occurs commonly only among two sorts : Type 71 strains from skin infections and penicillin-resistant Group III strains[3] from superficial infections acquired in hospital. Also, it is remarkable that strains producing opacity on serum agar are most uniformly negative to the egg-yolk reaction of Gillespie and

Alder[4]. Of 908 strains, from a variety of sources, 332 gave a positive serum opacity reaction and 498 were egg-yolk positive, but only two were positive to both tests.

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Production of Gliotoxin in Soils

Since the majority of micro-organisms which are known to produce antibiotics are soil inhabitants, there has been considerable speculation whether they can produce these antibiotics in their natural environment. It is now generally accepted that if antibiotics are produced in the soil, this would probably occur in localized micro-environments where there is a favourable food supply, such as around particles of plant debris or in the rhizospheres of certain plants.

So far no one has reported success in demonstrating the production of an antibiotic in normal soil; but it has been shown that some soils, when enriched with organic matter and inoculated with an organism known to produce an antibiotic, will support production of an active substance[1,2]. I have shown[2] that gliotoxin can be produced in soil supplemented with plant material and inoculated with *Trichoderma viride*.

To determine whether antibiotic production is localized in the vicinity of plant debris, pieces of wheat straw (1 in. long) were introduced into an acid podsol from Wareham Heath inoculated with a spore suspension of *T. viride*. After seven days the straws and the soil surrounding the straws were each separately extracted with ether and the extracts tested for antibiotic activity. An active substance was present and was identified as gliotoxin by paper chromatography. The amount of gliotoxin present could be estimated roughly from the size of an inhibition zone produced on agar seeded with *B. subtilis*.

Straws from inoculated soil were covered with a good growth of *T. viride* and produced approximately 1 μgm. gliotoxin/straw, whereas those from uninoculated soil produced no activity. The inoculated soil immediately surrounding the straws yielded approximately 1 μgm. gliotoxin/gm. soil. This is a much lower yield than that from an equivalent weight of straw (13 μgm. gliotoxin/gm. straw). It would seem that either the gliotoxin was produced only in the straws and then began to diffuse out into the soil, or that the fungus, using the straw as a food base, grew out into the soil and produced some gliotoxin there. No gliotoxin was produced in straws buried in a Kettering loam of pH 6·3 unless either the straws or the soil was first acidified.

During the course of an experiment in which mustard seeds were dusted with spores of *T. viride* in an effort to protect the seedlings against soil-borne diseases, it was noticed that in some cases the seedlings developed chlorotic patches on the cotyledons. As the damage was very similar to that produced on seedlings which had been grown in solutions of gliotoxin, it seemed possible that gliotoxin was produced around the seedling, probably in the seed coat. After the seeds had been dusted with spores of *T. viride* and grown in John Innes potting compost for seven days, the seed coats were removed and placed on agar plates seeded with *B. subtilis*. Zones of inhibition were produced around the coats which had been inoculated with *T. viride* spores but not around the uninoculated control coats. The seed coats were extracted with ether, and the active compound was shown to have R_F values identica with gliotoxin on paper chromatograms. It was estimated that approximately 0·25 μgm. gliotoxin was produced per seed coat. Pea seeds treated in the same way were found to produce 4 μgm. gliotoxin/seed coat.

When these experiments were repeated with a new batch of potting compost it was found that an antibiotic was also produced on uninoculated pea coats This active substance was both antibacterial and antifungal, and was found to have similar R_F values to gliotoxin in several solvent systems.

The fungus which was isolated from the pea coats grown in the new batch of potting compost was identified as *T. viride*, and was found to produce high yields of gliotoxin in Weindling medium. The *Trichoderma* was not a contaminant of the seed coat but was isolated repeatedly from the soil.

These experiments have shown that high concentrations of an antibiotic can be produced in and around particles of organic matter, such as pieces of straw and seed coats, buried in soil. In a batch of John Innes potting compost in which a gliotoxin-producing strain of *T. viride* formed part of the natural flora of the soil, the fungus grew on the seed coats and produced gliotoxin there. This is an example of antibiotic production in an uninoculated soil in the vicinity of a very natural organic supplement.

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Jan. 2.

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Lactophenol Preparations for Soil Nematodes

One of the essentials of a fluid preparation fo nematodes is that coverslip supports must be included in the drop of mounting medium to avoi distortion of the specimens. For this purpose Goodey recommends glass fibres arranged radially in the drop but as the fibres may be of varied and unknow diameter, it is difficult to judge the correct size o drop. If the drop is too large, the lactophenol flow on to the upper surface of the coverslip, and th ringing medium ('Zut' or lactophenol gum) will no seal the mount. If the drop is too small, air space are left near the edge of the coverslip and the ringin medium is drawn into them by capillarity.

This difficulty has been overcome by using length of 80/20 nickel–chromium resistance wire as coversl upports (Brightray 'C', H. Wiggin and Co., Ltd., Birmingham 6). This is manufactured to a tolerance f ± 2·6μ for the following diameters: 25μ (50 tandard wire gauge), 30μ (49 s.w.g.), 40μ (48 s.w.g.), nd 50μ (47 s.w.g.). As the diameter of the coverslip upport is both known and constant, the required drop size can be calculated and delivered on to the lide by a micropipette fitted with a 'Pumpett' ttachment. Wire of slightly greater diameter than that of the largest specimen is selected for each nount, and is cut in lengths approximately equal to ne-third of the coverslip diameter. The pieces of wire are arranged radially in the drop, the specimens re added, and a warm coverslip is lowered on to he preparation. With the correct drop size the actophenol fills exactly the space under the coverslip.

There has been no visible evidence of reaction etween the nickel–chromium wire and lactophenol n slides which have been left for six months. The method saves time, and because remounting is seldom ecessary, specimens are less likely to be lost or damaged.

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Goodey, T., Technical Bulletin No. 2, Min. Agric. and Fish. (H.M.S.O., 1951).

Accelerated Storage Tests for Dehydrated Vegetables

WHEN dehydrated vegetables are stored at high temperatures (for example, in the tropics) they ventually become unacceptable, usually because of the development of brown pigments. Since many ifferent factors, not precisely controllable, affect the ate at which the brown discoloration develops, it is irtually impossible to predict the storage life of the ehydrated product. Examination of the behaviour f dehydrated vegetables held at 37° C. has been the sual way of studying the effects of variables on ropical' storage life; but such tests may be prolonged and delay research, while they are of little alue to a manufacturer or purchaser who may need nformation before dispatching or purchasing the naterial.

The rate of development of browning is directly elated to the temperature of storage between about 5° and 50° C.[1], and it has been suggested that the eactions involved in the development of the brown gments at temperatures between 25° and 70° C. are milar[2]. It seemed possible, therefore, that storage t temperatures higher than 37° C. might enable a rediction to be made, in a relatively short time, of he rate at which browning would occur at the latter emperature.

Tests carried out at 37°, 55° and 70° C., in which amples after reconstitution and cooking were judged y an experienced taste panel, showed that at 70° C. rowning was too rapid for accurate assessment, but hat for a number of dehydrated vegetables the rate browning at 55° C. was approximately thirty mes that at 37° C.; that is to say, storage for a rtain number of days at 55° C. and for the same umber of months at 37° C. caused similar degrees browning.

In subsequent tests on dehydrated potato, more ccurate methods of assessment were sought. The gment was, in all but the most severely browned amples, completely soluble in 66 per cent ethanol, and a value for the extent of browning could be obtained by measuring the optical density of the resulting extracts at 400 mμ in a spectrophotometer. For large numbers of samples, however, this method was too slow, and a quick method was devised, in which the samples under examination were compared visually with a set of colour standards.

The standards were prepared by 'kibbling' dehydrated potato strips in a hammer mill, and using the fraction retained by a 16-mesh sieve but passing a 6-mesh sieve. The kibbled material was packed in nitrogen in Kilner jars and held at 55° C. for varying periods. A range of colours was selected from the browned material so produced, and assigned marks from 1 to 8, 1 being excessively brown and 8 being completely free from browning. When not in use the standards were stored in the dark at − 5° C. The material under test was kibbled, packed in nitrogen in Kilner jars in the same manner as the standards, and put into storage at the desired temperature. At intervals the test material was compared with the standards and awarded marks accordingly.

To check the validity of this visual colour scoring, a number of samples were tested both in this way and by measuring the optical density of the 66 per cent ethanol extract. The results were in satisfactory agreement: calculation of the correlation coefficient showed $r = -0{\cdot}90$. Similarly, the visual test results and the scores for colour obtained by the taste panel were also closely correlated ($r = +0{\cdot}94$).

In two successive years, the visual method was used to test the earlier finding that the rate of browning in dehydrated potato at 55° C. was approximately thirty times that at 37° C. The marks for material stored for 2, 3, 4, 5 and 6 days at 55° C. were plotted on the horizontal axis (x) against marks given to a sample of the same material after 2, 3, 4, 5 and 6 months respectively at 37° C. (y). Fig. 1 shows the results for 1954: the correlation coefficient was $r = +0{\cdot}91$ and the line of best fit to the pairs of readings was $y = 0{\cdot}989x - 0{\cdot}013$. Generally similar

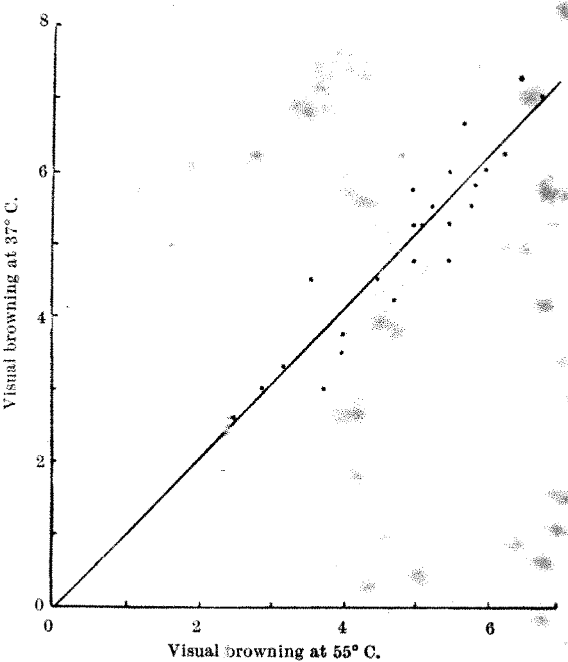

Fig. 1. Regression of visual browning after months at 37° C. upon visual browning mark after the same number of days at 55° C. (dehydrated potatoes, 1953–54). $y = 0{\cdot}989x - 0{\cdot}013$; $r = +0{\cdot}91$

results, though with somewhat wider scatter, were found in 1955 (correlation coefficient $r = +0{\cdot}81$ and line of best fit $y = 1{\cdot}028x - 0{\cdot}041$).

These results support the general thesis that the extent of browning developed in dehydrated potato during storage for a certain number of days at 55° C. is approximately the same as that developed during the same number of months at 37° C. It is evident that accelerated tests at 55° C. could be of value to both manufacturers and purchasers of dehydrated vegetables.

We are indebted to Mr. J. M. Harries for the statistical analyses.

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Regeneration of Yeast Cells from Naked Protoplasts

OBSERVATIONS of the ability of cell fragments to re-form into new cells are very old[1]. Many experiments have been carried out on Protozoa and Algae especially, and importance of the nucleus for regeneration has been ascertained.

In our experiments we have investigated the power of regeneration in cell fragments of yeasts (*Saccharomyces cerevisiae*). The fragments were obtained in two ways: (1) By mechanical pressure on yeast cells the plasma flows out and takes up the form of droplets (Fig. 1), producing a large number of plasma droplets, but only one of which contains the whole nucleus; some physical properties of plasma can easily be studied with these plasma droplets[2]. (2) Under certain conditions, lysis of cell membranes in the surface layer of the autolytic yeast culture takes place. The protoplast becomes loose and breaks into several droplets. A very similar process in bacteria was described by Weibull[3], who has deprived the bacterial cell of a membrane by means of lysozyme. In our experiments we did not succeed in demonstrating the free hemicellulases and we presume that the yeast membrane is lysed by ferments which are closely bound to the protoplast.

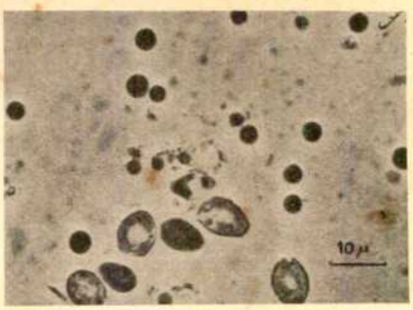

Fig. 1. Droplets of free plasma obtained by mechanical pressure on yeast cells. Phase-contrast. × 750

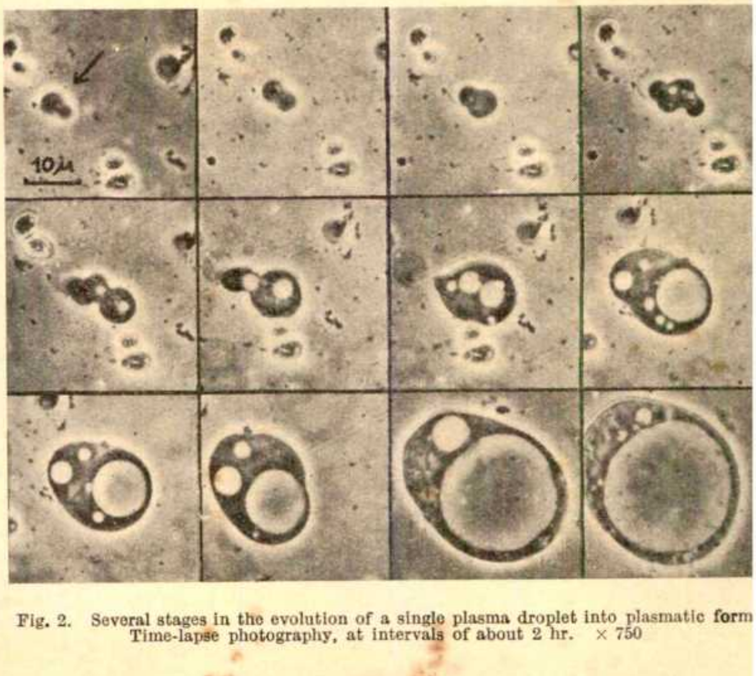

Fig. 2. Several stages in the evolution of a single plasma droplet into plasmatic form Time-lapse photography, at intervals of about 2 hr. × 750

Plasma droplets thus obtained can be transferred to nutrient media, though they are very fragile, and their further behaviour observed. We have transferred the droplets on agar with synthetic nutrient medium containing asparagine. Most of the plasma droplets die off in a few days, especially those obtained by the mechanical method. Others grow intensively for several hours. Growth is rapid and large plasma formations arise out of plasma droplets during 24 hr. (Figs. 2 and 3). The volume of plasma formations is ordinarily a thousand times bigger than the volume of a single yeast cell; they have no membrane and therefore an irregular outline. Th plasma is homogeneous, with many vacuoles. Plasm formations are often broken up, and the separate parts go on growing independently. I have show elsewhere[4] that the growth is not dependent o physical changes only of the plasma droplets, bu that there is real growth connected with quantitativ increase of plasma. In another investigation[5] it wa demonstrated that only the plasma droplets contai ing the nucleus develop; those without it die of In the later stages of development the plasma forma tions always contain more nuclei, which are structu ally rather different from the nucleus of the norm yeast cell. Neither Weibull[3] nor others[6,7] observe similar growth and the division of protoplasts aft lysozyme lysis of bacterial membrane, though prot plasts invariably remain alive, as is obvious fro their metabolism[6] and ability to form the bacteri phage[7,8].

Some of the plasma formations developed d generate after a few days without having change essentially; but others display further developmen changes. The plasma contracts, vacuoles disappea the plasma viscosity increases and there develo dense spherical formations, often of a large si (30–40µ). They, too, contain a greater number nuclei which are exactly like normal nuclei. If w

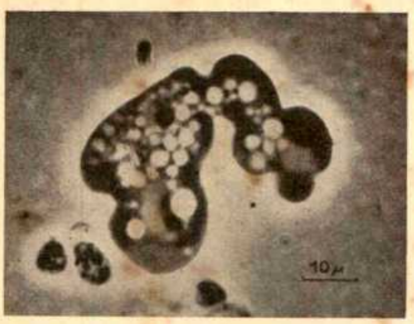

Fig. 3. A large plasma formation developed by growth from a plasma droplet. Phase-contrast. × 750

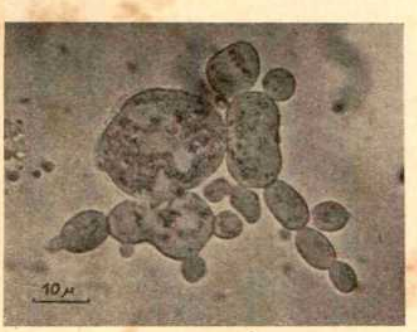

Fig. 4. Regeneration of new cells from a dense plasma formation. × 750

ransfer these dense plasma formations to a new
utrient medium, we find that a membrane develops
n their surface and that germination occurs in three
ays (Fig. 4). Cells result from this germination.
'he first generation looks very little like yeasts; but
ı later generations cells arise which correspond to
ıe yeast cell in size and form. The yeasts originating
ı this way can easily be isolated from the medium
nd cultivated by a technique customary for fer-
ıenting organisms. All changes described have been
ecorded several times on microfilm by time-lapse
hotography, so that there can be no doubt about
ıe right order of the separate evolutionary phases.

The majority of yeast strains developed by re-
eneration and isolated bear a morphological re-
emblance to the starting culture. Other strains
ere morphologically different and some of them
ave kept these deviations permanently. Among the
tter is one with permanently polynuclear cells.
mong the yeast strains obtained by regeneration,
ıere are considerable variations (in comparison with
ıe original strain) in biochemical properties,
specially in the speed of fermentation and production
f alcohol.

These observations show that cell fragments can
generate new cells even among Ascomycetes. The
ıode of regeneration described here differs a great
eal from those known hitherto; for (Fig. 5) the
rge amorphous and polynuclear plasma formations arise from the cell fragments before regeneration of yeast cells occurs.

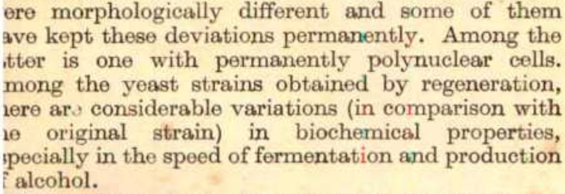

Fig. 5. Scheme of the course of regeneration: plasma droplet, vacuolized plasmatic formation, dense plasma formation and regeneration proper

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Jan. 17.

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Meloidogyne acronea, a New Species of Root-Knot Nematode

PLANTS of *Sorghum vulgare*, variety Radar (a variety of sorghum developed in South Africa), were collected on a farm in the Vryburg District, Cape Province. The land had for a number of years previously been planted only to maize and sorghum. The roots of the plants collected were found to be galled, the galling being caused by a root-knot nematode the morphology and pathological behaviour of which reveal it to be a new species. The name *Meloidogyne acronea* is proposed for this species.

Measurements, which in all cases were of fixed specimens, were as follows:

Adult female: length, 840μ–950μ; width, 400μ–600μ; length of stylet, 11μ–13μ; basal bulbs of stylet, width, 4μ, length, 2μ. The dorsal gland aperture is 4μ from the base of the stylet. The excretory pore opens anterior to the median œsophageal bulb, usually about fourteen annules from the lip region.

Infective larva: length, 440μ–460μ, width, 14·6μ; $a = 32$, $b = 5{\cdot}8$, $c = 9{\cdot}2$; length of stylet, 10μ; basal bulbs, width, 2μ, length, 1μ; dorsal gland aperture, 3μ from base of stylet.

Adult male: length, from 1·66 mm.; width, 0·04 mm.; $a = 38$, $b = 16$; length of spear, 16μ–18μ; basal bulbs, width, 4μ–5μ, length, 2μ; spicules (measured on chord of their arc), 32μ–34μ.

Eggs: length, 90μ–96μ, width, 44μ–64μ.

Meloidogyne acronea n.sp. differs from the type species *M. exigua*, *M. javanica*, *M. incognita*, *M. arenaria* and *M. hapla*, described by Chitwood[1], in the following particulars:

The posterior portion of the body of the female is drawn out into a distinct rounded protuberance on which are situated vulva and anus. The perineal pattern formed by the transverse annulation is extremely obscure. The cuticle is tougher. The mature female does not invariably remain embedded in the tissues of the host but often bursts out, the egg sac being lost in the surrounding soil. In both male and female, although the basal framework supporting the head does not appear to be as heavily sclerotized, the stylet appears slightly more robust. The tip of the tail of the larva is more rounded. The phasmids in the male are post-anal.

A large number of eggs was produced (approximately 1,000) by females parasitizing sorghum and laid in a gelatinous matrix.

The lip region in both larva and male is without cross-striations.

The development of the immature infective life-stages appeared to be similar to that of other species. *M. acronea* was successfully transferred to beans and tomatoes, on which reproduction took place.

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Chromosome Numbers in Three Species of *Uronema*

As part of a cytological investigation of members of the Ulotrichales, the following chromosome counts have been made in three species of *Uronema*. They are the first records for the genus.

386/1	*Uronema barlowi* (Pringsheim) n.prov.	$n = 18$
386/2a	*U. confervicolum* Lagerh.	$n = 16$
386/3	*U. gigas* Vischer	$n = 18$

The serial numbers given above on the left are of the cultures used from the Cambridge Culture Collection of Algae and Protozoa.

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Effects of Climate on Body Temperature and Respiration-rate of Buffaloes and Friesian Cattle

Observations were made on rectal temperature and respiration-rate of five groups of animals all kept in open sheds on the University Farm, Alexandria. Group I consisted of two buffalo cows and group II consisted of two Friesian cows, and all were in the same early stage of first lactation. The other three groups included two male calves each, from buffaloes, Friesians and native cattle. Readings of rectal temperature and respiration-rate were taken three times daily at 8.30, 11.30 a.m. and 2.30 p.m. on quietly standing animals on two days weekly for seven weeks from July 23 until September 9, 1955. Air temperature was recorded at the same intervals and ranged between 37·2° and 38·9° C.

There was a highly significant difference in body temperature and respiration-rate on different days and throughout the day due to different weather conditions between and during days. From Table 1 it will be seen that the mean body temperature and respiration-rate of the buffaloes was lower than those of the Friesians and the native cattle; the nativ calves, however, showed lower values than those c Friesian calves. The differences between all thes results were highly significant.

Table 1

Comparison	Mean rectal temperature (° C.)	*s.e.*	*d*	Mean respiration-rate/min.	*s.e.*	*d*
Buffalo cows	38·39	0·038	−0·25	25·08	0·388	−7·68
Friesian cows	38·64	0·040		32·76	1·026	
Buffalo calves	38·34	0·027	−0·32	21·30	0·442	−8·96
Friesian calves	38·66	0·036		30·26	0·706	
Buffalo calves	38·34	0·027	−0·17	21·30	0·442	−4·56
Native calves	38·51	0·025		25·86	0·498	
Native calves	38·51	0·025	−0·15	25·86	0·498	−4·40
Friesian calves	38·66	0·036		30·26	0·706	

s.e., standard error; *d*, difference. All differences are significant at the 1 per cent level.

In buffaloes, the correlation coefficient betwee the average daily body temperature and air tem perature for eight individuals was $r = + 0·10$ an non-significant. A similar estimate obtained for th respiration-rate and air temperature was $r = + 0·2$ and highly significant. However, the correlatio between body temperature and respiration-rate wa $r = + 0·20$, and this was statistically significant.

For the successive days, the repeatability betwee readings for respiration-rate of the buffalo stock wa found to be 36 per cent. Regarding body temperatur buffaloes did not tend to follow any particular patter in this respect.

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I. A. Ahmed

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Nov. 26.

Scent of Otariids

Some years ago I was engaged in an examinatio of the small, almost residual, herd of fur sea (*Arctocephalus australis*) in the Falkland Islands. I the course of it a number of animals were kille among them several bulls, or 'wigs' in the sealer' vocabulary. After handling the bulls' skins ther was left on the unwashed hands a general, no unpleasant, 'seal' smell; but after washing ther remained a definite perfume rather resembling th odour emitted by the common civet when it i pleasurably excited. On one bright, sunny da therefore somewhat warm on the rocks, I passed few feet away from and to leeward of a bull and was able to observe the pleasant perfume, whic was definitely air-borne. If I remember rightly, th seal was a little angry. The seals on which thes observations were made were all met with in summe that is, over the rather extended breeding seaso

At various times I have handled fresh skins of th adult male of the southern sea lion (*Otaria byroni* and on them I have observed a rather stronger an ranker odour which was undoubtedly that of th animals themselves, not of the generally insanitar terrain. This scent contained a suggestion of swee ness in it.

It seems possible that a distinctive odour produce by the adult males of the Otariidae, a family i which the bull occupies territory and waits for cow to come ashore, may be of value to the species as direction indicator to the cows. We cannot estima the distance at which the odour could be observe by the animals—it may be greater than we think.

It would be interesting to know if other worke on the mammals have made observations on scen characteristic, specifically or otherwise, of the su jects. Some of us, at least, have been from childhoo familiar with the 'smell of mice'.

J. E. Hamilton

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Stanley,
Falkland Islands,
South Atlantic.
Dec. 24.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 14

Chadwick Trust (in the Barnes Hall of the Royal Society of edicine, 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. Huntington illiams (U.S A.): "The Influence of Chadwick on American Public ealth"* (Chadwick Public Lecture)

British Society for the History of Science, Philosophy of ience Group (in the Joint Staff Common Room, University College, wer Street, London, W.C 1), at 5.30 p m.—Mr. A. G. N Weddell: roblems of Cutaneous Sensation".

University of London (in the Anatomy Theatre, University llege, Gower Street, London, W.C.1), at 5.30 p m —Prof F. S. denheimer (Jerusalem): "The Growth of Knowledge of Animals Palestine from Palæolithic Times".* (Further Lectures on May 16 d 17.)

Institution of Electrical Engineers, Education Discussion rcle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on n Elementary Presentation of the Principles of Magnetism and ectromagnetic Induction, with Demonstrations". Opening Speaker: of. K. A. Hayes

Royal Society of Arts (at John Adam Street, Adelphi, London, .C 2), at 6 p m.—Prof. David V. Glass: "Some Aspects of the velopment of Demography". (Second of three Cantor Lectures on ecent Studies of Sociology")

Institute of Metal Finishing (at the Northampton Polytechnic, . John Street, London, E C 1), at 6.15 p.m.—Mr. C. H. Rumble: he Processing of Gramophone Matrices".

Monday, May 14—Thursday, May 17

Physical Society (in the Royal Horticultural Society's Old and w Halls, Westminster, London, S.W.1)—40th (1956) Annual hibition of Scientific Instruments and Apparatus.

Discourses and Demonstration Lectures.

nday, May 14

At 6.15 p.m.—Mr. H. G. Jenkins: "Recent Developments in Light urces".

esday, May 15

At 6.15 p.m.—Prof. H. Lipson: "The Production of Images of emical Molecules".

ednesday, May 16

At 6.15 p.m.—Mr. G. G. Gouriet: "Colour Television—Considera- ns which have led to Recent Trends".

Tuesday, May 15

Wright-Fleming Institute of Microbiology (at St. Mary's spital Medical School, London, W 2), at 5 p.m —Dr. W. E van yningen: "Recent Trends in Research on Bacterial Toxins"* mroth Wright Lecture).

ron and Steel Institute (at the Royal Institution, Albemarle eet, London, W.1), at 6 30 p.m.—Mr. James Mitchell: Bessemer tenary Lecture.

Royal Aeronautical Society (at 4 Hamilton Place, London,), at 7 p.m.—Dr. A. Buchanan Barbour: "Medical Aspects of ght Comfort and Efficiency".

niversity of London (at the Institute of Archæology, Inner le, Regent's Park, London, N.W.1), at 8 15 p.m.—Prof. V. G. lde: "The Primary Spread of Neolithic Farmers in Temperate ope"* (Third of seven lectures on "The Dawn of European ilization—Thirty Years After". Further Lectures on May 22, 29, e 5 and 12)

Wednesday, May 16

oyal Society of Arts (at John Adam Street, Adelphi, London, .2), at 2.30 p.m —Commander C. G. Mayer, U.S.N.R.: "Electronic tography" (Peter Le Neve Foster Lecture).

eological Society of London (at Burlington House, Piccadilly, don, W.1), at 5 p.m.—Mr. R. W. R. Rutland: "Structure, Meta- phism and Granite Emplacement in the Sokunvatn Area of thern Norway"; Dr W. J. Phillips: "The Criffel-Dalbeattie nodiorite Complex" (to be read by Prof. A Wood).

nstitute of Navigation (at the Royal Geographical Society, ensington Gore, London, S.W.7), at 5 p.m.—Mr. G. P. B. Naish: e James Cook Exhibition at Greenwich"; Mr. C. H Gibbs-Smith, D. N. Harrison and Mr. C. S Durst: "Ballooning".

oyal Meteorological Society (at 49 Cromwell Road, London, .7), at 5 p.m.—Scientific Papers.

oyal Society of Medicine, Comparative Medicine Section 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General ting; followed by a Discussion on "Learning in Man and Animals".

oyal Statistical Society (at the London School of Hygiene and ical Medicine, Keppel Street, London, W.C.1), at 5.15 p m.— Dorothy Cole and Mr J. E. G. Utting: "Estimating Expenditure, ng and Income from Household Budgets".

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W C.1), at 5.30 p m.—Dr K. W. Keohane and Dr. W. K. Metcalf: "Microspectrophotometry of Hæmoglobin Using the Burch Microscope".

Wednesday, May 16—Thursday, May 17

Iron and Steel Institute (at the Royal Institution, Albemarle Street, London, W.1, and at 4 Grosvenor Square, London, S.W.1)—Eighty-Seventh Annual General Meeting.

Wednesday, May 16

(At the Royal Institution). At 11.45 a.m.—Prof. N. F. Mott, F.R S: Ninth Hatfield Memorial Lecture.

Thursday, May 17

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 4 p.m — Annual General Meeting. 5.15 p.m.—Prof. C. W. Dannatt—Presidential Address.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. J. C. Swallow "Research in the Plastics Division of Imperial Chemical Industries Limited".

London Mathematical Society (at the University, Nottingham), at 5 p.m.—Dr. E. F Collingwood: "Cluster Sets and Prime Ends".

Royal Aeronautical Society (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Sir William Farren, F.R.S.: "The Aerodynamic Art" (44th Wilbur Wright Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p m —Dr. B. B. Waddy: "Organization and Work of the Gold Coast Medical Field Units".

Friday, May 18

British Psychological Society, Industrial Section (in Room 425, Birkbeck College, Malet Street, London, W.C.1), at 1 p m.—Mr. R. N. Tronchin-James: "The Personality Structure of Senior Industrial Executives"; Mr. V. W. Wilson: "Some Personality Characteristics of Industrial Executives".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Computer (with G.C.E. with mathematics at "A" level, or equivalent qualifications) in the Scientific Department in London, to work with scientists engaged on a variety of mathematical and statistical problems—National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/£65 (May 18).

Senior Lecturer in Production Engineering, and a Senior Lecturer in Applied Thermodynamics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (May 18)

Lecturer or Assistant (Grade B) (with special qualifications in plant physiology) in Botany—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S W.3 (May 23).

Assistant Lecturer in Pure Mathematics—The Registrar, The University, Nottingham (May 26).

Lecturer or Assistant Lecturer in Zoology—The Secretary, Bedford College (University of London), Regent's Park, London, N W.1 (May 26).

Assistant Lecturer (with special qualifications in physical chemistry) in Chemistry—The Registrar, The University, Manchester (May 28)

Lecturer (with special experience in virus diseases) in Microbiology—The Secretary, The Queen's University, Belfast (May 30).

Lecturer (with research experience in aeronautics, preferably in the field of high speed aerodynamics) in Aeronautical Engineering—The Secretary, The Queen's University, Belfast (May 30).

Abstractor, Scientific Assistant grade (with a degree in agriculture or natural science, a knowledge of languages, and the ability to write clear concise English), for duties which mainly consist of abstracting world scientific literature on grassland and field crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks (May 31).

Assistant Lecturer in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (May 31)

Assistant Lecturer (with a good honours degree) in Pure Mathematics—The Registrar, King's College, Strand, London, W.C.2 (May 31)

Junior Lecturer (medically qualified graduate) in Pharmacology—The Dean, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (May 31).

Lecturer in Pharmaceutics, and a Lecturer in Pharmaceutical Chemistry, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C 1 (May 31).

Lecturer (with an honours degree in chemistry with considerable research experience and special interests in physical chemistry) in Physical Chemistry—The Registrar, College of Technology, Manchester 1 (June 1).

Physiologist or Biochemist (preferably honours science graduate with a knowledge of, or willingness to learn, foreign languages, especially German) to join a team on information work and abstracting—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading (June 1)

Principal of the Wellington Technical College, New Zealand, to be in charge of a technical high school and a large number of day and evening technical classes, and act as Secretary to the Board of Managers—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (June 1).

Lecturer in Physiology at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (June 4).

Chair of Chemistry—The Registrar, University College, Singleton Park, Swansea (June 5).

Lecturer in Education at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 7).

Physicists and **Electrical Engineers** (with a first- or second-class honours degree or equivalent in physics or electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.148/6A (June 8).

University Lecturer (with an honours degree in pure science with organic chemistry and biochemistry as principal subjects) **in Animal Nutrition**—The Secretary, School of Agriculture, Downing Street, Cambridge (June 8).

Lecturer or **Assistant Lecturer** (with special qualifications in organic chemistry) **in Chemistry**—The Registrar, The University, Manchester 13 (June 11).

Lecturer in Geology with responsibility for mineralogy and petrology to special degree standard, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 15).

Chair of Philosophy at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (June 23).

Lecturer or **Senior Lecturer** (with a university degree in civil and/or agricultural engineering, and some interest in structures and building planning) **in Agricultural Engineering** at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

Senior Research Fellow (with experience in electronic physics) for the development, under the direction of Prof. G. Porter, of pulse and rapid recording techniques for the study of fast reactions—The Registrar, The University, Sheffield (June 30).

Research Students (with the degree of Bachelor or Master of a British university other than Manchester) **in Science**—The Registrar, The University, Manchester 13 (July 1).

Assistant Experimental Officer (graduate in chemistry or biology, or both) **in the Unit for the Study of Biochemical Problems in Relation to Fisheries**, for duties which will include the estimation of vitamins in, and histology and culture of, aquatic organisms—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/6

Entomological Field Officer (with Inter.B.Sc., and between the age of 24 and 45) **in the Medical Department**, Kenya Government, to perform laboratory duties and assist with entomological research (including safari work)—Crown Agents, 4 Millbank, London, S W 1, quoting M3A/43289/NF.

Laboratory Assistant for School Physics Laboratory—Mr. P. Bateman, Highgate School, London, N.6.

Lecturer or **Assistant Professor in the Department of Mathematics**, Joint Faculty of Arts and Science at Dalhousie and King's Universities—The Dean of Arts and Science, Dalhousie University, Halifax, Nova Scotia, Canada.

Mathematician (preferably with a knowledge of electronics) to assist in the operation and development of an electronic digital computer used in the Statistics Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Physical Chemist (graduate or equivalent), to take charge of the Polymer Characterization Section—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Physicist in the Radiotherapy Department, to work with staff of the Department on a research programme on moving beam X-ray therapy dosage—Hospital Secretary, Royal Northern Hospital, Holloway Road, London, N.7.

Scientific Officer (Control) (with a good honours degree in either zoology, entomology, agricultural chemistry or physics or allied subjects) **in the International Red Locust Control Service**, Abercorn, Northern Rhodesia, to carry out operational research on the chemical control of red locusts in the outbreak areas in Tanganyika and Northern Rhodesia—The Crown Agents, 4 Millbank, London, S.W.1, quoting Ref. M3B/43298/TA.

Senior Laboratory Technician (with experience in laboratory management and glass-blowing) **in the Science Department**—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham.

Senior Technician (with experience in experimental physiology) **in Physiology**—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

Specialist (Chemist) (with at least a second-class honours degree in chemistry, preferably inorganic or physical chemistry, followed by one year's postgraduate training or approved experience in agricultural chemistry including statistical methods) **in the Department of Agriculture**, Gold Coast Local Civil Service, for duties which are concerned with the cultivation of cocoa and include planning and execution of research into soil fertility, field work in connexion with the use of inorganic manures, and the administration of staff, equipment and laboratory—Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/13/022.

Veterinary Bacteriologist (expert in the preparation of serums and vaccines) **in the Veterinary Laboratory** of the Directorate General of Veterinary Services, Iraq—The Ministry of Labour and National Service (A.S.12), Almack House, 26–28 King Street, London, S.W.1, quoting A.12/IRQ/162/ME

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Animal Husbandry: a Series of Lectures delivered during the 1954 55 Session under the Devon County Agricultural Association Lectureship. By Prof. J. E. Nichols. Pp. iii+40. (Newton Abbot: Seale Hayne Agricultural College, 1956.) 4*s*. [22

British Broadcasting Corporation: Engineering Division. Monc graph No. 5: Reproducing Equipment for Fine-Groove Record By G. V. Buckley, W. R. Hawkins, H. J. Houlgate and J. N. B. Percy Pp. 20. (London: British Broadcasting Corporation, 1956.) 5*s*. [22

Scottish Home Department. Freshwater and Salmon Fisherie Research. No. 11: Records of Salmon and Sea Trout caught at Sea By K. H. Balmain and W. M. Shearer. Pp. 12. (Edinburgh: H.M Stationery Office, 1956.) 3*s*. net. [22

University of London. University College Annual Report, 1954 1955. Pp. 81. (London: University College, 1956.) [24

University of Nottingham. Plant Growth and the Weather. B Prof. F. L. Milthorpe. (An Inaugural Lecture delivered at the Univer sity of Nottingham, 14th October, 1955.) Pp. 12. (Nottingham The University, 1956.) 1*s*. 6*d*. [24

Carnegie Trust for the Universities of Scotland. Fifty-Fourt Annual Report (for the year 1954–1955) submitted by the Executiv Committee to the Trustees on 20th February 1956. Pp. iv+72 (Edinburgh: Carnegie Trust for the Universities of Scotlanc 1956.) [24

Aluminium Development Association. Research Report No. 29 Local Instability Problems of Light Alloy Struts. By Dr. P. S. Bulsoı Pp. 75. 7*s*. 6*d*. Research Report No. 30: Investigations into th Optimum Dimensions for Countersunk Points for Aluminium Rivet particularly for Marine Work. By A. W. Brace and Dr. A. B. Watt Pp. 28. 7*s*. 6*d*. (London: Aluminium Development Associatio 1955.) [24

Other Countries

Research Bulletin of the Panjab University: No. 72 (Zoology) The Morphology of Chromosomes in *Laccotrephes Maculatis* Fab (Hemiptera-Heteroptera). By G P. Sharma and Ram Parshad. P 67–72. Rs. 1/–/–. No. 73 (Chemistry): Potentiometric Determinatio of Organic Compounds by Iodine Monobromide in Non-Aqueous So vent. By Balwant Singh and Mohan Singh. Pp. 73–90. Rs. 2/8/- No. 74 (Zoology): On the Origin of the Golgi Dictyosomes from th Mitochondria and Acrosome Formation in the Spermatogenesis of th Slug *Anadenus Altivagus* (Theobald). By Vishwa Nath and Hari Chander Chopra. Pp. 91–100. Rs. 1/12/–. No. 75 (Zoology): Studi in Reptilian Spermatogenesis. 1: Spermatogenesis of the Chequere Water Snake, *Natrix p. piscator* Schneider, with some Observations the Spermatids of the Krait and the Cobra. By Bhupinder Nath Su Pp. 101–117. Rs. 3/–/–. No. 76 (Zoology): Spermatogenesis of Whi Rat with Observations under the Phase-Contrast Microscope. P Miss Balbir Kaur Dhillon. Pp. 119–130. Rs. 2/4/–. No. 77 (Zoology Spermatogenesis of the Domestic Duck with Observations on Livi Material under the Phase-Contrast Microscope. By Brij L. Gupta. P 131–140. Rs. 2/4/–. No. 78 (Chemistry). Volumetric Studies Oxidation-Reduction Reactions. 6: Oxidation with Chloramine Iodine Cyanide Method. By Balwant Singh and Krishan Chand Sood. Pp. 141–144. Rs. 0/12/–. (Hoshiarpur: Panjab Universit 1955.) [2

Smithsonian Miscellaneous Collections. Vol. 131, No. 3: Synonym cal Notes on Neotropical Flies of the Family Tabanidae (Diptera). G. B. Fairchild. Pp. ii+38. (Publication 4225.) (Washington, D.C Smithsonian Institution, 1956.) [2

Smithsonian Institution. Report of the Secretary and Financ Report of the Executive Committee of the Board of Regents for t year ended June 30, 1955. Pp. ix+178+7 plates. (Publication 423 (Washington, D.C.: Government Printing Office, 1956.) [2

Tanganyika: Geological Survey Department. Bulletin No. 2 The Geology of the Songwe-Kiwira Coalfield, Rungwe District. D. A. Harkin. Pp. vii+33+9 plates. (Dar-es-Salaam: Governme Printer, 1955.) Shs. 7/50. [2

Chicago Natural History Museum. Fieldiana: Geology. Vol. No. 22: The Carboniferous Gastropod Genus *Glabrocingulum* Thom By Robert E. Sloan. Pp. 275–282. 35 cents. Vol. 10, No. 23 T Paragould Meteorite. By Sharat Kumar Roy and Robert Kriss Wya Pp. 283–304. 75 cents. Vol. 12, Nos. 1–4: Pennsylvanian Inver brates of the Mazon Creek Area, Illinois. By Eugene S. Richards Jr. Pp. 76. 2 dollars. Fieldiana: Zoology. Vol. 34, No. 34: Co Snakes of the Genus Micrurus in Columbia. By Karl P. Schmi Pp 337–360. 35 cents. Vol. 34, No. 35: On Some Small Collection Inland Shells from South America. By Fritz Haas. Pp. 361–3 1 dollar. (Chicago: Chicago Natural History Museum, 1955.) [

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CHEMICAL LABORATORY
Date 19-6-56
SCIENCE COLLEGE

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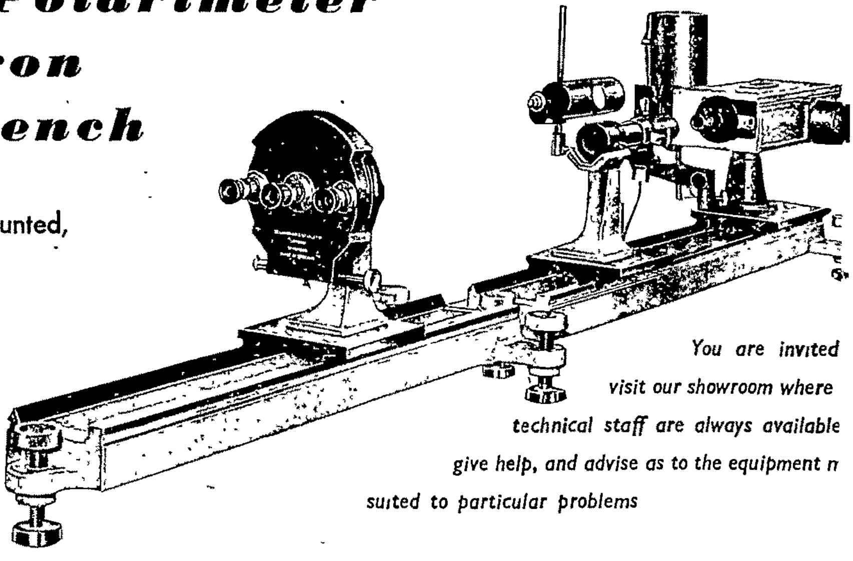

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HIGHER TECHNICAL EDUCATION IN BRITAIN

THE debate on higher technical education on Tees-side, which Mr. H. A. Marquand initiated n the House of Commons on the adjournment on March 29, was not reassuring to those who believe that, in spite of the care taken in the White Paper to distinguish between technical and technological education, the proposal to raise to colleges of advanced technology of university standard some twenty-four or more of the existing technical colleges which receive 75 per cent grant for certain of their advanced work, is likely to spread available man-power and money too thinly. Mr. Marquand, in pressing the claims of the Tees-side area for a college of technology, challenged in the first instance the regional distribution. Eleven of the colleges it is proposed to advance are in the London area, and only five, apart from the Manchester College of Technology, which is not included in the count, are in the north of Engand. Mr. Marquand said quite rightly that a much arger proportion of the industry of Great Britain is to be found in the north than is suggested by these igures, and it is obviously wise, in planning the extension of technological and technical education, particularly with sandwich courses in mind, to pay a good deal of attention to the location of ndustry.

This applies particularly to technical education, and thus far the argument is sound. Mr. J. E. S. Simon, in supporting Mr. Marquand's argument for the development of Constantine College, Middlesbrough, as a regional college of technology for the Tees-side area, suggested that besides this question of balanced distribution, location should also be determined by the existence in the area of a tradition of craftsmanship, and the attitude of local authorities, employers and trade unions. These may well be more important than the last factor to which Mr. Simon referred, namely, the existence of an efficient technical college capable of expansion. The presence of such a college may well, as the debate showed, engender questions of local prestige and involve difficult decisions as to the location of technical and technological education, which are not always carried on with full efficiency in the same institution.

Mr. Arthur Palmer, member for Cleveland, also urged that chemical developments on Tees-side as well as the expansion of other industries, especially steelmaking, make a technological institution of the highest standard desirable on Tees-side; and Mr. David Jones, member for the Hartlepools, agreed that in the Constantine College, Middlesbrough, there is the makings of an institution well situated to meet the needs of the area. The Parliamentary Secretary to the Ministry of Education, Mr. D. Vosper, in replying for the Government, agreed that such considerations should be taken into account and, more specifically, said that the Minister would bear in mind the large developments on Tees-side when deciding which additional colleges should be recognized as colleges of advanced technology. Mr. Vosper reiterated that other colleges besides those named in the White Paper might qualify for the 75 per cent grant, and he explained at some length why the Constantine College had not been named in the White Paper.

Much more important, however, was Mr. Vosper's indication that the White Paper on Technical Education is to be debated in full, when the Minister hopes to elaborate the position of the colleges of advanced technology, and his admission that we must ensure that our limited resources are not spread too thinly. In this welcome admission, Mr. Vosper had particularly in mind the teaching staff, and it is something that the Government should at last recognize that the supply of qualified teachers for advanced work is limited and must therefore be used to the best advantage by building up units of reasonable size. We must not try to provide too many or too varied courses in any particular place.

That, of course, is the real indictment of the Government's proposals as set out in the White Paper, coupled with anomalies such as the treatment of the College of Technology, Manchester, the Imperial College of Science and Technology, and the Royal Technical College, Glasgow, separately from other technological institutions. If the resources for technological education in Britain are to be deployed to the best advantage, they must be planned as a whole, whether training is given in a university department or in a college of technology. The responsibility must be placed fairly and squarely on some one authority, and if this cannot be borne by the University Grants Committee, an appropriate body must be created for the purpose.

Mr. Vosper's reply on March 29 indicates how far the Government has yet to go in facing the realities of the situation; nor did Mr. Vosper give any indication that the Minister of Education is likely to grapple with the problems that parochial rivalries will engender for an adequate regional plan for not more than a dozen colleges of technology where higher technological education is given under appropriate conditions of teaching and research. Those issues cannot be avoided, and the earlier they are faced and tackled the more likely we are to secure the understanding, goodwill and co-operation which have marked the relinquishing of local control over the College of Technology in Manchester. Moreover, if the issue is grasped with imagination and the expansion of technical education is tackled with the energy and understanding as well as on the scale it demands, there should be little chance of any local dissatisfaction that a particular technical college has not been raised to a college of technology.

It should be emphasized, in fact, that the difference between a college of technology and a technical college, between technologist and technician, is qualitative, and not one of social status. We need many more technicians than technologists; but their work is just as important and satisfying, and the idea of inferiority should be attacked wherever it displays itself. It is the difference in the nature of the instruction to be given and the conditions required that make it difficult for justice to be done to both types of training within the same institution. It is to be hoped that the forthcoming debate will force the Government to declare itself much more fully about its proposals for the expansion of technical education, that is, the training of technicians, than it has done in the White Paper.

It would appear improbable that in the forthcoming debate the plans of the universities over the next quinquennium for technological education will be made known; and until those plans are revealed, the adequacy of the Government's proposals for the expansion of technological education cannot be assessed. What needs to be emphasized now is that we are most likely to develop the resources of Britain to the best advantage if technological education, if not technical education also, is placed under the responsibility of one body of the standing of the University Grants Committee. Not only Dr. Venables in his recent book, but also Lord Waverley, at the annual luncheon of the Parliamentary and Scientific Committee on February 27, and others, have strongly pressed this view.

Financing the colleges of technology on a basis similar to that established under the University Grants Committee would give the colleges the status and independence which would help to attract staff of the highest ability; and the principle of quinquennial grants would greatly facilitate the undertaking of research on an adequate scale. Even more important, the standing of such a body would give its recommendations on technical education as well as technological education an authority which the Minister of Education could not ignore, and which should strengthen his hand in dealing with those authorities who, for any reason, were unwilling or unable to co-operate or maintain the standards which the national interest indicates. Technical and technological education cannot be sharply separated; but a body of this character would be well placed to indicate ways and means which would avoid placing on local authorities responsibilities they should not fairly be expected to meet from local funds.

While, however, the Government hesitates and, lacking the courage to deal with the real difficulty, has called into being what Dr. D. S. Anderson terms an entirely unnecessary body in the National Council for Awards in Technology, there is a remarkable unanimity of opinion among those best qualified to judge the needs of both technological and technical education in Britain. Dr. Anderson, addressing the Northern Counties Technical Examinations Council on February 14, emphasized the importance of sandwich courses. Like Dr. Venables, he believes these will be the major development of the next decade; but, unlike the White Paper, he detailed the conditions which should be met before an institution can efficiently participate in such schemes. These conditions would limit potential ultimate expansion to some twenty institutions at most, if the scheme was to lead to an award recognized as at least equivalent to a university degree. Moreover, Dr. Anderson pointed to the value of the co-operation to be obtained from the professional institutions, which the Government has ignored, as well as to the importance of greater co-operation with industry; and he stressed particularly the possibilities of making greater use of the staffs of technical colleges for consulting work and also the importance of making opportunities, by shorter sessions and a longer summer vacation, to keep up to date and maintain closer contact with industry.

These are not simple problems; but they should not be ignored and left unsolved as the Government proposes. Moreover, the release of teachers to return to industry and be brought up to date in the latest manufacturing technique is related to such problems as the education of older engineers which was discussed last January at a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers. Since the Second World War, the number of postgraduate courses available not only for engineers, but also for chemists, physicists and others, has greatly increased, and they are probably provided by most universities and colleges of technology in Britain. It does not appear, however, from either the papers presented or the subsequent discussion, that we have yet learned the best ways of presenting such courses, or are able to assess the real value of such short courses compared with the university or technological course of, say, six months duration. Nor is it clear where such courses are best organized.

The answers to such problems involve questions about the release of staff on both sides, or even its transfer from industry to the colleges of technology or vice versa, and much more critical and constructive thinking must be given to them if the essential co-operation from industry is to be secured. The point to be emphasized here is that the conditions created in both colleges of technology and the technical colleges by the proposed expansion should be such as to facilitate these developments and make the interchange and release of staff easier and no more difficult. Nor is it simply that postgraduate courses are designed to provide industry's leavening of men capable of technical leadership and really advanced thinking with the opportunities of advanced theoretical study they require. They are also part of the means of disseminating rapidly throughout industry knowledge of the latest techniques of design and knowledge.

In this sense both technical colleges and colleges of technology in Britain must form part, if not the nucleus, of a public technical information service. They cannot, however, add this to their primary function of teaching, if not of research, unless they are adequately equipped. The plain truth is that, as was pointed out in a memorandum recently prepared by the Library Association to the Scientific and Technical Information Committee of the Advisory Council on Scientific Policy, and is amply confirmed by the returns from the University Grants Com ttee, there is scarcely a major technological institution in Britain that is at present adequately equipped to render the library service alone that its wn staff and students need. Standards not merely f equipment and in the provision of space for readers ut also of expenditure on books and periodicals need o be expanded, quite apart from any prospective crease in the present number of students, before the olleges of technology or technical colleges can hope o make any useful contribution to the regional echnical library and information service that dmittedly is required to further the more effective tilization of existing knowledge.

This is only one respect in which the Government's resent proposals are unrealistic and appear to pay nsufficient attention to what needs to be done to aise the standards of even a dozen institutions in ritain to enable them to give efficient regional ervice in respect of teaching, research and the dis-emination of information. There are other respects n which more could be done to eliminate waste and ecure the full use of existing facilities. Nothing that e Prime Minister said to the Parliamentary and cientific Committee on February 29 removed such isgivings. Sir Anthony Eden repeated that it is the tention to increase the output of 'technologists' om some twenty or more technical colleges by fifty er cent, and that these colleges must have a high atus and be as independent as possible. He did not dicate, however, where the necessary qualified staff to be obtained; nor did he enlarge on the plans expand the output of technicians and craftsmen om the other technical colleges. Until such plans e indicated more precisely, it is probable that the ore nearly the Government's proposals to produce nother 2,500 technologists a year succeed, the more rious will be the effect on the output of supporting chnicians and craftsmen.

There are thus numerous points on which the overnment should be pressed to elaborate its plans nd to modify the proposals set forth in the White aper. But there are some hopeful features of the tuation. The Industrial Fund for the Advancement f Scientific Education in Schools, already within ght of its financial target of £3·5 million, should ntribute to encourage more boys and girls to take p careers in science, provided that full use is ade of the new special responsibility allowances nd other measures to deal with the shortage of ience masters. The scholarship scheme recently ndowed by Imperial Chemical Industries to enable hool children who have taken arts subjects at hool to enter the universities to train as scientists ould, like the scheme announced last year for the niversity of Liverpool, and the preliminary science ourse at the Imperial College of Science and Tech-ology, enable more school leavers to transfer from rts to science. Among the best proposals in the hite Paper are those which will permit State holarships to be held for courses leading to awards technology. There is still room, however, for other niversities and for local education authorities to romote these trends by their own action, and it hould be borne in mind that a similar scheme at University College, Oxford, met with so disappointing a response that no award could be made.

Moreover, at the other end, to which also Dr. Anderson referred, the concern of technical colleges with training for management is checking excessive specialization and encouraging the broad education, stressed alike in the White Paper and more recently at the Conference of the British Institute of Management and the Institute of Industrial Administration at Southport during March 20–21. We need, as Mr. D. R. O. Thomas urged there, men who can evaluate the significance of technology and science, who are responsive to ideas over a wide front and are capable of accepting responsibility and acting with courage and decision. We need also technicians and craftsmen who appreciate the significance of change and are ready, as well as competent, to adopt new techniques and products; and it should be noted that at the annual conference of the National Association for the Advancement of Education for Commerce, Mr. J. P. Jones's plea for liberal studies in technical courses found general support.

Perhaps the best feature of the discussion now proceeding on the expansion of technical and technological education in Britain is that it contributes to a fuller public understanding of all that is involved. Such understanding is essential if we are to secure for the technical college the amenities which Dr. Anderson rightly stressed as indispensable to enable it to fulfil its real function. It is equally essential in order to ensure that the expansion of technological education is carried out not as something apart, but as one element in the development of the whole education system of Britain, to equip the youth of the nation to play its fitting part in the age of nuclear energy, of the automatic factory and of other rapid technical changes on which the world is entering. That at least is what is implied in any action to give effect to recommendations which may come in due course from the Crowther Committee set up on March 2.

BIOCHEMICAL GENETICS

Genetics and Metabolism

By Robert P. Wagner and Herschel K. Mitchell. Pp. xi+444. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 60*s*. net.

It is probable that within the next generation the science of genetics may split. If so, one branch will perhaps unite with biochemistry. It will be concerned with processes which are understood at the molecular level. For example, what is now called crossing-over will probably be called transphosphorylation in nucleic acid chain molecules, and what is now called mutation will turn out to consist of several rather disparate processes. Another section will deal with developmental processes not yet reduced to biochemistry, and a third with the genetics of populations.

The book under review can be thought of as a pioneer exposition of the unified sciences of biochemical genetics and dynamical biochemistry. The authors are best known for their work on *Neurospora*, and Chapters 5 and 8, which are mainly concerned with this fungus, are particularly good. The book can be read by a student who does not know very much biochemistry or genetics; for it attempts to describe cellular structure, and the nature of enzymes and genes, and ends up with the discussion of a number of developmental questions, including the very fundamental one of 'self-duplicating' units outside the nucleus. Were it not for its price, I should recommend it to every student of biology.

It is so good that I have little doubt that a new edition will soon be needed, and it is therefore constructive to point out what seem to me to be defects in it. The discovery of the yellow anthochlor pigments derived from benzalcoumarone by Geissmann and his colleagues should have been included in Chapter 4, much of which was out of date when written. The treatment of human genetics is inadequate, particularly as this branch of genetics furnishes so many striking examples of conditions due to the absence of a specific enzyme, such as acatalasæmia, phenylketonuria and, more recently, galactosæmia. Again, human blood may fail to coagulate owing to the lack of any of six different proteins, each of the syntheses of which is controlled by a different gene. Most of them do not seem to be enzymes, in the ordinary sense of that word, and they are perhaps a model for systems which will later be discovered within cells. The account of the metabolism of homogentisate refers to no work since 1914, nor does that of the blood group antigens describe the work either of Morgan and his colleagues, or of Kabat and his colleagues, on their composition.

As I know to my cost, the compilation of a book on this subject involves very wide reading of periodicals, and the above criticisms are made in sympathy rather than malice. To sum up, the book was badly needed, and I hope that it will be widely read. But just because it is a pioneering effort, it lacks some of the balance and completeness which are to be expected in texts on a topic that has been systematically taught for some decades.

J. B. S. HALDANE

A NEW SYNTHESIS OF SPECIAL RELATIVITY

Relativity

The Special Theory. By Prof. J. L. Synge. (Series in Physics.) Pp. xiv+450. (Amsterdam: North-Holland Publishing Company, 1956.) 38 florins; 76*s*.

THIS notable book was originally planned to cover both the special and the general theories of relativity, but the special theory developed in such a way that, in the end, the general theory had to be omitted. The evident enjoyment with which it was written conveys itself to the reader, and even the sections dealing with the more classical parts of relativity show something of the excitement of fresh discovery. The book represents a breakaway from traditional modes of presentation. Here are no trains, or embankments, or lightning-flashes striking rails, or even the Michelson–Morley experiment except as an incidental. Neither is there a formal series of postulates and theorems designed to display logical self-consistency. Hypotheses are clearly stated as the need for them arises, and points of logical, physical or philosophical difficulty are never shirke self-consistency thereby being made apparent wit out fuss. Prof. J. L. Synge, remarking that the pu pose of a mathematical model is to assist in th exploration of Nature, expresses the opinion that " theory in mathematical physics is to be judge primarily on the basis of its logical consistency an only secondarily on the basis of the truth of it physical predictions", both Newtonian and relativisti mechanics being thus unassailable as mathematic models. With that doctrine one may well agre provided a given model does, in fact, fulfil the state purpose.

The basic plan of the book is to utilize fou dimensional geometrical ideas to the full, whil keeping their physical meaning and descriptio always in mind. The essential properties of Minkowskian four-space in relation to physical concepts ar established in the first three chapters with a clarit characteristic of the author. This is followed by full and fresh account of the Lorentz transformatio and its physical significance. Here and afterward the switch from the geometrical to the physica description, and vice versa, is constantly an illuminatingly made. A consequence is that, for all it comprehensiveness, the book is perhaps more suite to mature readers than to beginners in this field.

Nothing much short of a page-by-page account the author's arguments, methods and results coul do full justice to an interesting and lively book After a chapter on the mechanics of a particle including collision and disintegration problems, h proceeds to the mechanics of a discrete system. Here in order to obviate the difficulty caused by the absenc in relativity of a law of action and reaction excep for particles in direct contact, he uses his ow tentative theory of "internal impulses", these bein hypothetical entities, possessing energy and momentum, which the physical particles of the system ar supposed to fire at one another. Applied to tw particles only, with a single internal impulse shuttlin between them, the inverse-square law emerges as first approximation when the relative speeds of th particles are small compared with that of light. Thi remarkable deduction of the inverse-square law ma cause the reader to raise an admiring or a sceptica eyebrow according to his prejudices. Prof. Syng himself expresses no more than interest coupled wit a doubt about the general validity of his scheme fo physics as a whole.

From the mechanics of a discrete system he passe to that of a continuum by using statistical method This leads to the introduction of the energy tenso and to the macroscopic theory. The remainder o the book is devoted to electromagnetism, and contain a great deal of both mathematical and physica interest, including wave theory. A particularl interesting section is devoted to electromagneti shock-waves.

But, it may be asked, is all of this properl described as special relativity ? It comes very nea to being a general theory in which physical phenomen are mapped upon a flat Minkowskian four-spac instead of upon a curved space as in general relativit proper. It is admittedly a theory in which Lorent invariance is the dominating feature, and this doe perhaps legitimize its description as special. It ma be hoped that the second volume on general relativity promised by the publisher on the dust-cover, will i fact appear, for the present volume stimulates an appetite for more. The foundations of a furthe olume are here laid by a consistent use of tensor nd geometrical methods.

The book is full of wise saws and modern instances, ll eminently quotable if space did but permit. It is heerful in style, profusely illustrated by diagrams, nd beautifully printed. That its author himself directs attention to the debatable nature of some of is work in no way lessens its interest, but on the ontrary makes it all the more stimulating. The ure mathematics in it is alone sufficient to make it n important contribution to the literature of elativity.

H. S. Ruse

THE ORIGINS OF INTELLECT

he Child's Construction of Reality

y Prof. Jean Piaget. (Translated from the French
y Margaret Cook.) Pp. xiii+389. (London : Rout-
edge and Kegan Paul, Ltd., 1955.) 25*s.* net.

THIS is a companion volume to Prof. J. Piaget's earlier book on "The Origins of Intelligence in he Child" and should be studied in close connexion with it. In his earlier work, Prof. Piaget aimed to define the processes by which the young child comes o create an external world ; in the present volume, e devotes his attention more specifically to the nature of the world created. In short, we are now oncerned with the products of the child's thinking ather than with the thought processes themselves. None the less, the two aspects—subjective and bjective—are so closely related that an independent reatment of either is scarcely possible. For this eason, it is necessary to consider the two books ssentially as one.

The growth of the child's conception of external eality is treated by Prof. Piaget under four main spects : first, the development of object-concepts nd the correlated treatment of objects as being oth individual and permanent ; secondly, the volution of a spatial framework common to all ensory modalities ; thirdly, the development of deas of causal relationship ; and fourthly, the rganization of a temporal field endowing external vents with some measure of coherence. These four rocesses, which are of course closely inter-related, re supposed by Piaget to develop through a series f well-marked stages, and his main task in the resent book is to reconstruct the nature of the hild's world at each stage. In some measure he ould appear to succeed. The main theoretical onclusions derived from the two studies are brought ogether in a final section of this volume.

Although Prof. Piaget's systematic psychology s difficult, and at times obscure, his work brings ut a number of points of the highest interest and mportance. For example, his careful observations f the earliest reflex patterns make it clear that some measure of adaptation of response to the finer haracteristics of the stimulus field appears to be resent *ab initio*. This makes possible a theoretical reatment of reflex action much less rigid and mechan- tic than is *de rigueur* in present-day psychology, and ermits an altogether easier transition from the more o the less automatic varieties of behaviour. Again, Prof. Piaget's treatment of spatial perception clearly rings out that this activity, from a genetic point of iew at least, cannot be considered apart from the study of movement. Space, as he rightly points out, s an organization of movements such as to impose upon perception spatial relations that are increasingly precise and coherent. More generally, space may be regarded as a product of interaction between the organism and the environment in which it is impossible to dissociate the content perceived from the motor activity of the percipient. Although statements of this kind are perhaps too broad to convince, they serve at least to focus attention upon the rôle of action in the growth of our knowledge of the external world. Prof. Piaget's evidence may also be of great value to neurologists and others interested in the breakdown of spatial perception in abnormal states of the central nervous system.

Although Prof. Piaget bases his arguments throughout on empirical considerations, it cannot be said that the material presented in this volume possesses any great evidential value. It consists in the main of some two hundred observations—some little better than anecdotes—which the author has made on three young children (presumably his own), and no attempt is made to confirm the findings by means of appropriate large-scale inquiry. Indeed, many of these observations, despite their undoubted perspicacity, do little more than provide apposite illustrations of the author's theoretical contentions. Examples have great value so long as they are not confounded with evidence. Can we be quite sure that Prof. Piaget is himself free from this source of confusion ?

This book is original and thought-provoking. Prof. Piaget is perhaps the last of the great psychological system-builders. Although a whole host of empirical researches have been woven into the fabric of his system, it remains at bottom personal, speculative and unverifiable. It is not science, but it may well be the necessary precursor of a scientific psychology.

O. L. Zangwill

ARRESTED GROWTH IN ARTHROPODS

The Physiology of Diapause in Arthropods

By Dr. A. D. Lees. (Cambridge Monographs in Experimental Biology—No. 4.) Pp. x+151. (Cambridge : At the University Press, 1955.) 12*s.* 6*d.* net.

THE periodic arrest of growth or reproduction that is so characteristic of the life of arthropods in temperate latitudes forms one of those subjects which provide problems of the greatest theoretical interest and at the same time are of much practical importance to the applied biologist and the farmer. As his title implies, in this latest volume in the Cambridge Monographs in Experimental Biology Dr. A. D. Lees is concerned primarily with the more fundamental aspects of diapause : the physiological nature of the arrest and the ways in which its timing is regulated to fit in with the possibilities of life at each season. At one time diapause was regarded primarily as a state of subdued metabolism. Then it came to be thought of rather as an arrest of growth, the reduced metabolism being secondary ; and when growth in the insect was shown to be dependent upon the secretion of hormones, the theory was put forward by Wigglesworth that the immediate cause of diapause was a failure in this secretion. By and large that conception has been supported by experiment : in the pupa in diapause the neurosecretory cells in the brain are inactive.

But many insects, during the summer months, can pass through a number of generations without any arrest. With the approach of autumn diapause supervenes. By what token does the insect know that winter is coming? During the past few years it has been shown, in a wide range of species, that the absolute day-length is the most important sign: as soon as the light period is reduced to twelve or thirteen hours diapause supervenes. Falling temperature and reduction in the nutritional value of the foliage are important in varying degrees in different species; in some these factors may override the effect of day-length. It is also interesting to note that in at least one insect, the larva of a dragonfly, the *change* in day-length after the summer solstice is the important factor. What is still obscure is the nature of the connecting links between the duration of illumination and the inactivation of the neurosecretory cells in the brain. Presumably some photochemical reaction is the first step. The papers dealing with this rapidly developing subject are many of them scattered among the Russian and Japanese journals. One of the most valuable features of Dr. Lees's book is that all this material is critically assessed for the first time.

Since the classic researches of Duclaux it has been known that a more-or-less extended period at a very low temperature is necessary in order to 'break' diapause and to bring the insect to a state when it can once more develop in a favourable environment. This apparently mysterious change has been put in a proper perspective by the work of Andrewartha, who has pointed out that this progressive change is affected by temperature just like any other physiological process; but that it has an unusually low temperature optimum, usually around 5° or 10° C. The nature of this process, sometimes called 'diapause development', is still obscure.

All these matters, as described by Lees, make a fascinating story, closely argued and well written.

MINERAL DRESSING

An Introduction to Mineral Dressing

By E. J. Pryor. Pp. xii+649. (London: Mining Publications, Ltd., 1955.) 70*s.*

THIS, the first text-book on mineral dressing to be published in Great Britain since 1923, is based upon the elementary course in mineral dressing given to students of the Royal School of Mines, London. It is good in its conception and in much of its execution, especially the general lay-out and arrangement of subject-matter. Criticisms in this review are intended to be read in the light of the essential quality of the book; they are also intended to direct attention to shortcomings which, it is hoped, will be rectified in a second edition that the book well deserves.

It contains a very great deal of information, much more than might be expected in an introduction to the subject; indeed, in some sections, the author goes into great detail, much of it unnecessary and possibly disconcerting to those taking an elementary introductory course. Such people are, or should be, concerned with principles—as the author implies on p. 2. It seems out of place in an introduction of this sort to discuss, as the author does in places, details of what the alert [*sic*] shiftsman should do in controlling a mineral dressing plant; such details properly belong to practical application of principles

The style in places is somewhat pedantic; this may sometimes lead to a confusion in the mind of the reader, who may find it necessary to read some parts two or three times to be certain of what the author means. It may, perhaps, be unfair to selec part of one paragraph to illustrate this, but the following three consecutive sentences which appear in the first chapter could well have been more simply expressed: "A problem in physics can be analysed as Einstein shows, into three phases—the event, its signal and the effect produced on the observer Basic technology, as used in mineral-dressing research seeks to influence the nature of the signal, either by initiating the event or steering its course, and then by substituting for the observer a piece of apparatus which reacts specifically to the signal. With controlled initiation of noumenon, distinctive quality in phenomenon, and unilateral separatory reaction applied technology steps in". These, and othe similar descriptions, could deter a timid reader.

In the quotation made above the term 'mineral-dressing' has a hyphen; elsewhere in the book it ha not. This is typical of lack of attention to detail in writing. There is no uniformity in abbreviations *foot* may appear as foot, ft. or ′; *specific gravity* may be written in full or as sp. gr., s.g., or S.G. Th word *pennyweights* is given three different abbreviations; the British Standard series of sieves is referred to in different places as the B.E.S.A., the B.S.I., o the B.S. series; other terms have two differen abbreviations. The terms gravity, specific gravity and density (no units expressed) are used interchangeably; an example of this occurs in Table 12 where one part of the table is headed: "Bath S.G.= 2·70"; the other part is headed: "Bath Density= 2·80". The value of surface tension for water i given as 72·3 dynes instead of dynes per cm.; n temperature is stated. There are many mor examples of this lack of attention to detail.

It is surprising to find in this book, where Brownia motion is called pedesis, that space is devoted t explaining the significance of the suffixes *-ous* an *-ic*, as in ferrous and ferric, and that sodium hydroxide is called sodium hydrate. But perhaps the most remarkable feature of the book is the almost complete absence of mathematical approaches and explanations. One or two formulæ are given; but the author could have made some of his explanation much simpler if he had used mathematical aid Less than a quarter of the 233 figures have caption Some of the figures are poor and include numbere or lettered parts which are not referred to in th text.

The inclusion of a glossary of terms is good, but th glossary is spoilt by incompleteness and by th seemingly haphazard way in which items have bee selected for inclusion; for example, the word 'flotation' is included, but not 'flocculation'. Similarly the index is incomplete; for example, the Chance process is included, but not the Rheolaveur.

Inadequate attention to details of presentatio detract from a book which could well have bee outstanding. The general method of presentation commendable. It is to be hoped that there will be second edition in which uniformity is ensured, which certain sections (especially those on the physic and chemistry of pulps and on coal cleaning) a improved and from which details of plant operatio are omitted.

S. G. WARD

An Introduction to the Electronic Theory of Valency

By Dr. J. C. Speakman. Third edition. Pp. vii+180. (London: Edward Arnold (Publishers), Ltd., 1955.) 10*s*. 6*d*. net.

OUR ever-increasing knowledge of the structure of molecules and of the bonding of the component atoms not only expands the meaning of the term 'valency' but also makes a text-book account of it difficult to write. The second edition of Dr. J. C. Speakman's well-known introduction to the subject was published in 1943, and it is not surprising that he has now drastically revised it. In the new edition, he has changed the word 'modern' of the title to 'electronic' and has divided his work into two parts. The four chapters forming Part 1 deal, at sixth-form level, with the three chief types of bonds, and the treatment is but little changed from that in the second edition.

Part 2, however, he has almost completely rewritten. In a new chapter (5), without the use of any mathematics, Dr. Speakman has essayed to expound, in what he calls "a pictorial and descriptive way", the molecular configuration of electrons both from the valency-bond and from the molecular-orbital approach. The titles of Chapters 6–11 remain unchanged, but the subject-matter has been rewritten from the modern point of view. The hydrogen bond now gets six pages. Chapter 12 contains an interesting discussion of the meaning of the term valency and of the present-day position of the concept.

Throughout Part 2 Dr. Speakman, while admitting difficulties, apparent contradictions and conflicting views, is temperately critical and nowhere dogmatic. Implicit in his attitude to the subject is the advice to accept approaches to truth for their usefulness and not to let ideas on valency crystallize. His book is a praiseworthy attempt to give a simplified account of the present-day position of this concept.

G. FOWLES

Annuaire pour l'An 1956

Publié par le Bureau des Longitudes, avec un Supplément pour l'An 1957. Pp. viii+729. (Paris: Gauthier-Villars, 1956.) n.p.

THE "Annuaire" for 1956 of the Bureau des Longitudes, together with a supplement for the year 1957, consists of tables, definitions and articles contained on 614 principal and 121 supplementary pages, and several additional folding diagrams illustrative of the text.

The Bureau des Longitudes, constituted on June 25, 1795, by the then French National Convention, consists of fourteen members and six additional members, all of them French nationals, together with thirty internationally distinguished correspondents, not necessarily of French nationality (three are British). It is charged with making recommendations for the improvement of the different branches of astronomy and their application to geography, navigation and the physics of the Earth, and it is responsible for five other regular publications in addition to the "Annuaire".

The present "Annuaire" covers the following subjects: calendars—the principal world calendars and astronomical data associated with them, and tides; geophysics—the data of meteorological, atmospheric electricity and terrestrial magnetic phenomena; time—astronomical data concerning the Sun, Moon, major planets, comets and certain stars; tables of weights and measures; and physical and chemical constants. The articles are "Radio-électricité et opérations mondiales des longitudes", by B. Decaux, and "Les récepteurs photoélectriques", by A. Lallemand.

A Short History of Medicine

By Prof. Erwin H. Ackerknecht. Pp. xviii+258. (New York: The Ronald Press Company, 1955.) 4.50 dollars.

DR. ACKERKNECHT, an accomplished scholar, is professor of the history of medicine in the University of Wisconsin. He has here set himself to provide medical practitioners with a short and simple account of the development of their art and has succeeded admirably The work is concise and well balanced; but perhaps its most outstanding feature is the exceptional skill shown in treating the very intricate developments of the first half of the twentieth century—precisely the period where most such short histories tend to fail. This last chapter is so well done that many practitioners will find the volume a useful reference desk-book which they may conveniently consult for the dates, circumstances and authors of the main modern treatments and remedies. The historical perspective is well maintained throughout though, in my opinion, later editions would gain by condensing or telescoping the pre-Greek medical systems. These are of great interest and are well treated; but their bearing on scientific medicine is too remote to appeal to the audience for which this book is so particularly well designed. Further space might be saved on illustrations, the selection and reproduction of which show less of the care lavished on the text. These are minor and easily reparable faults in a work which I would heartily recommend.

CHARLES SINGER

Stratigraphic Geology

By Maurice Gignoux. English translation from the Fourth French Edition, 1950, by Gwendolyn G. Woodford. (Series of Geology Texts.) Pp. xvi+682. (San Francisco: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1955.) 9.50 dollars; 80*s*.

THE "Géologie stratigraphique" of Maurice Gignoux has been justly famous as an excellent exposition of stratigraphy as seen from the French point of view. Now that its fourth edition has been translated, it has become available to those who prefer to read it in English. The book has not changed its character as a result of G. G. Woodford's successful effort (translations of this kind are notoriously difficult); it has remained intensely French. There is the elegant and didactically effective method of dealing with typical areas in detail, leaving the rest of the world to a generalized treatment. Most examples have been taken from France, and the Alps have received special attention. Herein lies the chief value of the book for the English-speaking reader.

Similarly, references are particularly numerous for France and French territories, especially North Africa. In this edition, the questions of the Sahelian and of the Nummulitic formations of Egypt, Tunisia and Algeria have received careful attention. On the other hand, non-French Continental and British publications have been considered in a very uneven manner, but this is excusable in a work of world-wide scope.

F. E. ZEUNER

NEW METHODS OF PREPARING BLOCK COPOLYMERS

By P. E. M. ALLEN, J. M. DOWNER, G. W. HASTINGS, Prof. H. W. MELVILLE, F.R.S.,
P. MOLYNEUX and J. R. URWIN
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In recent years increasing attention has been given to the problem of the synthesis of block copolymers; that is, of copolymers in which the long-chain molecule contains long sequences of each type of monomer unit, as opposed to the normal copolymer molecule in which the units are distributed quite randomly. The term 'block' copolymer is not standard. We use it to describe linear molecules, whereas branched structures, arising from the attachment of side-chains of one type of monomer unit on to a backbone of the other type, we call 'graft' copolymers.

During the past few years a number of methods for the preparation of block copolymers have been described[1-9]. In most of these methods the yield of block copolymers is small—sometimes of the order of 10 mgm.—and in many cases separation is complicated by the presence of large quantities of other material of high molecular weight. Another complication in some of these systems arises from the difficulty in distinguishing between block and graft copolymer structures. Of all the processes listed above, only that of Woodward and Smets[5] can safely be said to give high yields of an unequivocable block copolymer which may be separated and obtained in a form uncontaminated by homopolymer or graft and random copolymers.

A number of these methods are purely chemical, involving either the use of a bifunctional initiator such as the phthalyl peroxide used by Woodward and Smets, or the introduction of a labile terminal group on to the growing chain by means of a suitable transfer agent such as bromotrichloromethane[2]. Both these methods lead to a homopolymer of the first monomer A containing a labile end-group which may be used to initiate polymerization in a second monomer B, or to couple with a suitable terminal group in a polymer of B. The great advantage of this method is that the first block may be fractionated before proceeding with the second stage, which greatly simplifies the fractionation of the final product. The method described below in which a dihydroperoxide is used to polymerize styrene is of this type. A polystyrene having a terminal hydroperoxide group is obtained, which is fractionated, and fractions having suitable molecular weight are used to polymerize methyl methacrylate.

Alternatively, the block copolymer may be built up in one stage from a continuously growing radical, the change in character of the chain being effected by transferring the radical end from an environment of monomer A to that of monomer B. Methods such as that of Hicks and Melville[3], who devised a method by which polymerizing methyl methacrylate or acrylonitrile may be injected into a large excess of styrene, and that of Dunn and Melville[1] in which the growing radical passes through a phase boundary, from, say, styrene in oil phase to acrylic acid in water, may be included in this group. A method is described here which utilizes the trapped radicals remaining in the polymer particles when an emulsion polymerization is taken to completion.

The methods described so far must all lead to bloc copolymers of the type $A_n.B_m$, or the sandwich-typ molecule $A_lB_mA_n$, depending on the relative pro portions of the combination and disproportionatio radical termination reactions. The third metho does not have this limitation. The essence of th method is to rupture the polymer chain by som mechanical method such as mastication[8], ultrasoni irradiation[4,6], or γ-radiation[9]. Such degradation i not accompanied by the depolymerization reactio characteristic of thermal degradation. If two differen polymers are degraded together, as described belov a cross-termination of the radicals results in a bloc copolymer. Alternatively, a polymer A may b degraded in the presence of monomer B as describe by Henglein[4].

The Dihydroperoxide Method

Monomeric styrene was polymerized in bulk usin *m* di-(hydroperoxy-*iso*propyl) benzene at 50° C. Th polymer formed was freed from initiator by suc cessive precipitations from benzene to methano The presence of hydroperoxy groups in the polyme has been demonstrated by the method of Wagne Smith and Peters[10]. The polymer was then fraction ated by a benzene–methanol solvent–precipitan system.

The second stage was carried out in emulsio The hydroperoxy-ended styrene was dissolved i methyl methacrylate and the solution emulsified wit a 'Manoxol O.T.' soap solution. The polymerizatio was initiated by ferrous ions according to the redo mechanism:

$$R.OOH + Fe^{2+} \rightarrow RO— + OH^- + Fe^{3+}$$

The polymerization was carried out under oxygen free nitrogen at 0° C. In a typical run the tota weight of polymer would increase by about 50 pe cent.

A turbidimetric titration of a benzene solution c the polymer against methanol revealed the presenc of considerable quantities of polymer intermediat in properties between polystyrene and polymeth methacrylate. The turbidimetric titration techniqu is described in more detail below.

A full-scale fractionation was carried out using th benzene–methanol system. Nine fractions were take and their polystyrene content determined b examination of the absorption maximum at 2620 A One fraction of 0·58 gm. was found to be pure poly styrene; three fractions, of total weight 2·28 gm had a styrene content of 82–89 per cent; tw fractions, amounting to 0·22 gm., contained 6 and 69 per cent styrene; and the remainde contained 1·39 gm. of polymer containing 8 pe cent styrene. It is suggested that the 82–89 pe cent styrene fractions arise from polystyrene containing one hydroperoxide group, whereas th 68 per cent fraction comes from dihydroperoxy polystyrenes.

The Emulsion Method

It has been established[11-13] that the site of the reaction in an emulsion polymerization lies in the polymer particles formed in the initial stages. The reaction is maintained by diffusion of monomer and initiator radicals into the particles from the aqueous medium. A large polymer radical cannot diffuse out of its particle into the aqueous phase, so the only way in which it may be terminated is by the diffusion of another initiator radical into the particle. If the generation of initiator radicals is stopped, the polymer radicals unterminated at that stage will remain trapped in the particles even when the polymerization ceases on the exhaustion of monomer. If an emulsion of a suitable second monomer is now added, the new monomer will diffuse to the polymer particles and, in those particles which contain trapped radicals, polymerization will be resumed, yielding block copolymer molecules.

We have used this process to prepare block copolymers of vinyl acetate and methyl methacrylate. Vinyl acetate emulsions stabilized by 'Manoxol O.T.' were irradiated at 20° C. by γ-radiation from a 100-curie cobalt-60 source. The polymerization was followed dilatometrically, and when the process had reached ~70 per cent conversion the source was removed. The polymer latex was mixed with a methyl methacrylate emulsion (a manipulative delay of 30 min. usually occurs) and the second stage of the polymerization was followed dilatometrically at 40° C.

The rate of polymerization of vinyl acetate by γ-radiation has been found to be extremely rapid and G values of 10^6 for monomer conversion have been found. In a typical run using a 20 per cent by volume vinyl acetate emulsion and a dose-rate of $6 \cdot 5 \times 10^{18}$ eV./c.c./min., a rate of conversion of 0·11 gm. monomer per min. was observed in a volume of 2·5 ml. This is equivalent to a G value of 94,500 monomer molecules/100 eV.

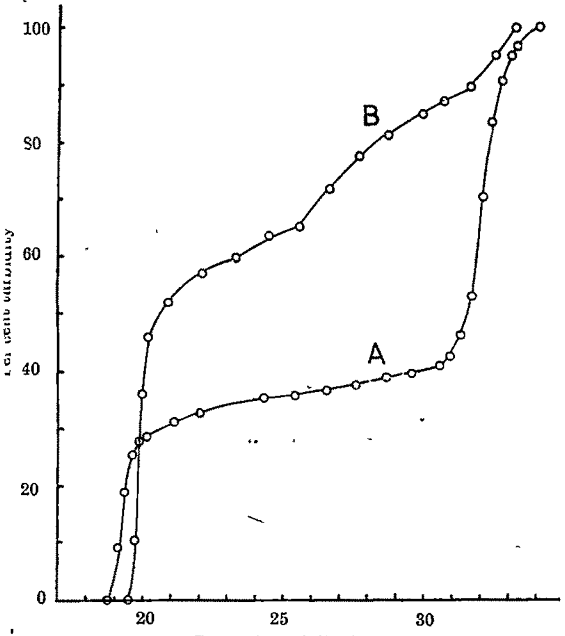

Fig. 1. (A) Turbidimetric titration of a solution of polyvinyl acetate and polymethyl methacrylate. (B) Turbidimetric titration of a solution containing vinyl acetate–methyl methacrylate block copolymer prepared by the emulsion method

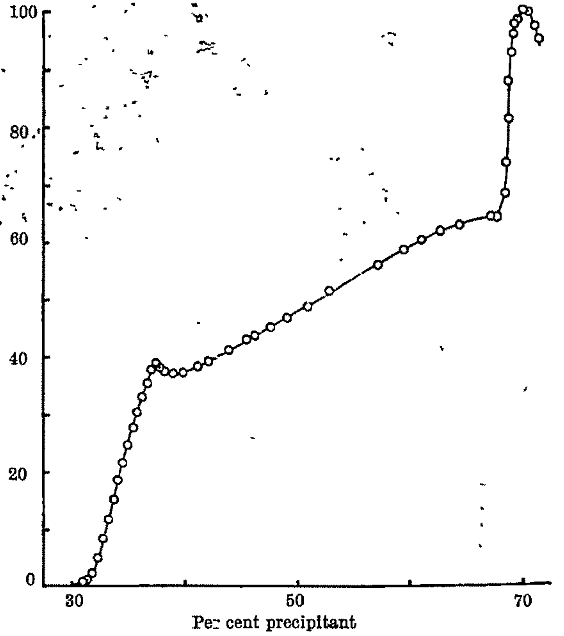

Fig. 2. Turbidimetric titration of a solution of polystyrene and methacrylate after ultrasonic irradiation

The latex formed under such conditions converted a methyl methacrylate emulsion at a rate of about 1 per cent per min.

Turbidimetric titrations were carried out on the polymer produced. This technique has been described elsewhere[14]. It is essentially a titration of a very dilute solution of the polymer (about 5 mgm./100 ml.) against a precipitant, the amount of polymer precipitated at a given point being indicated by the rate of increase in the turbidity of the solution. Curve A in Fig. 1 represents a turbidimetric titration of an acetone solution of polyvinyl acetate and polymethyl methacrylate against water. Percentage turbidity, that is, the ratio of optical density to optical density at complete precipitation, is plotted against the percentage of added water. It will be seen that the turbidity increases rapidly between 19 and 22 per cent water and again between 31 and 35 per cent. These steps may be attributed to the precipitation of the polymethyl methacrylate and polyvinyl acetate fractions, respectively.

Curve B is a titration of a polymer prepared by the methods described above. A sharp step is again observed between 19·5 and 22 per cent water, so presumably some polymethyl methacrylate is formed, either from hydroxyl radicals trapped in the vinyl acetate latex or from polymerization initiated by heat or a trace of peroxide in the methacrylate emulsion. However, precipitation continues at a steady rate beyond the 22 per cent water point until, in the region of 33 per cent water, the precipitation of large quantities of polyvinyl acetate causes the suspension to coagulate. The titration curve is indicative of a polymer mixture containing large quantities of polyvinyl acetate, a certain amount of polymethyl methacrylate, and a considerable amount of block copolymer varying widely in composition and molecular weight.

Ultrasonic Method

When a polymer solution is irradiated with ultrasonic waves, degradation occurs under cavitating conditions. It is now established that this occurs with the production of free radicals[15], which are removed presumably by reaction with solvent molecules.

Degradation of polymer in the presence of a second monomer would be expected to result in the formation of a block copolymer, the radicals produced by chain scission initiating polymerization of the monomer. This has been tried successfully for the system polyacrylamide–acrylonitrile[4].

In the method described here, two different polymers are degraded simultaneously in solution, the polymers being chosen so that their radicals combine when they interact. A suitable pair of polymers is polystyrene and polymethyl methacrylate.

Fig. 2 shows the titration of a mixture that had been degraded for 12 hr. This shows a pronounced discontinuity at 37 per cent methanol, and the turbidity increases continuously between this and 68 per cent, at which point polymethyl methacrylate is precipitated. Polystyrene itself is normally precipitated between 31 and 38 per cent methanol. A degraded polystyrene sample is almost completely precipitated at 37 per cent methanol (turbidity, 90 per cent), and polymethyl methacrylate does not begin to precipitate until about 68 per cent methanol. With an undegraded mixture of the two polymers, the curve shows a horizontal portion between the precipitation limits of the two polymers. The centra portion of the curve thus represents a third molecula species present in the mixture—in this case a bloc copolymer formed by cross-termination of the radicals Its structure would probably be of the 'sandwich type, since when any copolymer is formed it ca undergo further degradation. The copolymer appear to have a wide distribution of molecular weight, bu this is expected since ultrasonic degradation is random process, and radicals produced will have wide range of sizes. Secondary copolymer degradatio will also complicate the picture.

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IODINE AND FLUORINE IN NUTRITION

THE final meeting of a series on "Nutritional Requirements and Food Fortification", arranged by the Nutrition Panel of the Food Group of the Society of Chemical Industry, was held on April 11 ; the subject was "Iodine and Fluorine". In the first part of the meeting, dealing with iodine, the speakers were Prof. M. M. Murray (Bedford College, University of London) and Mr. J. C. M. Holman (Chilean Iodine Education Bureau) ; in the second part, on fluorine, the speakers were Prof. Murray, Miss J. R. Forrest (dental officer, Ministry of Health), Dr. G. Wynne Griffith (medical officer of health, Anglesey) and Dr. J. Longwell (Department of the Government Chemist). Copies of the various papers had been circulated in advance and the authors spoke briefly, illustrating the chief points with explanatory slides. The following account includes points raised in the discussion and the replies.

In the first part of the meeting, on iodine, Prof. Murray dealt with the uptake of iodine, the synthesis of thyroid hormones and their state in the circulation. It was pointed out that when the supply of iodine is inadequate, the thyroid in the first place becomes hyperplastic and increases in size, because the low level of circulatory thyroid hormone stimulates the release of thyroid-stimulating hormone from the anterior lobe of the pituitary.

Enlargement of the thyroid gland in adolescents and goitre in adults occurs to a greater or lesser degree in most parts of the world, even at the present time. Where the dietary intake of iodine is abundant, namely, in Iceland and Japan, the thyroid gland is small, rich in iodine and of comparable size in males and females.

It has long been considered that the iodine content of the water supply is a determining factor in the occurrence of endemic goitre. In the United States, surveys showed that areas with waters having 3 µgm./litre iodine were free of endemic goitre ; i many places in England and Wales this level i inadequate. Other factors in soil and water play a important part ; one of these may be the wate hardness, since a significantly greater incidence o thyroid enlargement in children occurs in place where the water is hard as compared with place where the water is soft, but with comparable iodin content. For rats on low iodine diets, a high intak of calcium carbonate has been shown to be goitrogenic.

The daily intake of iodine for man has been pu at 100–150 µgm. ; only about 10 per cent of this i usually supplied by the water, even in areas fre from goitre, so the remainder must be obtained fro food sources. Since only fish, fish products and se foods are rich in iodine, many people must exist o the verge of inadequacy. It is for this reason th the iodization of salt has been introduced into man countries, some by compulsion ; it would appe wise to advocate the use of iodized salt in a countries, including Great Britain.

Mr. Holman emphasized that endemic goitre still widespread ; and because this produces advers effects on the general health, social well-being an educability of the population, there is an ove whelming necessity for preventive measures, that i to raise the intake of dietary iodine. The mo practical method of doing this, and thereby erad icating endemic goitre, is by the use of iodized sal a procedure actively encouraged by the Wor Health Organization. The community use of iodize salt as a prophylactic has been practised for mo than thirty years, with remarkable decreases goitre incidence in the United States, Switzerlan New Zealand, Poland and elsewhere. The level iodization is 1 part of potassium iodide in 10,00 200,000 parts of salt. These levels respective upply 500–100 μgm. of iodine per day per person, nd even at the higher level no deleterious effects ave been found. In Great Britain the level recom-nended by the Medical Research Council is 1 part in 0,000 of salt.

The iodization of salt is easy and inexpensive nd the methods of production were clearly explained. he iodization of 'free-running' vacuum-dried salt, which is extensively used in more developed coun-ries, is also simple. For the crude, coarse salt, roduced in under-developed areas, a conveniently imple technique has been devised whereby a con-rolled mixing of the required weight of potassium odide or iodate, already mixed with inert powder uch as calcium carbonate to give greater bulk, is ed into a bulk mixer.

Potassium iodate has been shown by experimental ests on man to be effectively used by the thyroid land and has been used for the iodization of salt ith good results in certain countries for the past ew years. The stability of salt iodized by potassium odide was considered and data presented to show hat loss of iodine is not appreciable from dry and ree-running salt, if it is free from impurities and ontains a stabilizer, is packed in impervious linings nd stored in a dark, cool place for several months. 'or open pan and solar salts stored in hessian bags, articularly in adverse climatic conditions, potassium odide is not suitable; the loss is considerable, and herefore potassium iodate should be, and has been, fectively used because of its greater stability. It as not considered necessary to change the methods f iodization now in use in Great Britain.

To those who still have the impression that iodized alt might be unsuitable for certain individuals, the eply is that the amount of iodine in certain sea ods is considerable; and that the use of the high-vel iodized salt has not provided any evidence for is belief. Changes in the distribution of endemic oitre take place at all times, the incidence has ecreased markedly in some places and increased in thers; this is considered to be due to changes water supplies, dietary habits and population istribution.

Prof. Murray opened the second part of the eeting, on fluorine, emphasizing the following oints. Fluorine occurs in bones and teeth, hich consist mainly of calcium hydroxyapatite $Ca_3(PO_4).Ca(OH)_2$), the fluorine replacing OH oups in the lattice. The proportion of fluorine esent increases with age and in proportion to the mount present in the water supply or the diet and hen there is exposure to industrial sources of uorine. So far, it has not been possible to prove at fluorine is an essential dietary element; although is now generally accepted that the use of water pplies with 1 or more parts per million (p.p.m.) of uoride is associated with a lower incidence of dental ries than waters with less.

Fluorine can accumulate in bones, and excessive takes produce osteosclerosis, increased density and ostoses. However, the average daily intake in ritain is about 1 mgm. (water level of 0·2 p.p.m. orine) and 2·5 mgm. if the water has 1 p.p.m. orine, and this latter quantity is insufficient to use excessive accumulation. Severe outbreaks of orine poisoning in animals have occurred in ritain, due to the eating of pastures contaminated ith fluorine dusts from industrial undertakings, and remains to be proved whether this 'neighbourhood zard' affects the human population.

A high intake of sodium fluoride in laboratory animals can cause decreased kidney tubular function and inhibition of gastric acid secretion; the amounts used in these tests are outside the range likely to be encountered in endemic fluorosis.

Miss Forrest dealt with the matter of greatest interest, namely, caries incidence and fluoride in the water supply. In the United States a definite inverse relationship has been proved between caries in children and the level of fluoride naturally present in water. The best effects are seen in those born and living up to eight years in a fluoride area, although some protection is seen in children who are new-comers. In 1944 in South Shields (water 1·4 p.p.m. fluorine) the 5–14-year old children had 45 per cent less caries than in North Shields (water free from fluorine). The mechanism by which the fluorine gives this protection is not known; one suggestion is that it is due to the increased proportion of fluorapatite in the enamel. The various degrees of 'mottling', with and without staining, were illustrated by excel-lent coloured slides. Mottling occurs in 90 per cent of the population where the water has 5–6 p.p.m. fluorine, but at 1 p.p.m. mottling is less frequent and very mild. More recent surveys in areas in the United Kingdom with 5·8, 3·5, 2·0 and 0·9 p.p.m. fluorine, respectively, and fluoride-free areas have confirmed the findings in the United States. In the area with 0·9 p.p.m. there was 60 per cent less caries than in a trace-fluoride area; in the former 30 per cent of the children were free from caries and only 30 per cent had noticeable mottling.

Artificial fluoridation to a level of 1 p.p.m. was started in certain communities in the United States and Canada in 1945; the incidence of caries in children before and after has been compared with control non-fluorine areas. The results show that caries incidence has steadily decreased, and after the ten years by about 60 per cent, in the fluoridation areas, but remained unchanged in the control areas. Fluoridation at 1 p.p.m. is about to be introduced into four areas in the United Kingdom.

Dr. Wynne Griffith described the signs and symp-toms of chronic industrial and endemic fluorosis in man, pointing out that radiological changes in the bones are not always associated with disability. Bone lesions and severe disability in a certain pro-portion of persons have been recorded from areas in India, China and South Africa with waters having more than 4 p.p.m. fluorine; in these places it is likely that malnutrition increases the deleterious effects of fluoride. Dr. Griffith quoted evidence that the normal human kidney can excrete fluoride well in excess of the proposed level of fluoridation; nevertheless, a recent report from an endemic fluorosis area (Hyderabad, Deccan, water 11·8–5·2 p.p.m. fluorine) records impairment of kidney function in a proportion of individuals; but this was not proved to be due specifically to the fluoride.

On the basis of certain general health surveys in natural fluorine and fluoridation areas, Dr. Griffith concluded that available evidence gave no support to the contention that 1 p.p.m. represents any hazard to human health.

Mr. Longwell gave useful figures which he has recently obtained for daily fluoride intakes in Britain. These were: men 3·2 mgm., women 2·2 mgm. and children 1·2 mgm., amounts comparable to those recorded in the United States. He then dealt with the practical aspects of fluoridation of water, for which either sodium fluoride or sodium fluorsilicate is used. The proportioned addition to the main water supply of a solution of the chemical compound is carefully controlled by special meters. This addition should be made at the final stage of water treatment, when chlorination takes place. Frequent estimations of the fluoride content of the domestic supply mus be made and records kept.

Time limited the discussion on fluorine ; but i answer to a leading question, Miss Forrest made i quite clear that the fluoride-level in water is a important, but not the only, factor influencing toot structure and the incidence of caries.

AUTOMOBILE FREE-PISTON ENGINES

By F. D. ROBINSON
Engineering Laboratory, University of Cambridge

NEARLY twenty years have passed since Sir Frank Whittle's first gas turbine ran and six years since the Rover car JET I was driven around the circuit at Silverstone ; yet there is still no commercial vehicle driven by gas turbine anywhere in the world other than those few used for experimental purposes. Now, according to a report in *The Times* of April 16, General Motors have developed a free-piston engine for passenger motor-car service. Since the same Company has already produced an automotive gas turbine, it is perhaps a significant comment upon the prospects of gas turbines applied to vehicles that further research has been expended on an alternative prime mover.

It must be obvious to most engineers, in spite of Chryslers' success in the United States, that the gas turbine is at present still an unsuitable engine for the passenger car as visualized in Great Britain, where economy and compact size are of paramount importance. Perhaps one day when blade cooling has been developed, component efficiencies raised, regenerator sealing problems solved and turbine design improved to a level where part-load performance can match full-load performance, then the gas turbine may compete with the petrol and the diesel engine. It is, in fact, arguable if the effort put into producing a suitable small gas turbine would not bring a much greater reward if expended in designing small diesel engines.

Superficially, the new free-piston engine presents many attractive features. It should first perhaps be noted that this type of engine is not at all new. The Junkers version was used to compress air during the Second World War. In the United States a few large gas generator plants of around 1,000 and 1,500 s.h.p. have been built, mostly experimentally, by Baldwin–Lima–Hamilton and by Cooper–Bessemer, and in Britain free-piston air compressors delivering 100 cu. ft. of air per minute have been in use for some years. It is in France, however, where development has been nearly as intensive as that devoted in Britain to gas turbines, that the greatest progress has been made, and SIGMA with their 1,200 s.h.p. gas generator have achieved some notable results. A standard design is available and is in commercial use providing the motive power for mine-sweepers, trawlers, merchant ships, base power generation and pumping sets.

From a thermodynamic point of view, a gas generator is the combination of a diesel two-stroke engine, which fulfils the dual functions of a self-driven compressor and a combustion chamber, with a gas turbine using the high-pressure exhaust gases released from the diesel to produce the useful work. Since the work output of the diesel is expended in compression, it becomes logical to compress by a reciprocating piston attached to the diesel piston an so to omit the usual crankshaft and associate bearings. Various arrangements have been propose and used ; but the travel of the diesel and compressor pistons is always limited only by pneumati and not by mechanical restrictions. The cycle is th pure constant-pressure cycle ; but since the diese cylinder contains the high-temperature gases and i only intermittently exposed to them, a very muc higher peak temperature and compression ratio ar possible than when a simple gas turbine is used. O the other hand, the intermittent process in the diese cylinder makes it impossible for the engine to handl the huge quantities of air associated with a simpl turbine. As might be expected when due allowanc has been made for the losses which occur in practice the performance of a free-piston gas generator is compromise between that of the two engines c which it is compounded. Thus the power–weigh ratio is a little better than in conservative diese practice, but well below gas turbine possibilitie while the fuel consumption is always very muc better than gas turbine consumptions. In fact, a full load, economy is nearly equal to that of a diese and even at half load compares favourably with tha of a petrol engine.

Apart from these inherited merits, the free-pisto engine has advantages peculiar to itself and suited t its application to automotive use. Thus vibration very slight, so mountings can be of a simple natur It lends itself to considerable flexibility in installatio and thus it is quite feasible to place the turbine at considerable distance from the generator cylinde substituting a pneumatic drive for a mechanical on One or more generators may feed the same turbin or presumably vice versa. The torque characterist is very satisfactory, a large torque being produced zero turbine speed, while the response to acceleratic requirements both from an idling and from a cruisir speed are ideal. This cannot be said for the simp gas turbine as, if the compressor and compresso turbine are idling, the inertia of the combine rotating system is considerable and acceleration fro idling conditions is poor unless provided by gearin With the gas-generator the response is immediat the only fly-wheel effect being in the pow turbine.

On the debit side there are several features, pa ticularly of mechanical design, which suggest that will be a long time before this form of engine riva the standard types. Its advocates always emphasi the absence of crankshaft, bearings, poppet valv and cam-shafts in the free piston engine. These a not, in fact, components which give trouble, or, und good conditions of lubrication and filtration, wear all rapidly. In their place the free-piston engi imports several complications of its own. Accurate alignment of the four pistons and subsequent lack of distortion are required; non-return valves are freely strewn about the engine, so that leakage due to dirt, oil-varnish and distortion is always a possibility. Although there is no orthodox crankshaft, a light synchronizing mechanism is employed, while a fuel injector and its actuating mechanism are required. The two most sensitive features of the plant are the top ring of the exhaust piston and the gas turbine. It is possible by derating and by conservative design to sacrifice fuel consumption and achieve reliability with these components; but if run at full load, such evidence as is available suggests rapid wear of piston rings due to the compression pressures and temperatures, which are excessive compared with orthodox two-stroke diesels, where piston crown temperatures and ring sticking are always limiting features of design. Of course, it is well known that the working life of a passenger motor-car engine is passed almost entirely at part load, so that conditions are much less severe in this application. Similarly, the gas turbine can use low-temperature exhaust gases and so be made of non-strategic materials if the efficiency of the plant is compromised, or full load is maintained for short periods only. Matching of diesel and turbine over a wide range of speed and load is also known to be difficult.

Claims are made for the omnivorous nature of the free-piston engine. It is true that the free-piston engine will run on a wide variety of fuels—pea-nut oil is quoted—but so will the diesel engine, which has been well tested on palm oil, pea-nut oil, coconut oil, linseed oil and, what is more to the point, residual fuels. The vegetable oils are in point of fact prohibitively expensive, and in any event satisfactory combustion of a fuel is only a first essential; what is equally important is prolonged life of vital parts in face of attacks by products of combustion. This problem has not been solved for high-sulphur fuel oils in diesel engines and certainly not in free-piston engines.

It is praiseworthy that in the face of so many problems General Motors should pursue this line of research, and it is only concerns of such magnitude that can afford to investigate projects with a long chance of success. For, apart from the inherent difficulties of the free-piston gas generator, steady progress in the technical improvement of the diesel, leading to smaller, lighter and cheaper units, and even of the well-tried petrol engine, is still being made. General Motors are sensibly cautious upon the future prospects of the free-piston engine, but it will be interesting to watch the development of this slightly exotic prime mover, and to wonder whether it may be produced in a size one-fifth of the 250 h.p. engine General Motors quote as a respectable minimum.

INFRA-RED SPECTROSCOPY AND CHEMICAL INDUSTRY

By Dr. H. W. THOMPSON, F.R.S.

It is now generally accepted that much of the recent remarkable progress in the organic chemistry of complex molecules and natural products could not have been achieved without the help of the numerous modern physico-chemical techniques. Most of these new tools have a clearly defined sphere of utility. For example, chromatography is applied almost exclusively in the separation of mixtures or for purification of compounds, and isotopic tracers are for the most part used in the elucidation of reaction mechanisms. Infra-red absorption spectroscopy, on the other hand, can be applied in a wider sense. Its value in industry is twofold: first for qualitative or quantitative analysis, and secondly for the determination or clarification of molecular structure. In both these respects the range of applicability is enormous, and much of the information gained in the course of the work can be of great value in other connexions. The structural studies can be made with molecules in all states of aggregation, and the method is now pointing to a new line of attack on the nature of intermolecular forces and intermolecular complexes.

Many discussions on these applications of infra-red spectroscopy have been held during the past fifteen years, and they have served to illustrate the continual progress in many directions. Nevertheless, the symposium organized on April 9–10 by the London Section of the Society of Chemical Industry was opportune, for it provided an opportunity to take stock of the present position, not only as regards the experimental facilities now available but also in regard to the theoretical basis and possible extension of the different lines of application. The large attendance, and the diversity of problems which were raised, showed that the scope of this particular technique is still widening. It is now being used, in penetrating fashion, in the chemistry of fuels, textiles, paints, dairying, perfumes, polymers and resins, pharmaceuticals and antibiotics, and other general chemicals.

Industrial work requires two kinds of infra-red equipment, namely, (i) spectrometers with the appropriate accessories for use in research laboratories, and (ii) other apparatus for use on the plant in process control. The most urgent need in Britain at present is in the latter respect. Prism spectrometers of rugged stability are now commercially available for the region 1–40μ to meet all normal requirements. Although costs are still high, a choice can be made according to the spectral range to be studied, the resolving power required, and the speed and method of recording. Some general flexibility is also desirable so that accessories can be attached, such as long-path absorption cells, a reflecting microscope, or a low-temperature absorption cell. In view of the limited spectral range of the known photoconductive cells, it might be helpful if fast and more sensitive, spectrally black, bolometers could be developed. Also, although a satisfactory variety of synthetic crystalline materials for prisms and windows is now available, something might be gained from further examination of such substances as lead chloride. The resolving power provided by good commercial prism spectrometers is now adequate for most purposes, but the recent success in making cheap replica diffraction gratings has opened up the possibility of simple grating spectrometers. It is possible, in fact, that for more satisfactory work on band intensities, the higher resolving power may become necessary; but if such grating instruments are to be developed, more systematic work on filters should be undertaken.

The position as regards availability of instruments for flow-line control is less satisfactory, and this is where much help can be given to industrial production. For many years it has been clear that certain components of common industrial gas streams could be monitored continuously by means of their infra-red absorption. For such work, either dispersive or non-dispersive analysers can be used, measuring either the integrated infra-red absorption over a wide spectral range, or some selected band which has been isolated by means of filters or by a simple dispersing system. Typical components measured in this way include carbon monoxide and dioxide, sulphur dioxide, hydrogen sulphide, ammonia, acetylene, ethylene and other hydrocarbon gases. Much progress has been made in the United States and also in Germany with such instruments, in some cases leading to an effectively automatic process control. The older non-dispersive analysers use either a black-body detector with filters (negative type), or microphone detectors which are selectively sensitized to a particular spectral region (positive type). Improvements in both stability and sensitivity have been achieved by a combination of both types in the Perkin–Elmer 'tri-non' analyser. With all such equipment, the details of design must be carefully considered with specific reference to the gas stream involved, since in all cases the ease of determination of the main component is affected by the absorption of other substances present. Also, for plant operation, the most vital factor is obviously long-term reliability; but the difficulties in this respect have been overcome, and concentrations varying between parts per million and 90 per cent can be measured convincingly. An alternative method, using the so-called 'bichromator', is to use a simple prism spectrometer with split Littrow mirror, so that the absorption at two different wave-lengths can be compared continuously, one wave-length acting as a reference standard. For some purposes, this type of instrument has advantages over the non-dispersive analysers. The main conclusion is that there are scope and need for such plant control instruments in British industry. A few are already in use, and it is understood that others are to be installed for the analysis of water – heavy water mixtures.

Conventional infra-red analysis using prism spectrometers is being used on an ever-increasing scale. Among new examples are the determination of plasticizers, oil and rubber additives, copolymers, residual water in fibres, antibiotics, resins and paints. The pressed-disk technique has facilitated work with insoluble materials, although the quantitative background of this method needs further examination. Hitherto, most analyses have used the region 1–14μ, but the merits of other spectral regions are now becoming evident. Between 1μ and 3μ, where vibrational overtones are involved, more conveniently measurable thicker layers can be used, and several problems involving polymers, including the determination of end groups, have been solved.

Qualitative and semi-quantitative analysis has advanced significantly by use of 'differential spectroscopy'. If the absorption of the main component in a mixture is overlaid or masked by the absorption of other components, the background absorption of the latter may be cancelled out by use of a double-beam spectrometer in which a compensating cell is placed in the 'blank' beam. This method demands proper experimental care, but is capable of giving spectacular results. It has been applied successfully to many problems in the fuel industry and suggests a new approach to the discrimination between closely similar complex materials such as proteins, carbohydrates and polymer products. Meanwhile, the theoretical basis of infra-red quantitative analysis is now being examined critically. The optical densities at band peaks, which lead to the 'apparent' extinction coefficients, cannot really be regarded as satisfactory measures of band intensities, for they are much affected by the relatively wide spectrometer slits which are used in infra-red work, and by other instrumental factors. Unfortunately, therefore, quantitative data from different laboratories often disagree, and this has so far made it impossible to establish intensity values of universal applicability. The shapes and 'apparent' extinction coefficients of many vibrational bands have now been determined as a function of slit-width, and the experimental requirements for obtaining satisfactory 'reproducible' values of peak densities have been examined. At the same time, band intensities have been measured by taking the integrated absorption over the whole band. This latter method seems to provide a measure which is far less dependent upon spectrometer characteristics, and automatic integrating devices have therefore been developed. Whether it will prove better, as a regular procedure, for general analytical work, to use higher resolving power and the peak extinction coefficients, or to measure the integrated band areas, remains still undecided, but it should soon be possible to assess the relative merits of the two methods.

The use of key absorption bands for structural diagnosis has also reached an interesting stage. It is based upon the localization of certain molecular vibrations within a small group of linked atoms, and ceases to be of much value if nuclei of comparable mass are joined together by single valency bonds so that a larger part of the whole molecule is concerned in the vibration. A few more correlation rules may still be discovered, and there are suggestions that some characteristic differentiation of stereoisomers may be possible. However, the bulk of the useful data is now available, and more attention is being given to disentangling the influences within a molecule which cause the general rules to break down. The exact nature of the hydrogen bond is again under consideration, and interesting 'inter-space' group interactions have been found. It may, however, now be profitable to explore the use of intrinsic band intensities for diagnostic work. Results show that different types of a particular group can be distinguished in this way, and the comparison of the intensities of fundamental and overtone bands may sometimes be even more informative.

Among the ancillary techniques used for studying complex molecules, polarized infra-red radiation has been applied to ordered structures and crystalline materials, and the spectral changes arising from deuteration are sometimes instructive. The reflecting microscope has greatly simplified work on fibres such as silk or 'Terylene'. The α (helical folded) and β (open chain) forms of polypeptides have been distinguished, and natural and synthetic peptide materials have been compared. These methods have also been applied to the general problem of the crystallinity of polymers, which is so much related to their physical properties. In pharmaceutical chemistry, infra-red spectra are being used as a means of proving identity, for quantitative assay, and for unravelling the structure of steroids, hormones and antibiotics.

One new line of great significance is the study of inter-molecular interactions through the displacements of vibration bands. This may lead to valuable information about adsorption processes, adhesion, and the formation of intermolecular complexes in reacting systems.

Many of these more elaborate contributions to research problems are of real interest; but it is important not to lose sight of the more mundane and urgent needs of analytical process control mentioned above. There are hopeful signs that the necessary instruments may soon become available.

OBITUARIES

Prof. Megh Nad Saha, F.R.S.

The death on February 16 from sudden heart failure, at the age of sixty-two, of Prof. M. N. Saha has robbed India of one more of her leading men of science. He was well known for his distinguished researches, for his activity in scientific administration and for his other public activities. After an early education in India he came to England for post-graduate studies under Prof. Alfred Fowler at the Imperial College of Science and Technology, London. It was there that he developed his work on thermal ionization, which led up to 'Saha's equation', by which he will be remembered. By taking account of the important effect of pressure, as well as of temperature, in a gaseous mixture of neutral atoms, ions and electrons, he explained the increase in ionization as one moves outwards from the photosphere to the chromosphere of the Sun. His work led to important developments by R. H. Fowler and E. A. Milne in the study of the pressures and temperatures of stellar atmospheres. It has earned a permanent place in the history of astrophysics.

On going back to India, Saha returned to physics, and as professor of physics successively at the Universities of Allahabad and Calcutta he founded research schools on ionospheric problems and nuclear physics. He published many papers on a wide range of subjects, including the propagation of electromagnetic waves in the ionosphere, the escape of radio waves from the Sun, nuclear physics and spectroscopy. His position in the world of Indian science may be gathered from the many leading positions that he held from time to time. He was president of the Indian Science Congress, of the United Provinces Academy of Science (later the National Academy of Sciences), and of the Indian Association for the Cultivation of Science and the National Institute of Sciences. He was largely instrumental in founding the Institute of Nuclear Physics, Calcutta; as its director he was active both in training students and in supervising research work.

He was a member of the Board (or later Council) of Scientific and Industrial Research, which led to growing interest in the social relations of science, a subject on which he wrote a number of papers. As he grew older and became an established figure in his own country, he turned more and more to questions of education, industrialization, national planning and such details as river valley projects. His last paper of this kind appears on p. 923 of this ssue of *Nature*.] In 1951 he was elected to the Indian Parliament by a large majority as an independent member, having refused to stand as a party candidate. He loved fighting for causes which he felt to be right, even though by so doing he earned unpopularity in Government circles. But he retained a keen, active nterest in science, and only last year was one of the Indian members attending the General Assembly of the International Astronomical Union in Dublin. His sixtieth birthday was celebrated by a volume on his life, work and philosophy arranged by a committee of the Indian Association for the Cultivation of Science (see *Nature*, 174, 528; 1954). It is sad that he should have survived its publication for so short a time.

F. J. M. STRATTON

Mr. T. Harold Reade

THOMAS HAROLD READE, the third son of the late Thomas Reade, manufacturing chemist, of Wolverhampton, was born in 1889. He was educated at St. Paul's School, London, where he was a contemporary of Lord Montgomery, and at the University of Birmingham, where he graduated in science. During the First World War, Reade served in France and in Palestine, first with the 6th South Staffordshire Regiment and later with the Machine Gun Corps. On demobilization he went to Emmanuel College, Cambridge, where, under Dr. Hamilton McCombie, he carried out research on the preparation and properties of phenyltrimethylammonium perhaloids, perfecting methods for the determination of the constitution of these compounds. In 1921, Reade graduated and was appointed to the staff of the University of Aberdeen, where he became responsible for the teaching of organic chemistry, a duty which he performed with thoroughness and distinction until his retirement in 1945. A man of strong personality, a trifle impetuous, he was an inspiring teacher and a pleasant colleague.

Throughout his period on the University staff, Reade maintained an active research programme. Following on his work at Cambridge, he studied the addition compounds of halogens and quaternary ammonium salts, showing experimentally that the iodine in these perhalides is reducible but not oxidizable to molecular iodine and therefore is in a higher state of oxidation. Later, in collaboration with his research students, he investigated, among other problems, the simultaneous nitration of the nucleus and nitrosation of the nitrogen atom in a considerable number of dialkyl anilines by means of sodium nitrite in hydrochloric and sulphuric acids, finding a method of controlling the type of reaction that predominated. The numerous contributions which he made in these various spheres are recorded in the *Journal of the Chemical Society*.

In his retirement Reade devoted his leisure to golf and music; he was an accomplished performer on both the golf course, where on many occasions he represented the staff of the University of Aberdeen in inter-university competitions, and on the piano. His sudden death, on March 24, came as a great shock to his many friends; taken ill while playing his usual game of golf at his club, the Royal Aberdeen, he died a few hours later in hospital. He was unmarried.

R. B. STRATHDEE

NEWS and VIEWS

New Foreign Members of the Royal Society:

Prof. K. U. Linderstrøm-Lang

PROF. K. U. LINDERSTRØM-LANG, director of the Carlsberg Laboratory, Copenhagen, whose election as a foreign member of the Royal Society has recently been announced, is famous for his researches on proteins and for his pioneer work in the field of enzyme histochemistry. As a young man, his reputation was established by his acetone-titration method of estimating amino-acids; he followed this with a series of investigations on the physical chemistry of proteins, dealing *inter alia* with protein denaturation and various aspects of protein degradation by enzymes. His Lane Medical Lectures of 1952 on "Proteins and Enzymes" and his contribution to the Solvay discussion on proteins the following year show the breadth of his interests and his ability to apply theoretical treatment to his problems. One of the most interesting of his recent contributions has been the discovery and unravelling of the transformation of ovalbumin to plakalbumin. An investigator possessed of great manipulative skill, he has invented many ingenious methods of microanalysis which have enabled him to throw light for the first time on chemical reactions going on in individual cells. As an illustration, one may cite his elegant demonstration of the mechanism whereby the larvæ of the clothes moth are able to digest wool. Under his inspiring leadership the Carlsberg Laboratory has fully maintained the fine international reputation which had been handed down by his predecessor, S. P. L. Sørensen.

Prof. Hans Pettersson

WITH his election to the foreign membership of the Royal Society of London, Prof. Hans Pettersson, the well-known Swedish oceanographer, joins six eminent compatriots already in that distinguished company. Born in August 1888, son of Prof. Otto Pettersson, the renowned oceanographer who founded the International Council for the Exploration of the Sea and who died fifteen years ago at the age of ninety-three, Prof. Hans Pettersson has added greatly to the lustre of a family name so closely associated with marine research. After studying physics in Upsala under Knut Angström during 1908–11, he entered upon that period of work in England under Sir William Ramsay which gave him his love of London and his remarkable command of English. In 1914 he became both a doctor of physics of the University of Stockholm and a research associate in oceanography at Gothenburg. Eight years later he was leading a team of workers in the Radium Institute of Vienna in radioactivity and nuclear physics, and it is due to his skill in those fields that he has made such fruitful researches on the radium content of deep-sea sediments and on the rate of their accumulation. The author of numerous papers on oceanographical topics, he became professor of the subject at Gothenburg in 1930 and director of the Oceanographical Institute there in 1939. He is a member of learned societies of many countries and holder of the Patron's Medal of the Royal Geographical Society of London. Pettersson organized and led the highly successful Swedish Deep-Sea Expedition with the *Albatross* during 1947–48.

Dr. Fritz Zernike

THE election of Dr. F. Zernike as a foreign member of the Royal Society is the latest honour he has received in recognition of his distinguished work in physical optics, and in particular for his researches in phase-contrast microscopy. His election follows on the award in 1952 of the Society's Rumford Medal and in 1953 of the Nobel Prize for Physics. Zernike first described the principle of the phase-contrast method in 1933 in a short paper to the twenty-fourth Dutch Physical and Medical Congress; but prior to that his published papers were mainly concerned with the statistical aspects of a variety of physical problems. By extending Abbe's theory of the microscope, he showed both theoretically and experimentally, using apparatus which he had himself constructed, that an image of a phase-grating consisting of transparent lines alternating in thickness could be made visible if the phase of the direct image of the source were changed by 90° relative to the diffracted light. The elaboration of this principle is now well known and forms the basis of the highly successful phase-contrast microscope. Zernike has also carried out important fundamental work on the diffraction theory of optical images, including the effect of small amounts of aberration and of the coherence of the illumination. After being dormant for a period, the subject of microscopy has come very much to life during the past decade, and it is fair to attribute much of this vitality to the stimulus of Zernike's ideas.

Paris Academy of Sciences: Elections

THE following elections have been made in the Paris Academy of Sciences: Prof. P. Tardi, professor of astronomy in the École Polytechnique, Paris, to be a member of the Geography and Navigation Sections in succession to the late Prof. E. de Martonne Prof. A. Vandel, professor of zoology in the University of Toulouse, to be a non-resident member of the Academy in succession to the late Prof. M. Gignoux Prof. H. Lundegårdh, professor of plant physiology in the Agricultural College, Upsala, to be a *correspondant* for the Rural Economy Section in succession to Prof. S. Waksman, recently elected a foreign associate of the Academy; Prof. E. Schmidt professor of mathematics in the Humboldt University, East Berlin, to be a *correspondant* for the Geometry Section in succession to Prof. S. Bernstein recently elected a foreign associate of the Academy Prof. C. Killian, professor of agricultural and experimental botany in the University of Algiers, and Prof. F. W. Went, professor of plant physiology in the California Institute of Technology, to be *correspondants* for the Botany Section in succession to the late Prof. G. Nicolas and the late Prof. P. Becquerel

Leverhulme Research Awards, 1956

THE Leverhulme Trustees have approved th following fellowships and research grants, among others, tenable for periods up to two years, th subject of study being indicated in brackets: *Fellowships:* R. A. Crowson, lecturer in zoological taxonomy, University of Glasgow (young stages and habits of certain primitive endemic Coleoptera in New Zealand); Dr. P. J. C. Dark, Department o Anthropology, University College, London (Mixte ethnohistory: an analysis of the codical art); Dr A. T. A. Learmonth, lecturer in geography, University of Liverpool (land use in the Assam Valley wit special reference to population density and capacity)

Dr. A. I. Richards, formerly director, East African Institute of Social Research, Makerere College, Uganda (changes in the political system of the Bemba of North Eastern Rhodesia, 1935–55); Dr. E. G. Richardson, reader in physics, University of Durham (propagation of sound in a turbulent medium); R. A. Skelton, superintendent of Map Room, British Museum (foundation and early history of the Ordnance Survey, 1782–1825). *Research Grants:* Dr. R. F. Barrow, Fellow of Exeter College, Oxford (spectroscopy of simple molecules); A. R. Bailey, Turner and Newall Research Fellow, Imperial College, London (intercrystalline cracking and failure of high-tensile brass); P. R. Bell, lecturer in botany, University College, London (phylogeny and morphology of the ferns of tropical mountains); Prof. F. Debenham, emeritus professor of geography, University of Cambridge (the Admiralty and the Arctic in the nineteenth century); Lady Drower (a dictionary of the Mandaic language); Dr. K. A. Kermack, lecturer in biological statistics, University College, London (American mesozoic mammals); A. D. Rees, director of extra-mural studies, University College, Aberystwyth (an examination of some of the more important branches of Celtic mythology); H. Thomas, assistant buildings officer, University of Manchester (application of architectural acoustics to the design and construction of schools for the deaf); Prof. D. Williams, professor of Welsh history, University College, Aberystwyth (Benjamin Franklin's circle in London). Further information about the awards can be obtained from the Secretary, Leverhulme Research Awards, St. Bridget's House, Bridewell Place, London, E.C.4.

Royal Aeronautical Society

Honorary fellowship of the Royal Aeronautical Society has been conferred on Sir Roy Dobson and Dr. Hugh L. Dryden. The following awards have been made by the Society: *British Gold Medal for Aeronautics*, to the late Mr. Joseph Smith for his outstanding practical achievements in the design and development of military aircraft; *British Silver Medal for Aeronautics*, to Mr. J. Fenwick for his contributions to the development of air-traffic control systems; *The Society's Gold Medal*, to Sir William Farren for his outstanding contributions to aeronautical research and development (this is the Society's highest honour for work in aeronautics); *The Society's Silver Medal*, to Dr. E. S. Moult for his outstanding contributions to aeronautical engineering and, in particular, for his work in the design of aircraft engines; *The Society's Bronze Medal*, to Mr. J. W. Barnes for his contributions in the field of aircraft instruments; *Wakefield Gold Medal*, to Group Captain W. K. Stewart for his contributions to the design and development of aero-medical equipment; *George Taylor* (*Australia*) *Gold Medal*, to Mr. R. H. Woodall for his paper on some trends in the development of aircraft electrical and starting systems; *Simms Gold Medal*, to Mr. K. V. Diprose for his paper on analogue computing in aeronautics; *R. P. Alston Memorial Prize*, to Mr. D. P. Davies for his practical achievement in the flight testing of prototype civil aircraft; *Edward Busk Memorial Prize*, to Mr. L. E. Fraenkel for his paper on the unsteady motion of a slender body through a compressible fluid; *Herbert Akroyd Stuart Memorial Prize*, to Mr. O. N. Lawrence for his paper on fuel systems for gas-turbine engines; *Usborne Memorial Prize*, to Dr. G. N. Lance for his paper on the lift of twisted and cambered wings in supersonic flow; *Orville Wright Prize*, to Mr. K. W. Gunn for his paper on the effect of yielding on the fatigue properties of test pieces containing stress concentrations; *Branch Prize*, to Mr. W. Tye for his paper on the outlook on airframe fatigue (second Barnwell Memorial Lecture); *Royal Aeronautical Society Navigation Prize*, to Mr. John Grierson for his paper on the evolution of Arctic airways; *Pilcher Memorial Prize*, to Mr. H. Caplan for his paper on the investigation of aircraft accidents and incidents.

Iron and Steel Institute

The following awards have been made by the Iron and Steel Institute: *Bessemer Gold Medal for* 1956, to Dr. C. Sykes (Thos. Firth and John Brown, Ltd.) in recognition of his distinguished contribution to the study of alloy systems, particularly in the field of order–disorder changes and the effect of such changes on the physical properties of alloys; *Sir Robert Hadfield Medal for* 1956, to Mr. H. Morrogh (British Cast Iron Research Association) in recognition of his distinguished contribution to the study of the metallography of cast iron and for researches which resulted in the discovery of nodular iron and the improvement in the quality of cast iron; *Additional Williams Prize for* 1954, jointly to Mr. F. A. Gray and to Mr. S. A. Brooks (Appleby–Frodingham Steel Co., Ltd.) for their paper on an investigation of re-heating furnace design and performance; *Williams Prizes for* 1955, to Mr. A. J. Kesterton (Steel Company of Wales, Ltd.) for his paper on some starting and operating experiences at Abbey melting shop, and to Mr. R. Wilcock (Samuel Fox and Co., Ltd.), for his paper on the operation of a 60-ton arc furnace at Samuel Fox and Co., Ltd.; *Ablett Prizes for* 1955, to Mr. W. Ernest (Samuel Fox and Co., Ltd.) for his paper on waste heat recovery related to the generation of electric power; to Mr. S. R. Phelps (Guest Keen and Nettlefolds, Ltd.) for his paper on electrical requirements of flying shears for bars and billets; and to Mr. R. Stewartson (Guest Keen and Nettlefolds, Ltd.) for his paper on the mechanical design features of flying shears for bars and billets.

Royal Australian Chemical Institute

The following awards have been made by the Royal Australian Chemical Institute: *H. G. Smith Memorial Medal*, 1955, to Prof. R. S. Nyholm, professor of chemistry, University College, London, for his work in inorganic chemistry; *Rennie Memorial Medal*, to Dr. D. R. Stranks, assistant lecturer in radiochemistry, University of Leeds (this Medal is awarded to an Australian chemist less than thirty-one years of age for papers published during the past ten years); *Masson Memorial Scholarship*, 1956, to G. C. Morris, of the University of Sydney, now studying for his M.Sc.

Nuclear Power

The first number of the new journal by Rowse-Muir Publications, Ltd., *Nuclear Power* (1, 1; May 1956; single copy 3*s*. 6*d*., annual subscription £2 2*s*.), has now been published. This journal, designed to "further the development of atomic energy and nuclear techniques for peaceful purposes and in particular to credit British achievements", has an editorial panel of distinguished scientists from British universities and from the U.K. Atomic Energy Authority. Subjects covered in this first number include the methods and plants used for the production of heavy water, dose-rate meters, the production of reactor fuel elements, and the research facilities at the research laboratories of Tube Investments, Ltd., and at the Battelle Institute, Columbus, Ohio. There is also the first of a series of articles on reactor physics by J. F. Hill, of the Reactor School, Harwell. Other sections of the journal consist of editorial comments, news items from various parts of the world, news of equipment used in connexion with nuclear engineering, and abstracts of patents. The remaining section is devoted to reviews of books of use or of interest to the nuclear engineer. Synopses of the articles are given in five languages. These, as well as the contents on the title page, are in type which is unusually small in size. It is stated that forthcoming issues will contain papers, articles and features on nuclear fuel enrichment, fabrication and reprocessing, on reactor design, construction and performance, on the associated power plant, on instrumentation and on isotope production, handling and application to industry.

Courses and Awards in Technology

Details of the award to be given by the recently created National Council for Technological Awards, under the chairmanship of Lord Hives, have been announced. The National Council will grant a diploma in technology, the courses for which will be equivalent in standard to honours degree courses of a British university. The award will be denoted by 'Dip. Tech. (Eng.)' for engineering and by 'Dip. Tech.' for other technologies. There will be two honours classes and a pass level. The courses which will be recognized may be either full-time or sandwich. The minimum time required for a course in a technical college will be three years full-time or four years sandwich course. Students attending full-time courses will be expected to have suitable industrial training amounting in aggregate to not less than one year in industry. The minimum age of admission to courses will normally be eighteen. It should be assumed that the standard of admission to courses will be that of the General Certificate of Education, with two appropriate subjects at advanced level and three subjects at ordinary level, or a comparable standard. Holders of good Ordinary National Certificates, for example, will be eligible; in most other cases National Certificate holders will need additional instruction to qualify for entry to the course. Since the courses are intended for those aiming at becoming professional technologists, they should include a thorough education in the fundamentals of science and technology and their application to development and design. To help fit the students for future responsibilities, the courses must include liberal studies and some instruction in the principles of industrial organization.

Colleges seeking recognition for a course must make formal application to the Council. They will be expected to provide a substantial programme of advanced studies. In particular, the subjects constituting the course must be conducted in an environment where advanced studies are the main preoccupation of the staff. Good library facilities and social amenities are necessary. It is desirable for the college to have residential facilities; but the absence of such facilities will not prevent courses from being recognized at the moment. It is intended, however, to make this a condition as soon as possible. The staff will be expected to be of high quality. In particular, the leaders of each branch of study should have either higher degrees and substantial academic experience, or suitable academic qualifications supported by substantial industrial experience or both. They should also be professionally active in their subjects. It is highly desirable that colleges and industry should arrange their conditions of employment so that interchange of staff for suitable full-time periods can be encouraged. In assessing the staff, the emphasis will be on their intellectual and personal qualities. They should include persons to whom industry would go for advice. Above all, they will be expected to be good teachers and to be able to relate their industrial experience to their teaching work. It is essential that staff engaged on the course should have opportunities for research. Details of the procedure for applying for the recognition of suitable courses and the fees to be charged for the courses will be announced later.

Permanent Commission of the International Fisheries Convention

The fifth meeting of the Permanent Commission set up under the International Fisheries Convention of 1946 took place in London during May 8–11. Delegations attended from all thirteen of the member governments, namely, Belgium, Denmark, the Federal German Republic, France, Iceland, Ireland, the Netherlands, Norway, Poland, Portugal, Spain, Sweden and the United Kingdom of Great Britain and Northern Ireland. Observers were present from the Union of Socialist Soviet Republics, which was represented for the first time. There were also observers from the International Council for the Exploration of the Sea, the Food and Agriculture Organization of the United Nations, and the International Commission for the Northwest Atlantic Fisheries. Much of the Commission's discussion was devoted to the report of an *ad hoc* scientific committee set up at the previous meeting to review available information and to advise the Commission on minimum mesh sizes and minimum size-limits for fish, and to say whether any changes were required. This report is to be published, and it was agreed to recommend that the member governments should have it translated and should seek the views of their own fishing industries, and should report back with their recommendations and proposals by December 31, 1956. Meanwhile, the 75-mm. minimum mesh for ordinary trawls will be continued until April 4, 1958. The Commission also gave further attention to the problem of mixed fishing for protected and for other species. The Commission appointed a Committee composed of representatives of the six countries most concerned, namely, Belgium, France, the Netherlands, the Federal German Republic, Poland and Sweden, to study this problem further for the next meeting. Finally, the Commission received reports from the International Council for the Exploration of the Sea on the question of a definition of the light trawl, and the problem presented by the capture of undersized whiting in the industrial fisheries. No further action is to be taken at present on these problems since the International Council is continuing its investigations. Klaus Sunnanaa (Norway) was elected president for the next three years in succession to R. G. R. Wal (United Kingdom), whose term of office had expired and A. Alloy (France) was elected vice-president in succession to Dr. G. Rollefsen (Norway). The Commission will hold its next meeting in London beginning on May 14, 1957.

K. W. Feuerbach and his Geometrical Research

One of the most important theorems of the geometry of the triangle that was developed during the nineteenth century is the one which shows that the nine-point circle of a triangle is tangent to the inscribed and to each of the three escribed circles of the triangle. The theorem was discovered and first proved by Karl Wilhelm Feuerbach, a little-known mathematician who led a short and tempestuous life; an account of his life and researches has been given by Prof. Laura Guggenbuhl (*Scientific Monthly*, 81, No. 2; 1955). Feuerbach's proof was purely algebraic, being modelled upon the proof in an article by Euler in 1765; but while it is in principle simple enough, the detail of the working is exceedingly laborious, and in succeeding years many people, fascinated by the difficulties in Feuerbach's proof, seemed to find it a pleasant challenge to produce a different and simpler one. Feuerbach, the third son of a family of eleven, was born in Jena in 1800, his father being a successful lawyer. Shortly after the publication of his book, Feuerbach, only twenty-two years old and without previous teaching experience, was appointed professor of mathematics at the Gymnasium at Erlangen. Soon afterwards, he studied for a time at the University of Freiburg under Karl Buzengeiger, who is credited with having had a great influence upon the young mathematician. On returning to Erlangen, however, he was involved in political troubles and was arrested. At his trial he was acquitted; but he spent more than a year in prison awaiting trial, and during this time he commenced some further mathematical research. This was later completed, and was the subject of a review by Cantor in the *Sitzungsberichte der Heidelberg Akademie der Wissenschaften*; in a final summary, Cantor says that Feuerbach in this work proved himself to be an independent co-discoverer with Mobius of the theory of the homogeneous coordinates of a point in space. At the time of his imprisonment, Feuerbach was already showing signs of mental derangement, and by 1828 this was so serious that he had to retire from teaching. He died six years later when not yet thirty-four.

Mycological Collections in Latin America

The attention of mycologists is directed to the Second General Catalogue of Latin American Mycological Collections, published under the auspices of the Unesco Centre for Scientific Co-operation (Centro de Cooperación Cientifica para América Latina de la U.N.E.S.C.O., Bulevar Artegas 1320, Casilla de Correos 859, Montevideo, Uruguay; 1955). Indications are given of all the fungi in the collection and of the institutions or laboratories where they are maintained. Full information on the origin, biological properties and characteristics of the cultures, biographical citations, etc., can be obtained on application to the Centro de Cooperación.

The United States National Museum

The annual report of the United States National Museum for 1955 records the opening of the First Ladies Hall on May 24, 1955. The eight display units in the Hall are designed to represent different rooms in the White House, Washington, from the earliest period to the present time and contain architectural details acquired from the House during its recent reconstruction. They give the public an opportunity to view the dresses in surroundings similar to those in which they were originally worn. Each room contains three to six dresses representing a time of about twenty years. The changing styles in White House decoration shown in these rooms are based on available drawings and photographs together with written descriptions.

Royal Society Depository of Unpublished Mathematical Tables

The following is a list of accessions to the Royal Society's depository of unpublished mathematical tables since the publication of the last list in *Nature* (175, 712; 1955): (52) Étude de $3n^2 + 1$, $3n^4 + 1$, $3n^8 + 1$ (A. Ferrier); (53) Table of $\mathrm{Bi}'(+x)$, for $x = 0(0{\cdot}01)2$ and $\mathrm{Hi}'(-x)$, for $x = 0(0{\cdot}01)10$ (K. I. McKenzie and M. Rothman); (54) Table of a function related to the error function (H. J. Gawlik); (55) Étude de $5n^2 - 1$, $5n^4 - 1$ (A. Ferrier); (56) The self-consistent field for Zr^{4+}: supplementary tables (S. L. Altmann); (57) Tables for the regular reflexion of plane shocks in air (C. K. Thornhill and Katharine M. Stocks); (58) Tables of quantities associated with oblique shocks in air for which the flow deflexion is a maximum or behind which the flow is sonic (C. K. Thornhill and Katharine M. Stocks); (59) Tables of Sievert's integral (S. Johnston); (60) Solutions of the Poisson–Boltzmann equation for two equal spherical colloidal particles (N. E. Hoskin); (61) Tables of Fresnel integrals (J. R. Airey). Further information about these tables can be obtained from the Assistant Secretary, Royal Society, Burlington House, London, W.1.

International Union of Forest Research Organizations: Congress at Oxford

The twelfth Congress of the International Union of Forest Research Organizations is to be held in Oxford during July 7–14 and will be followed by organized tours in various parts of Britain. It is expected that nearly two hundred delegates from twenty-five countries, mainly European but including Canada, Australia, New Zealand, the United States and Japan, will take part. The previous Congress was held in Italy in 1953. The Union was founded as long ago as 1890, and its aims include the establishment of close personal relations between forest research workers of all countries, particularly between specialists working in the same field of activity. The meetings at Oxford will be under the following main headings: general forest influences; forest production; establishment and maintenance of forests; forest economics—operational efficiency; and forest products. The Congress is to be opened at Regent's Park College, Oxford, on July 7, by the Minister of Agriculture, Mr. Heathcoat Amory, and during the week-end there will be local tours for delegates. In the ensuing week, meetings of the Congress will be held at the Imperial Forestry Institute and there will be a closing plenary session on July 14 in Regent's Park College. On July 12 excursions will be available to the Forestry Commission's Research Station at Alice Holt Lodge, near Farnham, Surrey; the Forest Products Research Laboratory at Princes Risborough; and the Rothamsted Experimental Station, Harpenden. Following the Congress, there will be seven separate tours—three in England, three in Scotland and one in Wales—and the programme will include visits to Forestry Commission areas and a number of private estates known for their outstanding forestry.

Announcements

PROF. ARTHUR HOLMES, regius professor of geology in the University of Edinburgh, has been awarded the Penrose Medal for 1956 of the Geological Society of America. The Medal is awarded, on occasion, in recognition of outstanding original contributions or achievements which mark a decided advance in the science of geology.

SIR HARRY JEPHCOTT has been appointed chairman of the Advisory Council of the Department of Scientific and Industrial Research in succession to Sir Hugh Beaver, who has resigned; Sir Hugh will continue to serve as a member of the Council.

DR. R. A. WILKINS, vice-president, research and development, of the Revere Copper and Brass, Inc., Rome, New York State, has been elected a Fellow of the Institute of Metals in recognition of his outstanding services to the Institute, and in particular as corresponding member to the Council in the United States. Fellowship of the Institute is limited to twelve, and Dr. Wilkins is the first member resident outside the British Isles to be elected.

THE official title of the Commonwealth Bureau of Dairy Science at Shinfield, Reading, has been changed to the Commonwealth Bureau of Dairy Science and Technology. It is felt that this will reflect more accurately the scope of the Bureau's activities.

A SUMMER laboratory course on techniques and applications of the electron microscope will be held during June 11–23 in the Department of Engineering Physics of Cornell University. The course will be on the lines of those held in previous years. Further information can be obtained from Prof. Benjamin M. Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, N.Y.

A SUMMER school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory, Cambridge, during September 17–28. The course will be along the same lines as those held in previous years. Application forms, to be returned by June 15, and further information can be obtained from the secretary of the Board of Extra-Mural Studies, G. F. Hickson, Stuart House, Cambridge.

THE annual course on tropical hygiene for laymen will be held by the Ross Institute this year during July 16–20. The course is intended for those whose work in the tropics makes them responsible for the health and welfare of others. There is no fee. Further information can be obtained from the organizing secretary, L. G. Ponsford, Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1.

THE sixth summer school on welding, organized by the British Welding Research Association, will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during June 18–23. After a general introduction, the course will be divided into four separate groups dealing with the following topics: gas-shielded welding; resistance welding; metallurgy and physics of welding; and inspection, testing and quality control in welding processes. Application forms and further information can be obtained from the Organizing Secretary, Sixth Summer School of Welding, B.W.R.A., 29 Park Crescent, London, W.1.

A JOINT Committee of the Field Studies Council and the Royal Meteorological Society is again arranging a short vacation course in meteorology, which will be held at Malham Tarn Field Centre, near Settle, Yorks, during August 22–29. The course will be directed by Mr. C. D. Ovey, University lecturer in geography, Cambridge, and Dr. R. S. Scorer, University lecturer in meteorology, Imperial College of Science and Technology, London. The main emphasis will be on practical aspects of meteorology. The inclusive fee for the course is £7. Particulars can be obtained from the Publicity Secretary, Field Studies Council, Ravensmead, Keston, Kent.

APPLICATIONS are invited by the Atomic Energy Research Establishment, Harwell, from physicists and electronic engineers holding a degree or equivalent qualification, who wish to attend the eleventh specialized course, during June 11–15, on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry, and in work with radioisotopes. Attendance at the course is limited to twelve; the syllabus will include lectures and practical work concerned with counters, d.c. and pulse amplifiers, coincidence units, scalers and ratemeters, and the lecturers and demonstrators will be specialists from the Atomic Energy Research Establishment. The subject will be entirely non-secret. The fee for the course is 15 guineas, and living accommodation can be arranged locally at a charge of four guineas approximately. Application forms can be obtained from the D.A.O., Electronics Division, A.E.R.E., Harwell, Didcot, Berkshire. These must be returned by May 25.

THE Sixth International Mechanical Engineering Congress will be held in Paris during June 4–9, the subject for discussion being "Surface Treatment for the Improvement of Mechanical Properties and Protection against Corrosion". The following topics will be considered: improvement of resistance to wear by increase of surface hardness; improvement of resistance to wear through improvement of friction characteristics; improvement of resistance to heat; improvement of resistance to corrosion by metal coatings deposited by means other than electroplating; improvement of resistance to corrosion by electroplating processes; improvement of resistance to corrosion by chemical processes; improvement of resistance to corrosion by non-metallic coatings; and surface treatment for decoration and for improving optical properties. The official languages of the meeting will be English, French and German. Further information can be obtained from the Permanent Secretariat of the 6th I.M.E.C., 11 avenue Hoche, Paris 8^{e}.

THE second annual Guenter Loeser Memorial Lecture of the Geophysics Research Directorate of the Air Force Cambridge Research Center will be given this year by Dr. Robert G. Breene, jun., speaking on the "Phenomenological Considerations of the Interruption Theory of Line Broadening". The lecture will be delivered on June 29 in the Charter Room of the New England Mutual Building, Boston, Mass.

THE Central Laboratories for Scientific and Industrial Research, Hyderabad, have been formally taken over by the Council of Scientific and Industrial Research, Government of India, and will henceforth be known as the Regional Research Laboratory, Hyderabad. This is the first regional laboratory of the Council. Dr. S. Husain Zaheer remains as director, and the research staff will continue as before.

FUEL IN INDIA

By the late PROF. M. N. SAHA, F.R.S.

THE relative contributions of different types of fuels to the total energy production in India has received attention from many quarters in recent years[1–4]. Unfortunately the statements made are often contradictory; in this article I shall try to clear up this confusion.

By 'fuel' I mean anything which gives energy on combustion: coal, oil, wood, cattle dung, dried twigs and leaves. Other energy-producing agencies are nuclear fuel, which has not yet been used in India, and hydroelectricity. To compare the relative contributions of the different types of fuels to the total fuel economy of India, we have to know the absolute calorific value of each type of fuel.

The absolute calorific value of a fuel is the amount of heat given off on its complete combustion. This is listed for various types of fuels in Table I[5].

Table 1

Fuel	Calorific value (k.cal./lb.)
Soft coke	2,550
Hard coke	2,850
Charcoal	3,500
Wood (dry)	2,000
Dry leaves	1,500–2,000
Cow-dung (sun-dry)	1,500
Petroleum products (average)	4,460

Coal. The coal production in India in 1952 was 35 million tons. This was distributed among the consumers as follows[3]:

Table 2

Consumer	Amount consumed	Percentage
Railways	11·5 million tons	32·8
Iron and steel	4·0 ,, ,,	11·4
Collieries	2 0 ,, ,,	5·7
Steam and electric utilities	2 5 ,, ,,	7·15
Brick, cement, potteries, refractories and lime kilns	3·0 ,, ,,	8·6
Mills, works, etc.	3·0 ,, ,,	8·6
Bunker and export	3 5 ,, ,,	10·0
Other industries	2 5 ,, ,,	7·15
Domestic	3 0 ,, ,,	8 6

From Table 2, it can be seen that less than 10 per cent of coal in India is used as domestic fuel, so that more than 90 per cent of coal burnt is used by industries.

Petroleum products. The total amount of petroleum products imported into India in 1952 was 3·3 million tons, while the indigenous production was only 0·22 million tons; so the total was 3·5 million tons, which has a calorific value of 35×10^{12} k.cal. (see ref. 3). From Table 1, it can be seen that the equivalent amount of coal giving the same energy as the petroleum products in India per annum would be about 6 million tons.

Hydroelectricity. Total output of hydroelectric power in India was about 2,000 million kWh.[3], which is equal to $1 \cdot 72 \times 10^{12}$ k.cal. Assuming 30 per cent efficiency for the conversion of heat energy into electrical energy in a modern thermal station, the above amount of electrical energy should be equivalent to the burning of about 1 million tons of coal.

Cattle dung. Cattle dung is an important domestic fuel in India, though there is a good deal of controversy about its relative contribution to the fuel economy of the country. We can estimate the total amount of energy derived by burning cattle dung in the following manner. The cattle population (which includes cows as well as buffaloes), according to the Report on the Marketing of Cattle in India (1946)[6], was 212 million in undivided India. Taking the cattle population to be three-fourths of this number after partition, India should have now about 160 million. This is in agreement with the figure of 177·4 million published in the Draft Outline of the First Five Year Plan, published by the Planning Commission (1951)[7].

According to the Report on the Marketing of Cattle in India[6], the average Indian cow (adult) produces about 25 lb. of green dung a day, whereas the young cow produces about 18 lb. a day. The contributions of the adult and young buffaloes are 60 lb. and 40 lb. a day respectively, as given in the above report.

The actual fuel value of cow-dung can then be calculated from the data given above. Assume that of the 180 million head of cattle, 140 million are cows and 40 million are buffaloes, and that the percentages of adult and young among cows and buffaloes are 70 per cent and 30 per cent. Then the amount of dung produced by 140 million cows is approximately $100 \times 25 + 40 \times 18 = 3{,}220$ million lb. per day. Similarly, the amount of dung produced by 40 million buffaloes is approximately $30 \times 60 + 10 \times 40 = 2{,}200$ million lb. per day. Hence, the total amount of dung produced is $\frac{3{,}220 + 2{,}200}{2{,}240} =$ 2·42 million tons per day, say 890 million tons a year.

Now according to the Memorandum on the Development of Agriculture and Animal Husbandry in India (1944)[8] published by the Advisory Board of the Imperial Council of Agricultural Research, only 40 per cent of the total green dung is used as fuel, 40 per cent is used as manure and the remainder is lost. Actually there is some difference of opinion on the percentage of dung used as fuel. Thus the Report of the Expert Committee on Manures and Fertilizers (1953)[9] published by the Ministry of Food and Agriculture, Government of India, gives 50 per cent, whereas according to W. Burns, an officer on special duty in the Department of Education, Health and Lands of the Government of India (1944)[10], this figure should be 66·6 per cent. Here I accept the figure 40 per cent as more reliable. Hence total green dung used as fuel is $890 \times 0 \cdot 4 = 356$ million tons. Again, according to the above Memorandum (1944), 1 lb. of dried cow-dung comes from about 5 lb. of green cow-dung. So the equivalent weight of dried dung is $\frac{356}{5} = 71$ million tons.

Now, if the whole combustible material in dried cow-dung is fully burnt, about 1,500 k.cal. of heat per lb. of dried cow-dung is obtained[5]. But the calorific value of 1 lb. of coal is much higher, being in the range of 2,550–2,850 k.cal./lb. for Indian coal. The average may be taken to be about 2,700 k.cal./lb. Hence for complete combustion 1 lb. of coal gives as much heat as 1·8 lb. of dried cow-dung. Thus the contribution of cow-dung fuel to the fuel economy of India is equivalent to 40 million tons of coal.

Fuel wood. The position with respect to fuel wood is not very clear. Recorded figures of fuel wood consumption from lands classified as forests indicate an extremely low value, being only about 53 lb. per head per year. According to the President of the Forest Research Institute and Colleges, India, this is a ridiculously low figure (private communication). However, there are reasons for believing that unauthorized wood-cutting amounts to many times the recorded figures, and that leaves and twigs are also utilized as fuel[3]. Actually, some idea regarding the amount of domestic fuel wood burnt annually in India may be obtained in the following manner.

According to Lahiri and Das Gupta[3], the average per capita energy consumption in India amounts to about 80–100 therms per year, which is equivalent to about $2,800 \times 10^{12}$ to $3,500 \times 10^{12}$ B.T.U. a year for the entire population. Of this, about $1,100 \times 10^{12}$ B.T.U. a year is met from coal, oil and hydroelectricity. The remainder must therefore come from wood fuel and farm waste. The energy obtained from these sources must therefore be in the range of $1,700 \times 10^{12}$ to $2,400 \times 10^{12}$ B.T.U. We may therefore assume that about $2,000 \times 10^{12}$ B.T.U. or 500×10^{12} k.cal. of energy are obtained in India per annum by burning wood fuel and farm waste[2,3]. Taking the heating value of 40 million tons coal-equivalent of cattle dung to be about 242×10^{12} k.cal., the heating value of fuel wood should be about 258×10^{12} k.cal., that is, equivalent to 43 million tons of coal approximately. This would bring the per capita consumption of fuel wood in India to about 370 lb. per head per year, which is about seven times the figure quoted above.

Table 3

Fuel	Coal equivalent in million tons consumed annually	Percentage contribution to the fuel economy of India
Coal	35	28·0
Oil and hydroelectricity	7	5·6
Cattle dung	40	32·0
Wood, dried leaves and twigs	43	34·4

We are now in a position to estimate the percentage contribution of different types of fuels to the fuel economy of India. This is shown in Table 3.

[1] Putnam, P. C., "Energy in the Future" (London: Macmillan, 1954).

[2] Lahiri, A., and Das Gupta, A. K., "Problems of Energy Development in India"—I, *Fuel Res. Inst. News*, 4, No. 3 (1954).

[3] Lahiri, A., and Das Gupta, A. K., "Problems of Energy Development in India"—II, *Fuel Res. Inst. News*, 4, No 4 (1954).

[4] Bhabha, H. J., "The Role of Atomic Power in India and Its Immediate Possibilities", International Conference on the Peaceful Uses of Atomic Energy (1955).

[5] Lahiri, A., "Domestic Fuel", *Fuel Res. Inst. News*, 3, No. 3 (1953).

[6] Agricultural Marketing Advisor to the Government of India. Report on the Marketing of Cattle in India, 66 (1946).

[7] Planning Commission, "The First Five Year Plan—A Draft Outline", 109 (1951).

[8] Advisory Board of the Imperial Council of Agricultural Research. Memorandum on the Development of Agriculture and Animal Husbandry in India, 27 (1944).

[9] Ministry of Food and Agriculture. Report of the Expert Committee on Manures and Fertilizers, 34 (1953)

[10] Burns, W., "Technological Possibilities of Agricultural Development in India", 116 (1944).

THE U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

THE ninety-third annual meeting of the National Academy of Sciences was held in Washington, D.C., during April 23–25. At the annual dinner on April 24, there were two guests of honour: Dr. Alexander von Muralt, past president of the International Council of Scientific Unions, and now president of the National Research Council of Switzerland and rector of the University of Berne; and Dr. John E. Burchard, dean of the School of Humanities and Social Studies at the Massachusetts Institute of Technology, and president of the American Academy of Arts and Sciences. Thirty-four papers were read at five sessions, and, in addition, three other sessions were devoted to symposia on the following subjects: solar and terrestrial relationships; biomolecular organization and life processes; and science in education.

At the meeting the following awards of the Academy were presented: *Agassiz Medal*, to Prof. Alfred C. Redfield, associate director of the Woods Hole Oceanographic Institution; *Henry Draper Medal*, to Prof. Hendrik C. van de Hulst, professor of theoretical astronomy in the University of Leyden; *Elliot Medal*, to Prof. Archie Carr, professor of biological sciences in the University of Florida; *Kimber Genetics Award*, to Prof. Sewall Wright, professor of genetics in the University of Wisconsin; *Kovalenko Medal*, to Dr. Peyton Rous, member of the Rockefeller Institute for Medical Research; *Thompson Medal*, to Prof. Alfred S. Romer, Alexander Agassiz professor of zoology and director of the Museum of Comparative Zoology, Harvard University; *Watson Medal*, to Dr. Chester B. Watts, director of the Six-Inch Transit Circle Division, United States Naval Observatory.

The Agassiz Medal of the Academy, which is awarded for distinguished work in oceanography, goes to Dr. Redfield in recognition of his many and diverse contributions in this field. He has been associated with the Woods Hole Oceanographic Institution since 1931 and has been professor of physiology in Harvard University since the same date. His knowledge of physiology, a field in which he made important contributions before turning to the study of the sea, coupled with his interest in sailing and the seashore, has been an important part of his work in oceanography. For example, he translated the physiological functions of blood into the metabolism of the marine environment in which water and organisms interact as an entity with a physiology of its own. His analyses of biochemical cycles in the sea, of the origin and distribution of organisms, and of the products of biological activity have led to interpretations of the oceanic circulation which incorporate the physical, chemical and biological cycles. Lately he has been studying the development and growth of salt marshes and the genesis and propagation of waves associated with hurricanes.

The Draper Medal, which was established to recognize significant contributions to astronomical physics, has been awarded to Prof. van de Hulst for his noteworthy contributions to the field of radio astronomy and in particular for his prediction, made in 1944, that radiation of 21 cm. wave-length should be emitted by neutral hydrogen in interstellar space.

The probability of the transition in a given atom is extremely low; but because the total quantity of hydrogen in the vast reaches of interstellar space is enormous, detectable amounts of the radiation are emitted. In 1951 observers in the United States, Australia and the Netherlands detected the radiation independently as a sharp line in the radio-frequency spectrum. Because of its sharpness, the line is useful for the determination of the velocities at which the clouds of hydrogen are moving towards us or away from us, and because radiation at this frequency penetrates regions relatively opaque to visible light, the observations have contributed much to the great new fund of knowledge that comes from the rapidly growing field of radio astronomy. Soon after his prediction was confirmed by observation, Prof. van de Hulst, in collaboration with Jan Oort and C. A. Muller, began to study the hydrogen radiation around the equator of our galaxy, and by 1953 they had produced evidence of the spiral structure of the galaxy in striking agreement with observations by other means.

The award of the Daniel Giraud Elliot Medal has been made to Dr. Carr in recognition of his book, "Handbook of Turtles: the Turtles of the United States, Canada, and Baja California" (Comstock Publishing Associates, Cornell University Press, 1952). Dr. Carr has devoted a number of years in the field and the laboratory to the study of the anatomy and zoology of the turtle, and his "Handbook" is an account of all kinds of turtles found in the area north of Mexico, but including Lower California. After discussing the probable evolution of the turtle group with a summary of physiology, adaptation, anatomy and economic value, he describes the various kinds of turtles and their distribution, their appearance being illustrated by many excellent photographs and drawings. The Elliot Medal has been awarded by the Academy annually since 1917, under a provision of the will of Daniel Giraud Elliot expressing his wish to provide a medal and honorarium to the author of any paper, essay or other published work of outstanding merit in zoology or palæontology.

Prof. Wright, the recipient of the Kimber Genetics Award, has made important contributions to both theoretical and experimental genetics. His early experimental work was concerned with the effects of inbreeding in animals, and this led to studies on the relative importance of heredity and environment as causes of variation. His later work has dealt with the problems of physiological and developmental genetics, and, using guinea pigs, he has analysed the complex and remarkable interaction effects of genes. In theoretical genetics, Prof. Wright is perhaps best known for his series of mathematical papers on various aspects of evolution. His theoretical work on the statistical consequences of Mendelian heredity, although directed primarily to the problem of evolution, has had profound effects on the methods by which domestic plants and animals are genetically improved.

The award of the Kovalenko Medal to Dr. Rous is in recognition of his distinguished contributions in the field of experimental medicine. Very early in his career he observed an association between viruses and tumour growth. Because he was so far in advance of his field, working at a time when knowledge of viruses was meagre and cancer research was in its infancy, the significance of this relationship was not at first recognized. For the past two decades he has been actively concerned with the viral etiology of tumours. He has also worked on the physiology and pathology of the liver and the physiology of the blood vessels. In addition, he has been editor of the *Journal of Experimental Medicine* for many years. The Kovalenko Medal was established in 1949 by Dr. M. S. Kovalenko in memory of his wife, Jessie Stevenson Kovalenko, for outstanding contributions to medical science, and Dr. Rous is the second recipient.

Prof. Romer, the recipient of the Thompson Medal, has spent most of his research career studying the comparative anatomy and evolution of vertebrate animals. His speciality has been the reptilian and amphibian life of the Permian period, some 200–225 million years ago, soon after the vertebrates in the course of their evolution had emerged from the water and as their conquest of the land was getting well under way. In this connexion he has shown that the ancestral freshwater fishes already had lungs and other pre-adaptations for land life, and has developed the theory that legs, capable of walking on land, were originally an adaptation for staying in the water. They permitted the ancestral fishes to wriggle from a drying pool across land to other pools still holding water in seasons of drought. Especially noteworthy are his intricate studies of details of the brain-case and reconstruction of vanished nerves in fishes, amphibians and reptiles long extinct. Prof. Romer has himself discovered and collected many of the rare fossil animals that he has studied; he has led many fossil-hunting expeditions, especially in Texas.

Dr. Watts, who receives the James Craig Watson Medal in recognition of his outstanding contributions to astronomical research, has spent the greater part of his forty-five years at the United States Naval Observatory, determining positions of the Sun, Moon, planets and stars; and since 1934 he has been chiefly responsible for the six-inch transit circle, and with a judicious combination of mechanical, optical, photographic and electronic techniques, he has brought the instrument to an extremely high state of perfection. He has recently designed and supervised the construction of a new nine-inch transit circle at the Observatory. The precision of all these measurements is based on observations of the edge of the Moon's disk, and the edge is always irregular because of the high mountains and low valleys on the Moon's surface and also because a slightly different aspect of the edge is seen from time to time. About eleven years ago, Dr. Watts undertook to survey that part of the Moon's surface (comprising some 18 per cent) which is seen as an edge. To survey a surface a quarter of a million miles away to an accuracy of fifty feet required some thousand photographs, the invention and construction of an automatic photoelectric machine for tracing the profile of each photograph and drawing it on a strip of paper 30 ft. long, the design and construction of analogue computers for analysing the profiles and translating them into numerical form, the devising of means for integrating the profiles into a representation of the surface of the Moon in the vicinity of the edge, and finally the development of the most readily usable form for publication of the results. The survey is now complete and will be published shortly.

The following new elections were made to the Council of the Academy: *Treasurer*, Dr. William J. Robbins, director of the New York Botanical Garden, New York (this being the second such term of office for which he has been elected treasurer); *Members of Council*, Prof. I. I. Rabi, professor of physics, Columbia University, New York, and Dr. F. E. Terman, dean of the School of Engineering, Stanford University, Stanford, Calif. The other officers of the Academy, who were elected in previous years and will continue until expiry of their terms of office, are as follows: *President*, Dr. Detlev W. Bronk; *Vice-President*, Dr. George W. Corner; *Home Secretary*, Dr. Hugh L. Dryden; *Foreign Secretary*, Prof. John Gamble Kirkwood; *Members of Council*, Prof. Farrington Daniels, Dr. E. A. Doisy, Dr. James Gilluly, Dr. Theophilus S. Painter, Dr. Merle A. Tuve and Prof. Edwin B. Wilson.

The following have been elected members of the Academy: G. von Békésy, senior research Fellow in psychophysics, Harvard University; M. Benedict, professor of nuclear engineering, Massachusetts Institute of Technology; K. E. Bloch, professor of chemistry, Harvard University; K. S. Cole, director of the Laboratory of Biophysics, National Institute of Neurology, Diseases, and Blindness, National Institutes of Health, Bethesda; B. L. Crawford, jun., professor of physical chemistry, University of Minnesota; W. A. Fowler, professor of physics, California Institute of Technology; C. P. Haskins, president of the Carnegie Institution of Washington; E. W. Haury, professor of anthropology, University of Arizona; P. Kusch, professor of physics, Columbia University; A. L. Lehninger, professor of physiological chemistry, School of Medicine, Johns Hopkins University; M. G. Mayer, senior physicist, Argonne National Laboratory, Lemont; C. P. Miller, professor of medicine, University of Chicago; W. W. Morgan, professor of astronomy, Yerkes Observatory, University of Chicago; W. H. Munk, professor of geophysics, Scripps Institution of Oceanography, La Jolla; M. S. Newman, professor of chemistry, Ohio State University; R. F. Pitts, professor of physiology, Cornell University College of Medicine; J. D. Roberts, professor of organic chemistry, California Institute of Technology; K. P. Schmidt, emeritus curator, Department of Zoology, Chicago Natural History Museum; M. Schwarzschild, professor of astronomy, Princeton University; C. E. Shannon, research mathematician, Bell Telephone Laboratories, Inc.; F. K. Skoog, professor of botany, University of Wisconsin; N. E. Steenrod, professor of mathematics, Princeton University; W. H. Stockmayer, professor of physical chemistry, Massachusetts Institute of Technology; A. Szent-Györgyi, director of research, Institute for Muscle Research, Inc., Marine Biological Laboratory, Woods Hole, Mass.; C. H. Townes, professor of physics, Columbia University; F. J. Turner, professor of geology, University of California, Berkeley; J. Verhoogen, professor of geology, University of California, Berkeley; M. B. Visscher, professor of physiology, University of Minnesota; J. C. Warner, president of the Carnegie Institute of Technology, Pittsburgh; W. H. Zinn, director of the Argonne National Laboratory, Lemont.

The following have been elected foreign associates of the Academy: Prof. F. G. Gregory, director of the Research Institute of Plant Physiology and professor of plant physiology, Imperial College of Science and Technology, London; Sir K. S. Krishnan, director of the National Physical Laboratory, New Delhi; Prof. A. E. Michotte, professor of psychology, University of Louvain; and Prof. J. J. C. Pérès, dean of the Faculty of Sciences and professor of rational mechanics, University of Paris.

FORESTRY COMMISSION

REPORT FOR 1954

THE annual report of the Forestry Commission for 1954* opens with a statement on the unveiling of a memorial on the site in Keilder Forest where the ashes were scattered of the late Lord Robinson, chairman of the Forestry Commission during 1932–52 and a member of the Commission from its inception.

The year 1954 marks the peak of the Commission's planting so far, a total of 70,400 acres having been achieved, or 2,800 acres more than the previous year. Since the end of the Second World War the rate of annual planting has been increased each year up to this major total. The regular increase, it is noted, has only been maintained by materially reducing the reserves of land awaiting planting. So the point has been reached when the annual planting programme will not only not increase but will in fact fall. The report states that the planting to be carried out in 1955 will bring the planted forest area under the Commission up to and beyond the million acres mark: a truly remarkable and meritorious performance, with all the difficulties and setbacks the Commission has had to face since its inception in 1920, when five million acres of forests were aimed at. More land is required; but the problem is not merely one of acquiring land, for it must be suitably distributed plantable land. There are still large tracts of country running into many hundreds of thousands of acres the best use of which is undoubtedly forestry. It is this type of land which the Commission wishes to acquire if the owners are unable to plant it themselves. Private planting continues to rise steadily though surely: including areas planted without grants, a total of 19,100 acres were planted—nearly a thousand acres more than the previous year.

The production and consumption of home timber were the same as during 1953. The cut in hardwood species was probably less, due to the poorer quality of the timber now being felled and to the abolition of softwood consumer licences in November 1953. It is interesting to note that the expensive home-grown programme inaugurated in 1919 is now beginning to show a financial return, in the pulp and pitwood markets, though difficulties with reference to mining timber and its testing for quality are still under debate. The big Scottish windblow of January 1953 has continued to provide large amounts of timber, of which the National Coal Board has taken advantage. The large intake of home pit-props by the English collieries has been due to an increase in normal production—a most satisfactory position in view of the fact that at the beginning of the century, and before and after, the mines were dependent on Scandinavian and other imports at great cost. Nevertheless, only about one-quarter of the estimated consumption of Britain as a whole is being supplied from home sources.

An interesting investigation is in the possible utilization of inferior and poorly grown hardwoods for wood pulp. The main bulk of these hardwoods are to be found in the south of England, and two British paper-making groups are considering the question of ground wood-pulp for newsprint and

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* Forestry Commission. Thirty-fifth Annual Report of the Forestry Commission for the Year ended September 30th, 1954. Pp. 88. (London: H.M.S.O., 1955.) 3s. 6d. net.

"Kraft" pulp for wrapping and packaging. It is said that the requirements of the raw materials for such processes are less exacting in quality and quantity than in the case of dissolving pulp, which is largely used in the manufacture of artificial fibre.

Progress continued in the dedication of woodlands, and during the year the area dedicated increased from 225,000 acres to 343,000 acres.

E. P. STEBBING

AUSTRALIAN ATOMIC ENERGY COMMISSION

A REPORT of the work of the Australian Atomic Energy Commission since its establishment in 1953 is outlined in an article by Prof. J. F. Baxter, vice-chancellor of the New South Wales University of Technology, in the *Australian Journal of Science* (17, No. 5, 151; 1955). Details are given of the initial stages which led up to the establishment of the Commission, its composition and its two main fields of activity, namely, that related to the discovery and production of uranium and that related to the development of the use of atomic energy for industrial and other purposes. In surveying what the Commission has accomplished since its establishment, Prof. Baxter mentions the completion of the plant for the mining of uranium ore at Rum Jungle, which was set in motion by the Prime Minister on September 17, 1954, and of the opening of the Radium Hill mine and concentrator during 1954. A modern treatment plant at Port Pirie was expected to be completed in the near future.

In regard to its responsibilities for the development of uses for atomic energy, the Commission decided to try to obtain access to the large amount of secret information accumulated by Great Britain, the United States and Canada, and to work in partnership with these powers. After various discussions and visits by prominent scientific workers both from Great Britain to Australia and vice versa, Britain offered to give to Australia its accumulated knowledge arising from its industrial atomic-energy programme and, in addition, agreed to enter into a co-operative research programme with Australia whereby the Australian Atomic Energy Commission would set up a research and development organization in Australia while Britain would provide facilities for the training of Australian scientists and engineers in the various British atomic-energy establishments. Accordingly, a Scientific Advisory Committee, consisting of Prof. M. Oliphant, Prof. L. H. Martin, Dr. F. W. G. White, Prof. R. Myers, Prof. T. G. Hunter, Prof. J. S. Anderson, Mr. V. Brain and Prof. J. P. Baxter (chairman), was appointed by the Commission, and a comprehensive group of laboratories has been constructed and equipped on a site some twenty miles south of Sydney.

A large research reactor of a modern type, designed to give a high neutron flux, is to be installed; and a scientific staff of fifty senior scientists and about three hundred other personnel are to be recruited. The chief of research and development is Prof. C. N. Watson-Munro; the chief engineer and deputy chief of research, Prof. G. C. J. Dalton; and Dr. G. L. Miles and Mr. K. F. Alder, leaders of the chemistry and metallurgy departments, respectively. In addition, the initiation and support, on a very large scale, of research and development work in the Australian universities is planned by the Commission, and special facilities for research and advanced training for engineers and scientists from universities and industry in its laboratories at Sydney are to be provided. Finally, a Business Advisory Group has been formed by the Minister for Supply in order that the Commission and leaders of industry may confer closely and regularly on atomic energy matters.

THE TUBER-BEARING SPECIES OF *SOLANUM*

MUCH has been written of the potato, its South American origin, its introduction into Europe, its many varietal forms and its taxonomy. J. G. Hawkes (*Proc. Linn. Soc.*, 166, 1 and 2, 97; 1956) has now contributed a comprehensive and critical taxonomic study of the tuber-bearing species of *Solanum*, special attention being paid to *S. tuberosum* and the tetraploid species complex. In the designation of a nomenclatural type for *S. tuberosum* the early descriptions of C. Bauhin, Clusius and others are mentioned in relation to those of Linnaeus. Evidence is brought forward to show that one of the three specimens in the Linnean Herbarium labelled as *S. tuberosum* may be considered as the lectotype. It is then pointed out that Linnaeus's description, made when one species of tuberiferous *Solanum* alone was known, could equally well be taken as referring to some 80 per cent of the wild species described later. A new description has therefore been drawn up with attempts to include the complete range of variability of *S. tuberosum* under modern concepts, and this is followed by reference to the main features that distinguish it from other potato species.

The views of the Russian taxonomists on the subdivision of the cultivated tetraploid potato into two distinct species are outlined. The criticisms levelled at these views show that it is impossible to separate the cultivated tetraploids into more than one species and that the weed tetraploids previously described as distinct should also be included within *S. tuberosum*. Experimental data support these views.

An analysis of the difference between the Andean and Chilean South American potatoes makes it possible to recognize two subspecies, namely, (*a*) subspecies *andigena* from the mountains of Venezuela, Colombia, Ecuador, Peru, Bolivia and north Argentina; (*b*) subspecies *tuberosum* from Europe and South Chile. That the European and Chilean potatoes are included under the same subspecific name does not imply that the former were derived from the latter; but that each evolved under similar environmental conditions from original Andean stocks.

As to the origin of the tetraploid potato, it can be considered as an autotetraploid, but may have been formed as an amphidiploid hybrid between two species the genomes of which were not quite identical.

The conclusion is that *S. tuberosum* was derived from an already cultivated diploid species and not directly from a wild one. Indeed, it seems probable that the cultivated potato *S. stenotomum* or a precursor of this species was the original diploid ancestor of our tetraploid potato. There is also evidence that the weed diploid *S. sparsipilum* may also have played some part in the formation of *S. tuberosum*, though cytological opinion is more strongly in favour of *S. stenotomum*.

STRUCTURE OF TOBACCO MOSAIC VIRUS

Radial Density Distribution in the Tobacco Mosaic Virus Particle

MEASUREMENTS of the equatorial scattering of X-rays by orientated gels of tobacco mosaic virus[1] have been used for calculating the mean electron density in the virus as a function of distance from the axis of the rod-shaped particle. Using a Geiger-counter diffractometer with monochromatic copper $K\alpha$ radiation, accurate, high-resolution recordings of the equatorial scattering have been obtained for values of $2\sin\theta/\lambda$ up to 0·06, and for $2\sin\theta/\lambda$ between 0·06 and 0·094 intensities have been estimated from photographs.

Over the angular range examined, the amplitudes of the intensity maxima are real since, for a helix such as tobacco mosaic virus[2], this part of the pattern is determined only by the cylindrically averaged density[3]. Sign relations between some of the maxima can be established from their regular periodicity in certain regions. Where this periodicity corresponds to a dimension about that of the particle diameter, it follows that the amplitude changes sign at the zeros separating the maxima[4]. Radial density distributions were calculated for the sign combinations consistent with these sign relations, and all but two sets were found to be improbable since they would require an unreasonably large diameter for the particle and unlikely density values. Unambiguous determination of the correct set of signs was made from the changes in the equatorial X-ray scattering produced by lead bound to the virus.

When tobacco mosaic virus is treated with lead acetate, lead is specifically bound, and the virus (in concentrated solution) remains soluble with up to about one lead atom added per 17,000 molecular weight of virus. The differences in X-ray scattering from orientated gels of normal and lead-substituted tobacco mosaic virus were used to calculate the radii at which the lead is fixed and to establish the signs of the amplitudes. Equal amounts of lead are found to bind at radii of 25 A. and 84 A.

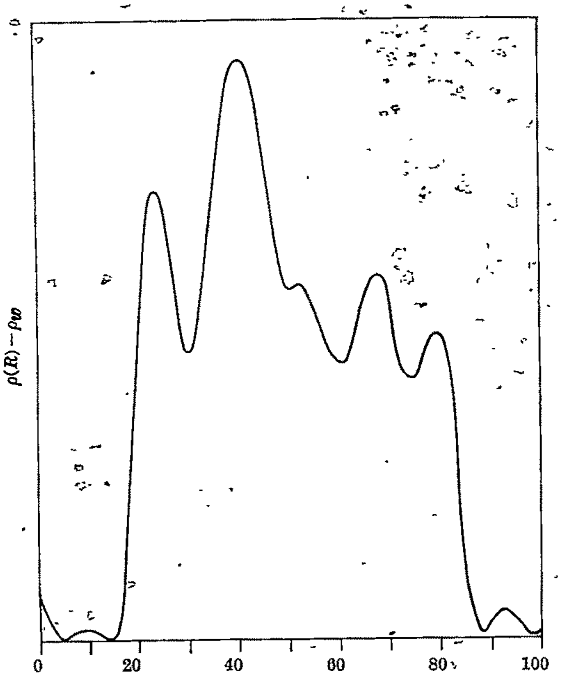

Fig. 1. Radial electron-density distribution in the tobacco mosaic virus particle plotted as a function of distance from the axis of the particle. Ordinate values are proportional to the mean density in excess of that of water

Using the signs so determined, the Fourier–Bessel transform of the equatorial amplitudes has been calculated to give the radial density distribution in the virus particle. This is shown in Fig. 1.

The following features of this transform should be noted: (1) The tobacco mosaic virus particle is hollow. A hole of radius about 19 A. extends along the axis of the particle. (2) The effective radius of the virus in solution is about 84 A., which is appreciably greater than the value 75 A.[1] obtained from the inter-particle distance in dry paracrystals. This difference is consistent with the results of Franklin and Klug[5], who found that there are rather deep indentations in the virus surface which follow the pitch of the helix in such a way that the particles can intermesh in the dry paracrystals. (3) There is a region of high density at a radius of 24 A. and one of higher density at 40 A. The peaks of smaller density at about 67 A. and 79 A. are also significant, but the other minor peaks are diffraction effects from the termination of the Fourier–Bessel integral.

Electron microscope studies[6] have shown that the ribonucleic acid in tobacco mosaic virus is located near the particle axis. From the present work alone it is not possible to decide at what radius the ribonucleic acid is located. This question is resolved by comparison of this density distribution for the normal virus with that for the ribonucleic acid – free virus protein, described by Dr. R. E. Franklin in the following communication.

Details of this work, which was supported in part by a grant from the U.S. National Science Foundation, will be described elsewhere.

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Location of the Ribonucleic Acid in the Tobacco Mosaic Virus Particle

IN the rod-shaped particle of tobacco mosaic viru the protein is in the form of sub-units set in helica array about the long axis of the particle[1]. Electro microscope studies[2] have indicated that the viru nucleic acid may form an axial core. In this com munication, however, a brief account is given of an X-ray diffraction investigation which provides strong evidence that the nucleic acid in the intact virus particle does not lie very close to the particle axis. The nucleic acid seen as a core in electron micrographs of partially degraded tobacco mosaic virus is therefore presumably in a collapsed form.

Using monochromatic copper $K\alpha$ radiation and a high-resolution focusing X-ray camera, measurements have been made of the scattered intensities on the equator and layer-lines of X-ray fibre-diagrams of orientated gels of the following substances: (1) tobacco mosaic virus, normal strain, prepared by Dr. H. Fraenkel-Conrat; (2) a mercury-substituted tobacco mosaic virus containing one mercury atom per 20,000 molecular weight of protein, prepared by Dr. H. Fraenkel-Conrat; (3) repolymerized *A*-protein prepared by Prof. G. Schramm[3]. This material is obtained from a normal strain of tobacco mosaic virus by breaking down the virus in weak alkali, removing the nucleic acid by electrophoresis, and repolymerizing the protein by lowering the *p*H.

A few non-monochromatic measurements were also made on a mercury-substituted repolymerized *A*-protein prepared by Dr. H. Fraenkel-Conrat.

The above materials, although prepared in two different laboratories, were all obtained from 'normal' virus strains. All normal strains of tobacco mosaic virus which we have so far examined give X-ray diagrams which are almost indistinguishable from one another. Moreover, our equatorial intensities, obtained photographically, are in excellent agreement with Caspar's data[4] obtained with a Geiger counter and a different virus preparation. Quantitative comparisons of diffraction data obtained from the materials listed above are therefore justified. The main purpose of this communication is to report such a comparison of accurate measurements on the normal tobacco mosaic virus and the repolymerized *A*-protein preparations (1 and 3 above).

It has previously been shown[5] that the X-ray fibre-diagram of repolymerized *A*-protein resembles that of tobacco mosaic virus so closely that there can be no doubt that the structural arrangement of the protein characteristic of the virus is preserved in the repolymerized protein. There are, however, important points of difference in the two diagrams. These are most marked on the equator, but are significant also on all the layer lines which can be accurately measured. It is from a study of these differences that the location of the nucleic acid in the tobacco mosaic virus particle can be determined.

Before discussing the differences between the tobacco mosaic virus and repolymerized *A*-protein diagrams, however, it is necessary to mention some results obtained from a comparison of the normal and the mercury-substituted virus, that is (1) and (2) above (Franklin, R. E., and Holmes, K. C., unpublished results). This has both served to confirm Caspar's allocation of signs[4] to the equatorial intensity maxima of the normal virus, and led to a new determination (Franklin, R. E., unpublished results) of the hitherto somewhat uncertain parameters of its helical structure[1,6]. This makes it possible to make the comparison between tobacco mosaic virus and repolymerized *A*-protein by two independent methods.

In the first method, the intensities recorded on the layer-lines for the two materials were compared. Using the newly determined parameters of the helical structure of the virus it can be shown that, on each of the first eight layer-lines, the principal difference between the X-ray diagrams of tobacco mosaic virus and repolymerized *A*-protein must be attributed to a structural difference at a radial distance of about 40 A. from the particle axis. This strongly suggests that the nucleic acid in tobacco mosaic virus is situated in this position.

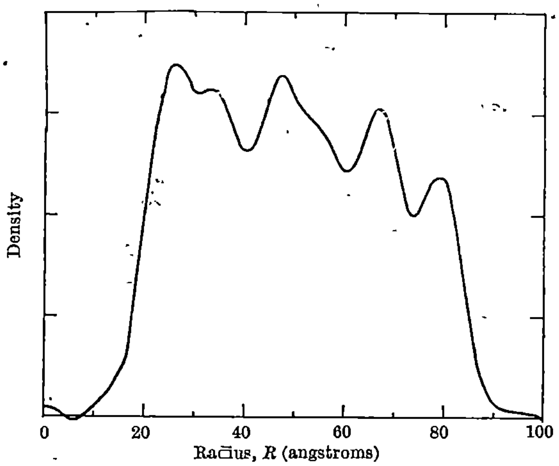

Fig. 1. Radial density distribution in repolymerized, nucleic acid-free tobacco mosaic virus protein. Ordinates are proportional to the excess electron density of the protein over that of water. Note that the density maximum observed at 40 A. for the complete virus (ref. 4) is here replaced by a density minimum

The second method is independent of the helical structure of the virus. The radial density distribution in repolymerized *A*-protein has been calculated by means of the Fourier–Bessel transform of the equatorial amplitudes. Amplitudes for values of $2\sin\theta/\lambda$ up to 0·1 were used for this purpose. It was found possible to determine the signs of the amplitudes unambiguously in this range by comparing the intensity data with those for tobacco mosaic virus on one hand, and mercury-substituted repolymerized *A*-protein on the other. To eliminate or reduce spurious peaks in the transform, an 'artificial' temperature factor' of $\exp\{-(11{\cdot}8 \times 2\sin\theta/\lambda)^2\}$ was imposed on the amplitude data. The resulting radial distribution function is shown in Fig. 1.

This distribution bears sufficient resemblance to the density distribution of tobacco mosaic virus calculated by Caspar[4] to show once again (cf. ref. 5) that the structural arrangement of the protein in the two materials is very similar indeed. (Some minor points of difference between the two curves may be attributed to the different cut-off position used and to the use of an 'artificial temperature factor' for the repolymerized *A*-protein. For example, the small peak at 53 A. in Caspar's curve is a spurious maximum resulting from the sharp cut-off at $2\sin\theta/\lambda = 0{\cdot}094$.) But there is one striking difference between the two curves. Whereas tobacco mosaic virus has its strongest density *maximum* at a radial distance of 40 A., repolymerized *A*-protein has a pronounced *minimum* at just this position. The radial density distribution in the protein thus provides strong confirmation of the conclusion, reached independently from a study of the layer lines, that the principal structural difference between tobacco mosaic virus and repolymerized *A*-protein occurs at a radius of 40 A. The strong density maximum at 40 A. in tobacco mosaic virus must therefore be due to the presence of nucleic acid at this radius.

In X-ray scattering by nucleic acids, the phosphate group of the nucleotides acts effectively as a 'heavy atom'. X-ray studies of deoxyribonucleic acid have shown[7] that scattering by this compact group can have an effect which predominates over that due to the rest of the nucleotide. It is thus the phosphate back-bone chain of the ribonucleic acid molecule which must lie on a radius of about 40 A. in the tobacco mosaic virus particle.

It will be noted that the first density maximum, at a radius of 25 A., is present in both tobacco mosaic virus and repolymerized *A*-protein, and represents an approximately equal weight of material in the two substances. We must therefore conclude that, whereas the 40-A. density peak in tobacco mosaic virus is due to nucleic acid, the 25-A. peak is due to protein. Thus the nucleic acid in tobacco mosaic virus is deeply embedded in the virus protein. Its molecular structure and chain direction must therefore be closely related to the structural arrangement of the protein. Further study of the X-ray data is in progress with the view of determining how many nucleic acid chains the tobacco mosaic virus partic contains, and in exactly what direction they run.

The work summarized above will be described : detail elsewhere. I am most grateful to Dr. I Fraenkel-Conrat and to Prof. G. Schramm for su plying me with the tobacco mosaic virus and vir derivatives used in this investigation. The work w supported by the Agricultural Research Council.

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Feb. 27.

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PROPAGATION OF AUDIO-FREQUENCY RADIO WAVES TO GREAT DISTANCES

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THE propagation of low-frequency radio-waves was studied many years ago using long-wave commercial transmitters. The well-known Austin–Cohen law was widely used for estimating field-strengths, and because of the theoretical justification of its general form this law was used as a basis for the computation of attenuation coefficients at very low frequencies. According to the law, the attenuation of signals decreases as the frequencies decrease; in fact, at a frequency of 3 kc./s. or less, the attenuation would appear to be very small indeed. The absence of observations at frequencies less than about 12 kc./s., however, meant that the mode of propagation of radio waves at lower frequencies was for many years the subject of speculation.

Now in the course of our observations on the electromagnetic waves radiated by lightning discharges, we have found evidence of a high attenuation of waves in the frequency-range of 2–3 kc./s., in complete contradiction to that predicted by the Austin–Cohen law.

In the original observations on these naturally-occurring disturbances known as atmospherics[1], it was found that they acquired characteristic patterns during their passage between the ground and the ionosphere. An inspection of their wave-forms up to very considerable distances from the source clearly showed that the main concentration of energy lay in the audio-frequency band below 10 kc./s. and that the higher-frequency components moved forward relative to the lower-frequency or 'slow tail' components as the distance of propagation increased. Furthermore, it was observed that a band of frequencies in the neighbourhood of 2 kc./s. was either entirely missing or at least very heavily attenuated. This band of missing frequencies lay between the predominant frequency of the characteristic 'oscillatory head' and the 'slow tail' of the atmospheric and, as was stated earlier[1], unless there is some factor operative corresponding to anomalous dispersion for the missing frequencies, the higher-frequency group and the slower disturbance do n originate in exactly the same portion of the discharg

It is pertinent to remark here that Eckersley his early studies of radio-transmission[2] question the continued validity of the Austin–Cohen law wi decreasing frequency of the wave. In fact, he su gested a theoretical reason for supposing that tl attenuation ceases to decrease at frequencies low than about 12 kc./s.

In order to elucidate this problem, we hav during the past few years, supplemented atmosphe wave-form observations by simultaneously recordi the relative amplitude of the frequency componen in the spectrum of the wave-form. In their fir experiments, Chapman and Edwards[3] recorded t wave-forms and corresponding response of a numb of narrow-band receivers tuned to frequencies in t range 1–25 kc./s. The amplitude of the vario frequency components was calculated from the responses and the observed spectrum of atmospheri due to lightning strokes between the cloud a ground compared with that to be expected fro this type of discharge. Later, Chapman and Matthew used an improved apparatus covering the frequen range 40 c./s. to 16 kc./s. split by twenty-seven ban pass filters arranged logarithmically at three chann per octave. Here the amplitude-frequency spectru was presented directly on the screen of a cathode-r tube and photographed along with the correspondi wave-form. They discussed the relation between t well-known wave-form characteristics and the si nificant changes in the spectrum as the distance propagation increases.

In our more recent experiments we have appli magnetic tape sound-recording techniques[5] to obta permanent records of the complete history in tir of all the disturbances appearing at the aerial vertical rod). A second channel on the tape, link by telephone line to the Meteorological Offi C.R.D.F. network for locating thunderstorm centr provides information on the source of individu

:mospheric disturbances. The ndom distribution of the differ- it types of atmospheric and their nplitude in relation to the con- nuous background noise-level at ie site can thus be readily assessed. he spectrometer has also been odified to record single wave- rms and their amplitude-fre- iency-spectra at a maximum rate ' one record per second, and an ectronic switching device ensures iat spurious signals do not add the spectrum recorded.

The results to be described are ised on one particular type of :mospheric, namely, that resulting om cloud-to-ground discharges id at known distances up to about 000 km. Observations have been ade under both day and night nditions of propagation and at fferent seasons of the year. The tenuation coefficient of signals in ie frequency range 40 c./s. to ; kc./s. has been computed from ie experimental results for both nd and sea paths and different nospheric conditions. In all cases ie presence of a marked absorption ind has been found at a frequency ' 1 or 2 kc./s. Finally, the results ɔtained are compared with the ırlier long-wave transmission results and the more :cent theories of propagation.

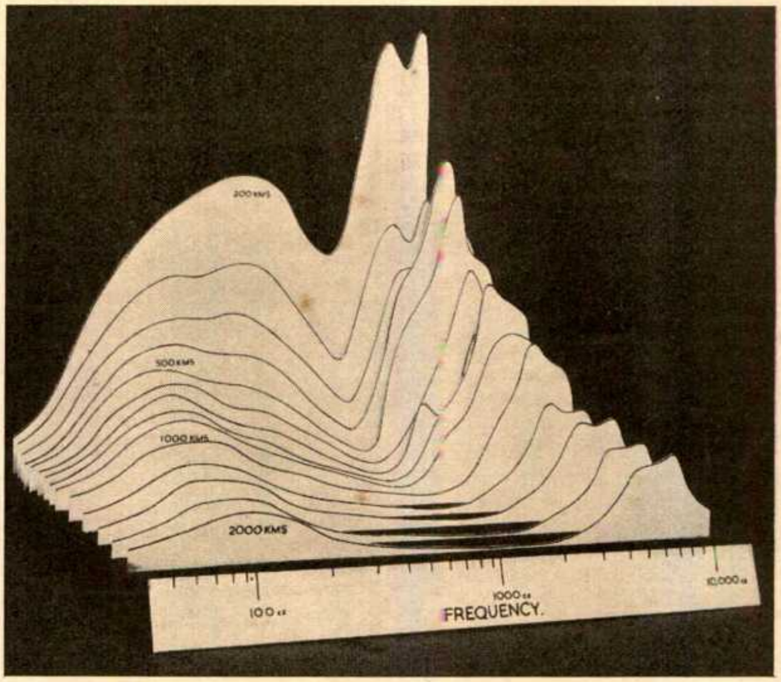


Fig. 1. Model showing the relative amplitude of the frequency components of atmospherics resulting from an average cloud-to-ground lightning stroke observed by day at different distances from the source. The vertical scale shows relative amplitudes in micro-volt, sec./metre (1 cm. in the model corresponds to 10 micro-volt, sec./metre)

In Fig. 1 is shown a photograph of a model illus- ·ating the way the spectrum of the disturbance ıdiated by an average cloud-to-ground lightning roke varies with the distance of propagation. This articular model was constructed from a large ımber of observations made on land sources at ɔon during winter months. It clearly shows that ith increasing distance the various frequency com- ɔnents, besides falling off in amplitude due to a vo-dimensional divergence of energy, also suffer ·lective attenuation due to ionospheric influences ; had previously been reported by Appleton and hapman[1]. The preponderance of energy in the ghest and lowest frequency-ranges represents the ımiliar 'oscillatory head' and 'slow tail' parts of the ave-form, respectively.

It is not our purpose to discuss here the various 'pes of disturbance and their characteristic spectra ; ut it should be mentioned that frequently the 'slow- iil' components are either absent or at least very nall. This is undoubtedly an effect of the source ɜpendent on the mode of destruction of the thunder- oud charge by the lightning stroke, that is, whether : not the current in the discharge channel rapidly ɜcreases after the 'return stroke' has reached the oud[6]. However, in all cases of both high- and very ·w-frequency radiation at the source, there is an ɔsorption band in the spectrum of the distant :mospheric which is clearly the result of propa- ıtion. This phenomenon, together with the law of ropagation at these very low frequencies, are the ıbject of our present discussion.

In dealing with our experimental results, we are ıced with two problems. What is the strength of ıe signal radiated at the source on any particular ·equency channel, and how does propagation affect the amplitude of the signal observed on this channel at a distance ? It will be seen that we cannot interpret our observations without some knowledge of one or the other.

The diverse nature of lightning discharges makes it difficult to derive any useful data on the spectrum of the radiation field at the source, although some information already exists for a simple type of discharge[3,7]. However, as regards the effect of propagation, it is possible to be more definite.

It is well known that electric waves of very low frequency are guided around the earth by the ionosphere and, as already indicated, many attempts have been made, both empirical and theoretical, to derive expressions for the signal-strength $E(f,r)$, where f is the frequency and r the distance of propagation. A survey of the extensive literature on the subject indicates that the main contribution to the signal-strength may be represented by an expression of the form

$$E(f,r) = A(f)r^{-1/2} \exp [- \alpha(f)r]$$

(200 km. $< r <$ 3,000 km.), where $A(f)$, the amplitude coefficient, depends on the spectrum at the source and $\alpha(f)$ is the attenuation coefficient.

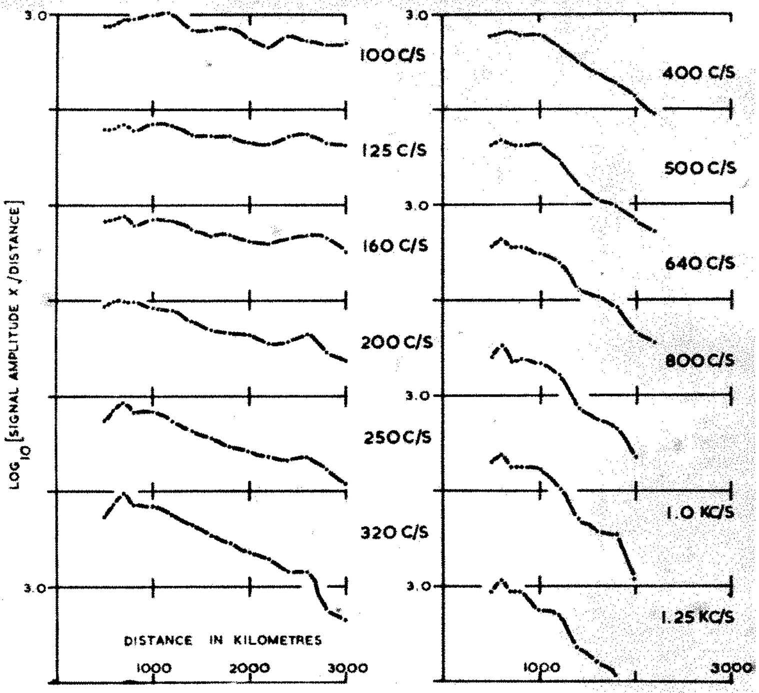
This is essentially the formula used by Round, Eckersley, Tremellen and Lunnon[8] for the interpretation of their observations on the propagation of signals from long-wave transmitters (frequencies down to 12·5 kc./s.), and as will be seen later, there are good grounds for assuming that the formula may be applied at much lower frequencies.

According to the above expression, the value of the quantity $\log [E(f,r)r^{1/2}]$ at any particular frequency varies linearly with the distance r, so that the value of the attenuation coefficient $\alpha(f)$ at that frequency can be determined directly from the slope of the line obtained by plotting the results in this way. This was the method used by Round and Eckersley[8] and later by Budden[9] in his discussion of the measurements made by Weekes on the field-strength of the 16 kc./s. Rugby transmitter *GBR*.

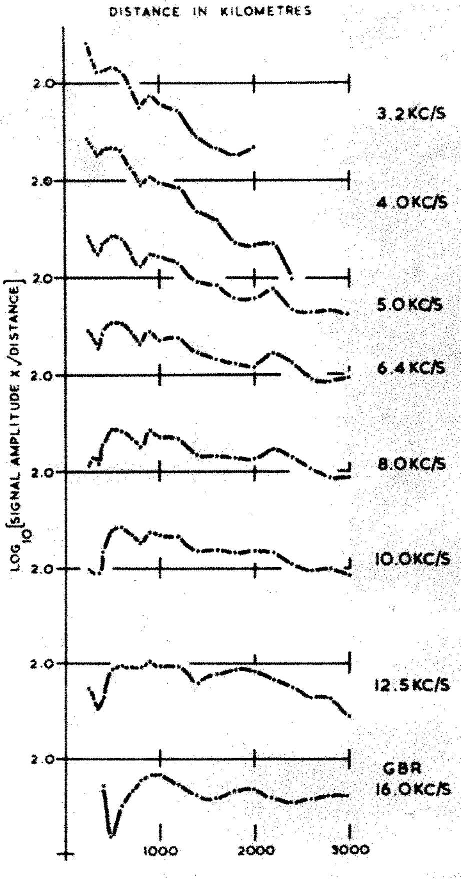
In Fig. 2 (*a*) and (*b*) we have plotted our results for a number of frequency components derived from the spectrum of atmospherics and ranging from a frequency of 100 c./s. to 12·5 kc./s. For comparison, the corresponding curve given by Budden[9] for *GBR* is included. It will be seen that each curve shows a characteristic variation with distance more pronounced at shorter distances. Budden considered that the variations in field-strength for *GBR* could be explained in terms of the interaction of two predominant modes of propagation in the wave-guide bounded by the ground and the ionosphere. Ya L. Al'Pert[10] also calculated this kind of variation of signal-strength with distance for *GBR*. The striking similarity in the form of the curves derived at lower frequencies using atmospherics and that measured by Weekes and Budden for *GBR* transmissions is to be noted. Also, the results for frequencies less than 1·5 kc./s. do not show this effect so markedly.

Evidently, by smoothing out the effect of the secondary modes of propagation, the mean slope of the straight line obtained for each channel gives a value for the attenuation coefficient of the principal mode or main signal contribution on that channel. The values of $\alpha(f)$, expressed in decibels per 1,000 km. path, are plotted against frequency in Fig. 3 for both day and night conditions of propagation, the experimental values for which are marked by circles and crosses, respectively. The values of the attenuation coefficient over the frequency-range 20–30 kc./s. as measured by Eckersley[8], using signals from long-wave transmitters, are shown for comparison. These follow fairly closely the Austin–Cohen law of attenuation, which predicts a progressive decrease in the value of $\alpha(f)$ as the frequency is lowered but fails to account for the remarkable increase in attenuation at about 10 kc./s. to a maximum value at a frequency of two or three kilocycles per second. The propagation path, in fact, exhibits selective absorption, which, together with the low attenuation at the extreme ends of the audio-frequency range, accounts for the observed long-distance propagation characteristics of atmospherics[1]. As is to be expected, the attenuation at all frequencies is greater by day than by night, but the difference between the day and night values is greatest in the region of maximum absorption.

We recall here the experiments of Gardner[11], who recorded the integrated noise-level of atmospherics using four receivers tuned to different frequencies between 3·5 and 50 kc./s. Gardner found that the ratio of the day to night noise-level was less at 3 kc./s. than at 10 kc/.s., from which he inferred that the onset of daylight conditions gave a marked increase of attenuation for frequencies less than 10 kc./s. These conclusions were confirmed by



(*a*)



(*b*)

Fig. 2 (*a*) and (*b*). Variation with distance of log $E(f,r)r^{1/2}$ at different frequencies. (The interval between horizontal lines represents one unit on the logarithmic scale)

Bowe[12]. From our observations, it is clear that the greatest increase in attenuation occurs at a frequency of about 2 kc./s., it being then about 10 db. greater than at either 10 kc./s. or at 200 c./s.

It is of interest now to compare our results with those predicted by Budden, assuming propagation in a 'waveguide' bounded by a perfectly conducting Earth and an imperfectly conducting sharply bounded ionosphere. The full-line curves *A* and *B* in Fig. 3 are those derived by Budden[13] for the different ionospheric parameters quoted. The attenuation coefficient so calculated as a function of frequency relates to the zero-order mode of propagation, as do our experimentally determined values. The parameter p_r depends on the ratio N/ν where for the upper boundary there are N electrons per c.c., and these are assumed to make an average of ν collisions per second. The orders of magnitude of N and ν for the region in question are 10^2 cm.$^{-3}$ and 10^7 sec.$^{-1}$, respectively; but, as Budden has pointed out, although a small change in p_r does not result in any marked change in the form of his curves, changes in the value of h (the height of the upper boundary) have an appreciable effect. It is also known that the height of reflexion of very long waves is greater at night than by day, and the general agreement between the theoretical and experimental values of $\alpha(f)$ both substantiates the waveguide theory and the experimental method followed in this work. Moreover, the appropriate value of h for these very low-frequency waves can be inferred from the measurement of their attenuation.

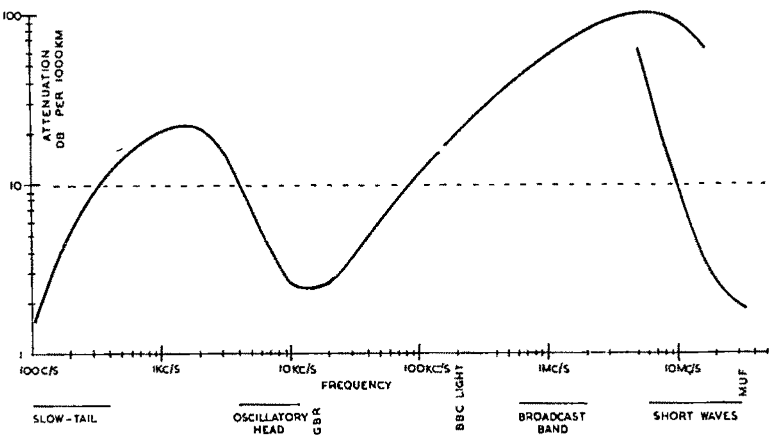


Fig. 4. Variation of attenuation with frequency. The curve for the frequency range 30 kc./s. to 30 Mc./s. is taken from Eckersley (ref. 2, Fig. 31)

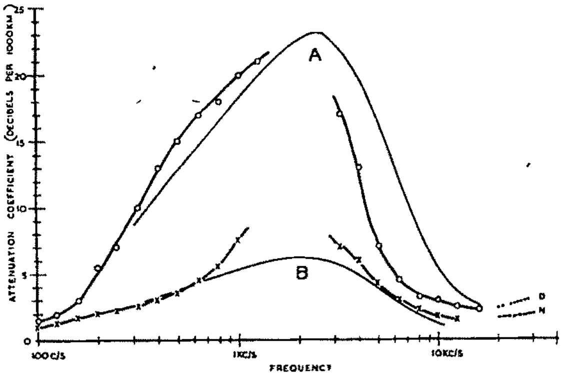


Fig. 3. Variation of attenuation coefficient with frequency for propagation over the ground

—○—○—, Day-time values; —×—×—, night-time values compared with the theoretical curves for different ionospheric parameters; *A*, ionospheric height, $h = 50$ km., $p_r = 6 \times 10^4$ sec.$^{-1}$, and *B*, for $h = 80$ km and $p_r = 2 \times 10^5$ sec.$^{-1}$. Eckersley's values, ...; *D*, day, and *N*, night

The attenuation curves shown in Fig. 3 were derived from atmospherics originating in European storm centres and relate to propagation over the ground. A difference, however, has been found for Atlantic sources giving an appreciable sea-path, the most striking difference being the improved transmission of signals at the higher frequencies, particularly in the region of 5 kc./s. This is undoubtedly an important factor in determining the characteristic type of atmospheric observed from Atlantic sources. Further, the diurnal and seasonal differences in propagation, which will be dealt with elsewhere, clearly follow changes in the ionosphere. For all ionospheric conditions the same type of attenuation curve is obtained. There is a marked selective absorption band, and this is associated with a discontinuity in the group velocity of the waves. Calculations have shown that the group velocity of the atmospheric 'slow tail' component is less than that for the higher-frequency 'oscillatory head', and that in the neighbourhood of the absorption band the group velocity decreases rapidly.

Finally, in Fig. 4, we link the results of the work now described with the attenuation curve for long-distance day transmission of radio signals of frequency up to about 30 Mc./s. as given by Eckersley[2]. This curve gives a fair idea which waves are the least attenuated and can travel to the greatest distances. It is a remarkable property of the ionosphere that extremely low-frequency waves less than two or three hundred cycles per second only suffer the same small attenuation as that assigned to the short waves so extensively used in world-wide communication.

The work described here was carried out with the co-operation of the Meteorological Office Sferics Organization for the location of the sources of atmospherics, and without which the investigation would not have been possible. We gratefully acknowledge our indebtedness to the Director of the Meteorological Office and his staff, also to the Department of Scientific and Industrial Research for a grant to cover the cost of equipment.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sensitivity of the Mouse Testis to the Mutagenic Action of X-rays

Dr. C. Auerbach is a recognized authority on the induction of mutations, and her publications are likely to carry considerable weight. There is a danger, therefore, that the recent letter in *Nature*[1] (claiming to have detected greater mutational sensitivity in spermatids than in sperm) may have greater weight attached to it than the results would warrant. The authors admit the paucity of their data; but a number of other criticisms can be made.

The usual method of classifying sperm samples in the mouse is by time from irradiation rather than order of the litters conceived by it. This is the classification used by Russel and Hertwig, with whose results Auerbach and Slizynski compare their own. It would be of interest, therefore, to learn whether the alternative classification of these data gives the same picture of variation in sensitivity.

The class sizes are rather small for the χ^2 test to be applied to the variation due to the order of litters, but this yields a χ^2 of 5·8056 for 7 degrees of freedom, which is non-significant ($P = > 0{\cdot}5$). Drs. Auerbach and Slizynski have crammed a large part of this non-significant χ^2 into 1 degree of freedom which they have selected as giving the maximum difference between two groups.

Finally, if more extensive observations did confirm their empirical conclusions, there would remain the question of interpretation. Auerbach and Slizynski expected to find spermatids more sensitive than mâture sperm. Thus, when they believed they had found an ultra-high mutation-rate in the fifth and sixth litters, they assumed that these represented the irradiation of spermatids and that their three-week mating period represented at least all post-meiotic stages. But this is most unlikely. My own work (unpublished) has shown that following a dosage of 200 r., male mice remain fully fertile for five weeks, throughout which period dominant lethals are detectable. After a sterile period of about one week, full fertility is restored without dominant lethals. Thus the interval from meiosis to the utilization of the sperm initiated at that meiosis is about six weeks, and Auerbach's and Slizynski's samples, as those of other workers using doses of 400–600 r. and higher, were probably confined to irradiated sperm or at most late spermatids. Presumably spermatids irradiated with the higher doses fail to produce viable sperm.

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We are grateful for the opportunity of replying to Dr. Bateman's criticism.

(1) The main and most pertinent of his objections is levelled against the small scale of our experiment. We fully agree with him on this point. We thought we had made this clear when we described our work as a "pilot experiment", for which "confirmation on a larger scale is desirable". It is true that, from purely statistical point of view, it would not b permissible to apply a test of significance to a difference between two parts of a series which as a whole shows no significant deviation from homogeneity Nevertheless, we felt justified in applying such a tes to the two non-overlapping groups of points in ou curve; for our working hypothesis had been that translocation frequency would show just such discontinuity about midway through the presterile period, and that the change would be from a lowe to a higher frequency. We based this expectatio on the much more extensive work by Hertwig[1] an Russel[2], which clearly shows that, after irradiatio with either X-rays or neutrons, dominant lethality is higher in the late than in the early stages of th presterile period. Since with the doses used by thes workers 30 per cent or more of dominant lethal presumably are due to inviable translocations, i would indeed be unexpected to find that translocations do not follow the same trend. The fact tha our results agreed with expectation was taken to reinforce the findings on dominant lethals and together with these, furnish 'presumptive evidence for a varying degree of sensitivity in post-meioti stages of spermatogenesis. Again we thought w had made this clear in our communication.

The remainder of Dr. Bateman's objections ar based on his own observations. Since these have no been published and are only vaguely hinted at in hi communication, we could not, and cannot now, take account of them. Whatever the nature of these observations, they appear to contradict results by Snell, Hertwig, Russel and others[3]. Admitting the possibility that Dr. Bateman's newer data may make a re-assessment of the older work necessary, we can at the moment base our conclusions only on these older, generally accepted results.

(2) We considered that the number of copulations would be a better measure of sperm utilization than time after irradiation. For *Drosophila*, Dr. Bateman himself has shown[4] that sexual activity, more than time, determines rate of sperm utilization. For the mouse, Hertwig has shown the same[1]. In fact, however, there is scarcely any difference between the grouping of our data by time or by litter number All litters in our first group were conceived between the first and eleventh day after irradiation, and the remainder between the eleventh day and the onse of sterility in the third or fourth week. The only overlap was a fifth litter of one male, which had been conceived on the eleventh day.

(3) Russel[3], basing himself on all available evidence up to 1954, states that "there is now almost unanimous agreement that spermatocytes, spermatids and sperm are resistant to radiation and that spermatogonia are quite sensitive". In a footnote he mentions that also primary spermatocytes "show appreciable sensitivity", and this agrees with Hertwig's opinion. We therefore felt justified in the assumption that, by testing all litters from the presterile period, we were sampling all post-meiotic and, possibly, late meiotic stages, and that therefore the increase in translocation frequency after the fourth litter was due to admixture of spermatozoa which at the time of treatment had not yet reached maturity. Whether these immature stages should be called "spermatids", or "late spermatids" (as Dr. Bateman does), seems a secondary question, which cannot be decided on the present evidence. The relevant point is the existence of a stage in spermatogenesis, prior to complete matura-

tion of the sperm and probably after meiosis, which is more sensitive than mature spermatozoa. The only alternative to this interpretation is that the amount of chromosome damage is increased in irradiated mature spermatozoa which are stored in the testis. This possibility has been considered by Hertwig, who tested and rejected it on the evidence of experiments in which irradiated males were kept for seventeen days before their first matings.

(4) Dr. Bateman seems to give much weight to the observation that in his own experiments with 200 r. the presterile period and one week of sterility together extended over six weeks. However, the length of the presterile period varies considerably between experiments (see Table 12–1 in ref. 3) and is certainly, as established by Hertwig, dependent on the amount of sexual activity of the males. The length of the sterile period varies even more between experiments and is determined mainly by the dose and the correlated more or less severe damage to spermatogonia. The sum of these periods is therefore not suitable for determining the time interval between meiosis and the availability of mature sperm. This interval is almost certainly much shorter than six weeks, as shown by older histological observations (see ref. 3) as well as by newer work with labelled phosphorus[5].

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A Convulsant Alkaloid of *Dioscorea dumetorum*

An alkaloid, dioscorine, has been isolated from various species of yam of the family Dioscoreaceae. Pinder[1] has summarized the history of this, confirmed its molecular formula as $C_{13}H_{19}O_2N$ and has documented certain of its chemical and physical properties[2]. A similar alkaloid has been extracted from a further species common in the wild state in Nigeria and identified by its botanical characteristics and typically small starch grains as *Dioscorea dumetorum* (Yoruba name, èsúru[3]).

The latter alkaloid has not been obtained crystalline, but has been extracted and purified by various procedures; together with its crystalline salts, its analysis supports the formula $C_{13}H_{21}O_2N$. Its infra-red and ultra-violet spectra differ from those reported for dioscorine. Thus the *D. dumetorum* alkaloid shows a single absorption maximum at 2080 A. on a calibrated 'Unicam' spectrophotometer as compared with a maximum at 2170 A. reported for dioscorine. The chemistry of the former is being further investigated.

When injected into mice, the alkaloid of *D. dumetorum* acts as a convulsant poison. The convulsions are usually clonic at first, later tonic and may be followed either by death or recovery. When injected by the intra-peritoneal route, using a freshly prepared 1 per cent aqueous solution, the *LD*50 is approximately 65 mgm./kgm. Concentrations of 10^{-5} reduce the response to acetylcholine on the isolated guinea pig ileum and isolated rabbit duodenum preparations. At a dose-level of 20 mgm./kgm. the responses of the cat's blood pressure to acetylcholine and to adrenaline are altered. The depressor effect of the former is reduced, and the pressor effect of the latter is enhanced. No local anæsthetic effect could be demonstrated. Dioscorine[2] apparently lacks atropine-like properties in the concentrations mentioned above, nor does it potentiate the action of adrenaline on the cat's blood pressure.

We are indebted to Mr. B. Reiff for technical assistance. Grants from the Nigerian Government Fund for the Investigation of West African Drugs and Medicines are gratefully acknowledged.

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Aminomalonic Acid Decarboxylase: a New Enzyme

Aminomalonic acid was first described by Baeyer[1] in 1864, who found that heat treatment converted the amino-acid smoothly into glycine. Knoop[2] suggested the intermediary formation of aminomalonic acid in the biological formation of glycine from serine. But Haas[3] could not find evidence that it is a precursor of glycine in the rabbit, either in experiments on the whole organism, or in the isolated liver, or with liver homogenate. Shemin[4] has claimed to have excluded aminomalonic acid as an intermediate in the metabolic change of serine to glycine from results obtained by isotopic studies. However, this view was criticized by Ogston[5].

In the present communication, we report the presence in animal tissues of an enzyme which catalyses the decarboxylation of aminomalonic acid to glycine. This enzymatic activity was first observed in the homogenate of silk-gland tissue and afterwards in rat-liver homogenate.

The enzyme solutions used in the present work were prepared by homogenizing the posterior silk-glands of silkworms as the fifth instar with 3 vol. of 0·15 *M* potassium chloride and centrifuging off the undissolved material. The test system contained 0·5 ml. of aminomalonic acid solution (88 μmoles per ml., ammonium salt), 1·0 ml. of phosphate or acetate buffer and 1·0 ml. of the enzyme solution.

The rates of the reaction were followed in two ways. In one procedure the determination of carbon dioxide production was carried out with the conventional Warburg manometric apparatus. The amount of glycine formed was also determined. Aliquot samples were taken from the reaction mixtures and deproteinized by the addition of one-third volume of 95 per cent alcohol and boiling for 1 min. in the water-bath. The filtrates were assayed for glycine by a quantitative paper chromatographic technique. The glycine formed was also identified as its 2,4-dinitrophenyl derivative.

The activity of this enzyme solution, expressed as µl. carbon dioxide formed per hr. per 250 mgm. fresh tissue, was about 80. The rate of the reaction was found to be proportional to the time of the reaction over a period of 90 min. under the conditions employed, showing that the kinetics of this reaction is zero order for a limited time. The Michaelis constant was determined as $6 \cdot 5 \times 10^{-2} M$.

The *p*H optimum for the decarboxylation of aminomalonic acid was found to be at 5·9–6·1. The crude enzyme solution did not decarboxylate malonic acid, aspartic acid or glutamic acid.

When the crude enzyme solution was held at 70° for 10 min. or at 100° for 5 min., enzyme activity was entirely destroyed. Several inhibitors were tested, and it was found that the enzyme activity was inhibited completely by hydroxylamine at a concentration of $10^{-3} M$ and also by potassium cyanide at a concentration of $10^{-2} M$.

The activation energy of this enzyme – substrate system was determined over the temperature-range 27°–42°, and found to be about 14,600 calories. This value is considerably lower than that for non-enzymatic decarboxylation in the system $0 \cdot 3 N$ sulphuric acid – aminomalonic acid.

The activity of this preparation was not affected by dialysis against distilled water for three days at 0°–4°. The enzyme was partially purified by fractionation with ammonium sulphate and absorption on and elution from aluminium hydroxide $C\gamma$ and the product was about thirteen times as active as the starting material.

Our results indicate that the decarboxylation of aminomalonic acid takes place by the action of a new enzyme which we propose to call 'aminomalonic acid decarboxylase'.

This work is continuing and will be reported in full elsewhere.

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New Amino-Acid – Glycosides isolated from Tryptic Hydrolysates of Milk Products

THE protein – sugar complex formed by interaction between the free amino-group of protein and reducing sugar recently became of interest to food chemists as the first intermediate in the amino-carbonyl (or Maillard) reaction of those systems. The formation of such a protein – sugar complex in milk products, for example, heated milk and dried skim milk, has been confirmed by Henry *et al.*[1] and Patton *et al.*[2] respectively. On the other hand, it has been known that carbohydrate is contained in casein and bound with the amino-acid residue of it in the form of glycoside[3,4]. In consequence, it seems reasonable to assume that carbohydrate can exist in these protein materials either as preformed or as secondarily formed glycoside.

Table 1

	Amino-acid – glycosides	
	I	II
Hydrolysed products by 6*N*-hydrochloric acid	Glucose Galactose	Galactose
Colour reaction with developer: Benzidine	Positive	Positive
Colour reaction with developer: Resorcine	Negative	Positive
Colour reaction with developer: Ninhydrin	Positive	Positive
Hydrolysed products by β-glucosidase	Galactose	Galactose
Alkaline methylamine reaction (for 1 ~ 4-bond) (ref. 7)	Positive	Positive
Cystein-carbazol reaction (for ketose) (ref. 8)	Negative	Positive

While the chemical behaviour of the preformed protein – sugar complex, that is to say, mucoprotein and mucopolysaccharide, and the formation of secondary complexes are now well known, the chemical properties of the complex have not so far been investigated in any detail. The present experiments refer to the isolation and identification of amino-acid – glycosides which are the fundamental constituents of the secondarily formed protein – sugar complex in milk products.

The amino-acid – glycosides were isolated from the tryptic hydrolysates of evaporated milk and dried skim milk by the procedure of Inoue *et al.*[3], and Masamune *et al.*[4], except that the large-scale multiple paper chromatogram was used for purification of the crude material. The developed paper was sprayed with aniline hydrogenphthalate and ninhydrin reagents. The chromatograms gave three spots (I ~ III) corresponding to amino-acid – glycosides. The R_g values calculated from four chromatograms of I, II and III showed, respectively, 0·21, 0·55 and 0·87.

To confirm the presence of these compounds in milk protein, casein[5] and whey protein isolated by the method of Kondo *et al.*[6] were used to prepare amino-acid – glycosides according to the procedure described. Paper chromatograms from both these substances gave essentially the same spot, corresponding to III. The most reasonable conclusion to be drawn from these results is that I and II are secondarily formed glycosides, and that III is originally present in raw milk.

On the basis of the results shown in Table 1, it is suggested that the carbohydrate constituents of glycosides I and II were β-galactosyl-α-glucoside (lactose) and β-galactosyl-1-deoxy-α-fructoside (lactulose), respectively. The liberation of these disaccharides from the glycosides by treatment with 'Amberlite *IRA*-410' in the H+ form confirmed the presence of these glycosidic linkages in them. The presence of the disaccharide of I and II in the eluate was proved by comparison with corresponding standard compounds.

The aglycones of these materials were liberated without decomposition of the peptide bonds by treatment with *N* hydrochloric acid. As paper chromatograms sprayed with ninhydrin gave a spot of the same R_F for various solvents, it seemed that the aglycones of I and II are identical and are derived from the same secondarily formed protein – sugar complex in the milk products. The constituent amino-acids of the aglycones were histidine, alanine, lysine, leucine, with traces of glutamic acid, aspartic acid, serine and valine. Accordingly, it may be concluded that I is converted to II in accordance with the Amadori rearrangement, and that this rearrangement is carried out on the glucose residue bound to the amino-radical of the aglycone. It may also be seen that the terminal amino-acid of aglycone bound to those carbohydrates is lysine derived from casein as shown by some workers[9,10].

I wish to thank Profs. R. Sasaki and T. Nakanishi for advice and criticism. These investigations are being continued, and a full account will be published elsewhere.

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Oxygen Consumption and Active Transport of Sodium in the Isolated, Short-circuited Frog Skin

FOR the isolated, short-circuited frog skin with Ringer solution on both sides, it has been found that the active transport of sodium is equal to the current required to reduce the potential difference across the skin to zero[1,2]. It is also a well-known fact that the active transport of sodium depends on the oxygen supply to the skin. Francis and Pumphrey[3] found that oxygen-free Ringer solution caused an irreversible disappearance of the potential difference across the kin in the course of 20–40 min.

It was the purpose of the present study to investigate the relation between sodium transport and the oxygen consumption in the frog skin (*Rana temporaria*). In principle, the apparatus employed was the ame as that used by Ussing and Zerahn[1]; but it was made exclusively of glass, since Andersen and Lehmann (personal communication) have found that 'Perpex' is not suited for such investigations. The solution was circulated by the action of a magnetic field on an iron core sealed into glass. The apparatus was assembled with the frog skin placed between the wo halves, filled with the required solutions and closed by means of two ground joints greased with ilicone.

The oxygen determinations on the solutions were made by the Winkler method as modified by Krogh[4].

The compartment on the inside of the skin was filled with Ringer solution to which vasopressin was added in some experiments in order to increase the sodium transport and hence the oxygen consumption. During the actual experiment the compartment on the outside of the skin is filled with Ringer solution. In this way, the sodium transport can be recorded by reading the short-circuiting current, and the oxygen contents of the solutions can be determined before and after the experiment. This procedure gives the total oxygen consumption and sodium transport.

However, one cannot expect that all the oxygen will be used for active transport of sodium, and the oxygen consumption was therefore also measured when no sodium transport occurred. This is done most easily by removing the sodium ions from the outside compartment by replacing the Ringer solution with distilled water. The oxygen then consumed by the skin is not used for sodium transport and may be subtracted from the total oxygen consumption as a blank.

Control experiments were performed before and after the sodium transport experiment. All the measurements were made on the same skin, and the skin was cut free and weighed after the last control period. Oxygen consumption and sodium transport were both expressed in µequivalents/hr. in order to make them directly comparable. Control runs with the apparatus filled with Ringer solution and secured with silicone grease instead of mounting a frog's skin showed that the oxygen concentration of the solution in the apparatus did not change during 2 hr. (the usual time for an experimental period). This proves that nothing outside the frog's skin interferes with the oxygen consumption.

Some representative experimental results are shown in Table 1. It is seen from column 3 that the total oxygen consumption in µequiv./hr. is often smaller than the number of µequiv. of sodium transported (column 2). The net oxygen consumption is 20–25 per cent of the sodium transported (column 6), that is, for each additional oxygen atom consumed, eight to ten atoms of sodium can be transported. The last column indicates the oxygen consumption in millilitres per gram of the wet weight.

Stapp[5] defined coulomb efficiency as

$$\frac{\text{total coulombs generated by skin}}{\text{coulomb equivalents of total oxygen}}$$

This ratio expresses, as we now know, the amount of sodium transported per gram equivalent of oxygen used. Stapp found in frog skins that were partially short-circuited by means of an external conductor coulomb efficiencies varying from 10 to 65 per cent, and he was surprised at this high value.

Linderholm[2] calculated the coulomb efficiencies from mean values of current and oxygen consumption in a large series of experiments; he arrived at a figure of 82 per cent for the short-circuited skins. This result is not in contradiction with the results

Table 1

Date	Active sodium transport (µequiv./hr.)	Total oxygen consumption (µequiv./hr.)	Net oxygen consumption (µequiv./hr.)	Coulomb efficiency (per cent)	Net oxygen consumption, as per cent of active sodium transport	Oxygen consumption (ml.gm.$^{-1}$hr.$^{-1}$)
March 9	10·8	6·95	2·57	155	23·8	–
April 4	6·50	5·33	1·65	122	25·3	0·118
April 5	5·87	7·16	1·42	82	24·3	0·155
April 19	10·0	6·47	2·51	155	25·1	0·163

given in Table 1. These results were observed mainly with skins with a high sodium transport, in some cases obtained by adding mammalian posterior pituitary extract. It may be added that in experiments with skins that were not short-circuited, Linderholm found an average coulomb efficiency greater than 100 per cent.

The present experiments show that more than one equivalent of sodium is transported for each equivalent of oxygen taken up. The coulomb efficiencies observed by Stapp and in some experiments by Linderholm were less than 100 per cent, and this led Linderholm to assume a one-to-one sodium to oxygen relationship. Since, however, the epithelial layer, which is presumably responsible for the sodium transport, represents only one-sixth of the skin weight, such an assumption would require an unreasonably high oxygen consumption in this layer, even if all the oxygen were used for sodium transport.

It is possible that the oxygen consumed by the skin during the control periods (no transport of sodium) may be used for sodium transport when sodium becomes available, the net oxygen consumption being thus only an extra consumption. In this case the amount of oxygen utilized for the transport of one equivalent of sodium will be somewhere between the net consumption and the total consumption. Whether this will fit into the theory advanced by Conway[6] may be a question of interpreting his symbols. The low relative oxygen consumption does, however, suggest that more than one step of the oxidative metabolic cycle is involved in the transport of sodium.

A more detailed report of this work will appear in *Acta Physiologica Scandinavica.*

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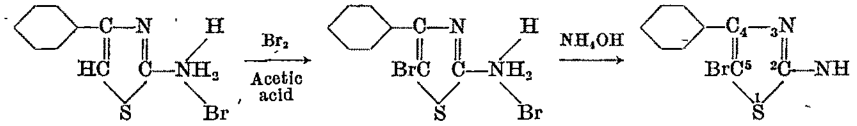
Non-metallic Fungicides

In the course of investigations on the synthesis of 2-amino-4-aryl thiazoles and their derivatives, it was decided to examine their fungicidal properties, as they contain a cyclic grouping, —N—C—S—, which is present in the structure of some of the well-known fungicides[1], and the presence of lipophilic and polar substituents like aryl- and amino-groups in the thiazole nucleus is expected to increase the fungitoxic properties of the thiazoles as reported earlier[2]. The recent use of some thiazole derivatives as fungicides[3] has greatly stimulated work in this direction. The introduction of halogens into the benzene and other aromatic nuclei of various phenolic compounds greatly increases their fungicidal properties[4], and as bromo-derivatives are often more potent than the chloro-compounds, it was thought worth while to introduce bromine into the thiazole nuclei with the hope of augmenting their fungicidal and other activities. In the present communication seventeen different 2-amino-4-aryl (phenyl; p-tolyl p-ethyl phenyl; p-methoxy and p-ethoxy phenyl β-phenylethyl and β((p-methoxy)phenyl)ethyl; 2 : dimethyl phenyl and 3 : 4 dimethylphenyl; α- an β-naphthyl; o- and p-hydroxy phenyl; m- an p-amino phenyl; p-bromo phenyl and 2-thienyl thiazoles have been prepared by the method of Kin and Hlavacek[5] by allowing different aryl methy ketones to react with thiourea in the presence c iodine. These compounds have been brominated witl bromine in acetic acid medium after protecting th amino-group either by converting it to the hydrobromide salt or by acetylating it. In all these case bromine entered position 5 of the thiazole nucleu The position of bromine was ascertained by th inability of such compounds to undergo couplin with diazotized aniline, which usually takes place a position 5[6] if it is free.



All the seventeen bromo thiazoles have bee screened for both fungicidal and bactericidal actio For fungicidal assay, the method of Montgomery an Moore[7] was used. *Piricularia oryzae* Cav., th causative organism of rice blast, was used as the tes fungus. The compounds 4(p-hydroxy phenyl), 4(α naphthyl) and 4(p-bromo phenyl), 5-bromo thiazole completely inhibited spore germination at concentrations of 20, 20, 22 p.p.m. respectively, and at concentrations of 10, 12, 10 p.p.m., spore germinatio was only 50 per cent. The unbrominated thiazole inhibited spore germination at a concentration c 90 p.p.m.

The Rideal–Walker serial drop dilution metho was used for the study of the antibacterial activity The test organism was a 24-hr. culture of *Staphyl coccus aureus.* While some of the unbrominate thiazoles were active in 1 : 8,000 (*M.E.D.*) dilutio 4(m-amino phenyl), 4(p-ethoxy phenyl), 4(α-naphthy 5-bromo thiazoles showed activity in 1 : 20,00 (*M.E.D.*) dilution, and 4(β-naphthyl), 4(β-pheny ethyl) 5-bromo thiazoles showed activity at a dilutio of 1 : 15,000.

Details of this work will be published elsewher I thank Dr. M. K. Rout, reader in chemistry, fo his interest and help in the work, and Mr. S. Y Padmanavan, mycologist of the Central Rice Researc Institute, Cuttack, for supplying the culture of th test fungus for the fungicidal work.

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Potassium Ion Stimulation of Hydrocarbon Oxidation by a Soil *Corynebacterium* sp.

The oxidation of straight-chain aliphatic hydrocarbons by a soil *Corynebacterium* sp. has been described previously[1]. The present communication demonstrates that the rate of hydrocarbon oxidation by washed suspensions may be stimulated markedly by potassium ions, which, however, have little effect on the oxidation-rate of possible intermediates.

Suspensions of the bacteria were grown either in a synthetic glucose broth deficient in potassium ions, or in nutrient broth, *p*H 7·0, incubated two to three days at 26° C. on a shaking machine. The synthetic medium had the composition 10 gm. glucose, 3·0 gm. ammonium nitrate, 1·5 gm. diammonium hydrogen phosphate, 0·25 gm. magnesium sulphate, 0·1 gm. calcium chloride, trace amounts of ferrous, zinc, cupric, manganese and molybdate ions per litre. The harvested cells were washed once with distilled water, shaken overnight at 26° C. to reduce endogenous respiration, centrifuged and resuspended in distilled water (1 ml. suspension equivalent approximately 1·0 mgm. total cell nitrogen). The hydrocarbons were obtained from L. Light and Co., Colnbrook, England. Respiratory exchanges were measured by the Warburg technique at 27° C. in 0·02 *M* tris (hydroxymethyl) amino methane buffer *p*H 7·0. 0·05 ml. hydrocarbon was added from the side-arm.

The effect of potassium ions (0·0008 *M* final) was tested on the rate of oxidation of *n*-hexadecane, *n*-tetradecane and *n*-decane by suspensions of *Corynebacterium* sp. harvested from potassium-deficient media. There was an initial lag period of low oxygen uptake during which potassium ions caused a slight but consistent inhibition of the oxidation-rate. The lag period varied from 1 to 2 hr., depending upon the hydrocarbon oxidized. There followed a marked stimulation of the rate by the added potassium ions. The respective overall oxygen consumptions in the presence of the C_{16}, C_{14} and C_{10} paraffins were stimulated 231, 108 and 122 per cent by 0·0008 *M* potassium ions in 7 hr. No further stimulation was obtained by adding ten times this concentration of potassium ions. *n*-Octane was oxidized much more slowly, but after 7 hr. a net oxygen uptake of 125 µl. in the presence of potassium was observed, compared with 43 µl. in its absence.

The effect of other monovalent cations on hydrocarbon oxidation by potassium-deficient cells was investigated. 0·0008 *M* ammonium ions, after 6½ hr. incubation, stimulated *n*-hexadecane oxidation even more than potassium ions (225 compared with 168 per cent). Rubidium ions were less effective (138 per cent). Caesium, sodium and lithium ions had no significant effect.

Similar results were obtained with *n*-decane as substrate, except that 0·0008 *M* ammonium ions had no effect upon the oxidation-rate, and rubidium ions only stimulated after 5 hr. incubation. In a separate experiment, however, it was shown that 0·008 *M* ammonium ions, after 4 hr., stimulated *n*-decane oxidation 111 per cent compared with 114 per cent stimulation by an equivalent of potassium ions. Rubidium ions (0·008 *M*) again stimulated only after a lag period (35 per cent in 4 hr.).

The monovalent ions were added as their chlorides. The stimulation achieved is due to the cation, since identical results were obtained with equivalent amounts of potassium chloride, sulphate and nitrate.

Table 1. STIMULATION OF *n*-DECANE OXIDATION BY POTASSIUM IONS USING FRESH AND LYOPHILIZED CELLS OF *Corynebacterium* SP

Period of ageing cells at 4° C. (days)	Fresh cells			Lyophilized cells		
	Oxygen consumed (µl.)		Percentage stimulation	Oxygen consumed (µl.)		Percentage stimulation
	Decane + 0 008 *M* K^+	Decane only		Decane + 0 008 *M* K^+	Decane only	
0	339	282	20	307	220	40
1	346	287	21	285	159	79
3	335	280	20	270	134	102

Each cup contained cell suspension ≡ 0·52 mgm. cell nitrogen (non-lyophilized cells), or 0·42 mgm. cell nitrogen (lyophilized cells) in 2·5 ml. 0 01 *M* (final) 'tris' buffer *p*H 7·0, incubated at 27° C. for 3½ hr.; 0·1 ml. *n*-decane was added from the side-arm.

The stimulation of hydrocarbon oxidation by potassium ions may be demonstrated in another way. Lyophilized cells of *Corynebacterium* sp. grown in nutrient broth showed a marked increase in potassium stimulation of *n*-decane oxidation, when aged in 0·025 *M* 'tris' buffer, at 4° C., compared with identically treated cells of the same suspension which had not been freeze-dried (Table 1).

The effect of potassium ions on the rates of oxidation of the aliphatic monohydric alcohols (range, ethanol to *n*-undecyl alcohol) and of the monocarboxylic acids (range, acetic to *n*-decylic acid) by potassium-deficient cells was investigated. 0·0008 *M* potassium ions had no effect upon the oxidation-rates, although identical concentrations of the cation caused a 244 per cent stimulation in 6½ hr. of oxidation of *n*-hexadecane by the same suspension. If the potassium ion stimulation of hydrocarbon oxidation is a direct effect upon one of the enzyme systems involved, then it would appear it must exert its influence before the formation of likely intermediates such as the fatty alcohols and acids. Further work with cell-free extracts is proceeding to this end.

I thank Miss G. Banos for technical assistance.

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Magnetically Induced Vortex for Small-scale Aerated Culture Studies

The advantages of aerating liquid cultures of bacteria to enhance the yield are well known. The use of sparger aeration techniques on a small scale is subject to certain disadvantages due to difficulties in sterilizing the air supply and controlling the frothing of the medium—particularly when it contains serum.

Aeration by the production of a vortex in the medium has been described by E. B. Chain *et al.*[1]. This method provides a simple means of finely dispersing the air bubbles and at the same time automatically controls frothing. On a small scale such a vortex can easily be induced by means of a magnetic stirrer, thus obviating the necessity for sterile stirrer paddles and shaft seals. No forced air supply is required, the exchange through a conventional cotton-wool plug being sufficient for the organisms so far cultivated.

We have employed this method for the pilot-scale production of suspensions of *Pasteurella septica*, 'Insein' strain[2], for vaccine investigations. 1,200 ml. amounts of 'Tryptose' broth (Difco) at *p*H 7·3 were sterilized in 4-litre boiling flasks, a magnetic stirrer bar being enclosed with the medium. The flasks were inoculated with 1 ml. of an 18-hr. broth culture of the organism and incubated at 37° C. The medium in the flask was rotated by means of a magnetic stirrer at such a speed that a continuous stream of fine air bubbles was dispersed by the rotating stirrer bar. Growth curves based on bacterial dry weights were plotted. The peak of the logarithmic phase of growth occurred at approximately 18 hr., at which point the bacterial dry-weight content of the medium was 0·1556 gm./100 ml.—equivalent to ten times Brown's tube 5. A non-aerated control contained, at this point, 0·0152 gm./100 ml., indicating approximately ten-fold increase in yield due to aeration.

The state of capsulation of the organisms was determined by microscopical examination of films stained by an indian ink/methyl violet method. There appeared to be no decrease in the size of the capsule in such aerated cultures when compared with films made from infected blood.

This method has also been employed for the cultivation of *Asterococcus mycoides* for antigen production. The medium used was 'Tryptose' broth supplemented with 10 per cent yeast extract and 10 per cent pig serum at a *p*H of 7·6.

A. mycoides appears to be highly sensitive to mechanical agitation during the lag phase of cultivation. It was found to be advantageous to incubate the inoculated flasks for 18 hr. before starting the stirrer, otherwise on some occasions no growth took place. A bacterial dry-weight growth-curve estimation showed that the peak of the logarithmic phase of growth occurred at approximately 24 hr. after commencement of aeration. At this point the bacterial dry-weight content of the culture was 0·0368 gm./100 ml. This figure is similar to the mean of 0·0322 gm./100 ml. previously recorded in sparger aerated culture[3].

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A Mutant of *Drosophila* without *Iso*xanthopterine which is Non-Autonomous for the Red Eye Pigments

*Iso*xanthopterine has recently been found in tissues of various anthropods[1,2]. It seems to be a common and regular constituent of normal genotypes of many species. We also found this substance in the following mutants of *Drosophila melanogaster*: *b, bw, ca, car, cd, cl, cn, e,* g^2, kar^2, *ltd, lt,* lz^{cl}, *ma, mah, p,* pn^2, *pr,* rs^2, *se, sed, st, v, w,* w^a, *y*. In certain genotypes such as *w* and *bw*, however, the *iso*xanthopterine disappears from the body[2] during the first days of imaginal life.

By studying the inventory of substances obtained from a new mutant with reddish-brown eyes, we discovered that this genotype of *Drosophila melanogaster* does not at any stage of development contain *iso*xanthopterine. This biochemically exception mutant was isolated from one of our laborato stocks; for the respective gene we determined t locus 51 ± 1 in the third chromosome. We th searched for known Mendelian eye-pigment facto within this chromosomal region and found that little-known mutant, *rosy* (*ry*), which was discover and approximately located by Bridges[3], correspon phenotypically and genetically with our mutant, f which we now use the term "*rosy*^{2}" and the symb ry^2. The F_1 hybrids ry/ry^2 have the same reddis brown eyes as both their parents, and they, t do not contain *iso*xanthopterine.

Table 1 FLUOROMETRIC VALUES OF THE RED PIGMENTS OF SIN EYES IN ARBITRARY UNITS

Exp	Host	Implant	*n*	Mean and its standard error	
				Host	Implant
I *a*	+ ♀	+	16	27·0 ± 0·75	14·5 ± 0·8
b	+ ♂	+	18	22·3 ± 0·80	12·3 ± 0·5
II *a*	ry^2 ♀	ry^2	10	8·3 ± 0·71	6·8 ± 0·5
b	ry^2 ♂	ry^2	4	5·25 ± 0·64	5·25 ± 0·4
III *a*	+ ♀	ry^2	10	26·77 ± 0·50	15·0 ± 0·8
b	+ ♂	ry^2	14	23·33 ± 0·75	13·29 ± 0·7
IV *a*	ry^2 ♀	+	12	10·25 ± 1·09	7·69 ± 0·7
b	ry^2 ♂	+	11	6·91 ± 0·58	5·0 ± 0·4

In addition to the mutant eye colour and the la of *iso*xanthopterine, there are some further featur characteristic of our *rosy*^{2} allele. The Malpighi tubes become inflated, and they contain in the lumens large inclusions of a yellow- to orange-colour excretion material. The viability of our ry^2 sto is reduced at 25° C.; 30–60 per cent of the imagin die either before, during or shortly after hatchi from the puparium. Thus ry^2 behaves as a *P* semilethal[4].

The reddish-brown eye-colour is due to a conside able reduction of the red pigments, and in the co binations $cn/cn, ry^2/ry^2$ or $v/v, ry^2/ry^2$ the eyes beco orange, owing to further lack of the brown omm chrome pigments.

By transplanting eye disks and other larv primordia, we have studied the inventory of fluore cent pigments of ry^2 organs after their developme in normal hosts (+) and vice versa. Each met morphosed transplant was chromatographed and i fluorescent substances compared with correspondi organs of the host and untreated controls. In th way the amount of pigment was determined fluor metrically on the chromatographic paper by a meth used earlier[5]. A group of representative experimen is summarized in Table 1.

Table 1 shows the following results: (1) A tran planted abdominal eye usually does not form much red pigment as an *in situ* eye of the san genotype (Exp. I and II). (2) Eye disks of ry^2 beha non-autonomously in wild-type hosts (+); they c form as much red pigments as transplanted + ey in + hosts (Exp. III and I). (3) Transplanted + ey do not behave autonomously when developing in r hosts; their pigment formation is inhibited by t mutant host (Exp. IV and I).

It was further shown that ry^2 eye implants nor ally become pigmented not only in + hosts but al in *bw, ca, cn, ma, mah, p,* rs^2, *se, w* and w^a.

We then found that the (unknown) substance substances which ry^2 host eyes need in order become normally pigmented can be supplied especial by implanted larval fat bodies and Malpighian tub of ry^+.

A second biochemical character of ry^2 also behaves non-autonomously. Implanted Malpighian tubes, fat bodies, testes and eyes from a + donor cause, in ry^2 testes, the formation or at least the accumulation of *iso*xanthopterine.

The investigation of the gene-conditioned synthesis of *Drosophila* eye pigments has hitherto been much hampered, since most of the colour mutants behaved autonomously as transplants as well as towards fed or injected substances. Only *vermilion* (*v*) and *cinnabar* (*cn*) could be influenced experimentally, so that an analysis of the genic action of the respective loci on the formation of brown ommochrome pigments became possible (compare the well-known work of Beadle, Ephrussi, Clancy, Tatum, Butenandt and others). With regard to the red pigments, however, no suitable mutant with non-autonomous development was known. Thus the *rosy* mutant provides an approach to a developmental and biochemical analysis. A detailed report of our studies will be published in the *Zeitschrift für induktive Abstammungs- und Vererbungslehre*.

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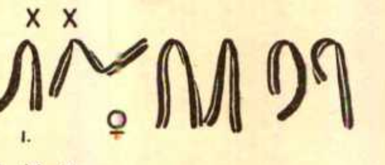
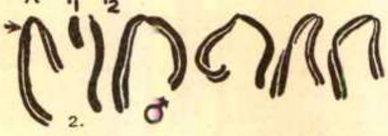
Chromosomes of the Common Shrew

BOVEY[1] reported that two male specimens of the common shrew (*Sorex araneus* L.), from Switzerland, had a sex-chromosome trivalent at first metaphase of meiosis. He did not examine female chromosomes, so was unable to determine whether the sex-chromosome mechanism was $XY_1Y_2 : XX$ (the female having one sex-chromosome *less* than the male) or $X_1X_2Y : X_1X_1X_2X_2$ (the female having one sex-chromosome *more* than the male). Study of four male and two female shrews collected in Britain confirms the presence of a sex-chromosome trivalent in the male and shows that the female has but two sex-chromosomes (XX).





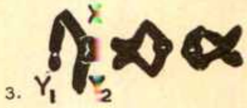


Fig. 1. Female. Two X-chromosomes and the two largest autosomal pairs. × 2,400

Fig. 2. Male. X-, Y_1- and Y_2-chromosomes and the largest two autosomal pairs. × 2,400

Fig. 3. Male. First metaphase showing the sex trivalent and the largest two autosomal bivalents. × 2,400

Three unequal-sized sex-chromosomes are present at metaphase of spermatogonial mitosis (Figs. 2, 5), and these form a trivalent at first prophase and metaphase of meiosis (Fig. 3). These male sex-chromosomes are a large nearly V-shaped chromosome (X), a long rod-shaped chromosome (Y_2) of nearly equal length to the largest arm of X, and a small chromosome (Y_1). In addition, there are two large pairs of approximately V-shaped (metacentric) autosomes, and a number of smaller autosomes. In female bone marrow cells (Figs. 1, 4) two X-chromosomes of identical appearance to that of the male, the two large pairs of metacentric autosomes, and the smaller autosomes are present. The acrocentric Y_2 and the short Y_1 are absent in female cells. A similar $XY_1Y_2 : XX$ sex-chromosome system is known in the marsupials *Potorous tridactylus*[2] and *Protemnoden bicolor* (= *Macropus ualabatus*) (Sharman, G. B., unpublished results) and has also been reported in the rodents *Gerbillus pyramidum*, by Matthey[3], and *G. gerbillus gerbillus* by Wahrman and Zahavi[4].

At prophase of meiosis the trivalent of *Sorex* is composed of two parts, one of which shows the same degree of condensation as the autosomes, whereas the other shows precocious prophase condensation like the sex bivalents of other mammals. We thus conclude that the compound X-chromosome has arisen by a reciprocal translocation between an ancestral X-chromosome and one member of a pair of acrocentric autosomes. Assuming permanency of the end segments of chromosomes (telomeres), this calls for a 'two-break' rearrangement. Presumably one break took place in the homologue of Y_2 and resulted in the loss of an almost terminal centromere, whereas the other took place near the end of one arm of the ancestral X-chromosome. The point at which

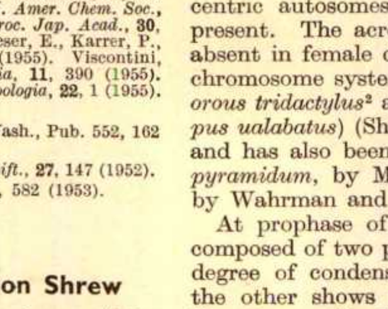


Fig. 4. Female, *S*6. Photograph of a squash preparation of bone marrow pretreated with hypotonic saline. There are twenty-five chromosomes, ten of which are rod-shaped and show a two-armed as distinct from a four-armed structure. × 2,400

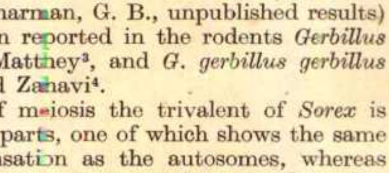


Fig. 5. Male, *S*1. Photograph of a squash preparation of spermatogonium. There are twenty-three chromosomes. Rod-shaped Y_2 overlying metacentric chromosome at 3 o'clock. Four small rods and Y_1 in centre of plate. × 2,400

the broken chromosome ends probably rejoined is indicated by an arrow in Fig. 2. This point can be detected in some mitotic metaphase preparations by the different degrees of condensation of the two types of chromatin making up the compound X. The evolution of the XY_1Y_2 system in *S. araneus* thus appears to parallel the evolution of the same type of system in *Potorous tridactylus*[2], where (in contradiction to White's statement[5]) the mode of origin of the multiple system is clear. A comparison of Bovey's figures[1] with the chromosomes of my material indicates that he has mistaken one of the smaller metacentric autosomes for the X-chromosome. As is obvious from Figs. 1–5, the X-chromosome is among the largest of the set and its origin, as explained above, requires that one of its arms be longer (or at least as long as) the Y_2-chromosome. This is not so in the sex-chromosomes as pictured by Bovey, whose caryograms show the Y_2 (Y_a in his notation) to exceed the combined lengths of both arms of the X-chromosome.

The chromosome number in six specimens of *S. araneus* studied varies between twenty-two and twenty-five. The number of sex-chromosomes is constantly two in the females and three in the males, so that autosomal numbers vary between nineteen and twenty-three. The common shrew, therefore, shows cytological polymorphism, which can be explained on the assumption that what White[6] calls "centric fusions" (that is, Robertsonian changes) have occurred between non-homologous acrocentric autosomes. In all specimens examined there are, almost certainly, thirty-six autosomal arms, some of which are represented either by one metacentric or by two acrocentric autosomes. Apart from the observations of Wahrman and Zahavi[4], intrapopulational chromosomal polymorphism in mammalian species does not hitherto appear to have been reported. Five of the six chromosome counts obtained during this survey were, of necessity, determined from bone marrow preparations, the animals having been captured out of the breeding season. This survey will be resumed in the spring, and these and further observations will be fully reported elsewhere.

This study was carried out at the Medical Research Council Radiobiological Research Unit, Harwell, where, through the courtesy of its director, Dr. J. F. Loutit, I was provided with laboratory facilities while receiving financial support from the Nuffield Foundation. I wish to thank Dr. C. E. Ford for helpful supervision and Dr. Dennis Chitty, of the Bureau of Animal Population, Oxford, for collecting one of the specimens used.

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Two Modes of Inheritance of the Short-styled Form in the 'Genus' *Oxalis*

AN investigation to find the mode of inheritance of style-length in the tristylic species *Oxalis articulata* Savign., the gardeners' *floribunda*, was begun in 1949 when the genetic situation in *O. valdiviensis* had been established[1,2]. In the latter species inheritance is disomic; there are two linked dominant genes, that for Short being epistatic to Mid, and the long-styled form is the double recessive.

Data obtained from *O. articulata* revealed a different situation, for when a Long and Mid were crossed reciprocally, both plants having one Short parent, Shorts appeared in their progenies as follows:

	L	M	S	Total
L × M	28	56	35	119
M × L	19	51	41	111
	47	107	76	230

Ten Longs from the M × L progeny were crossed to a Short. In the following year, three of these Longs gave only Longs, 360 in all, and seven gave 452 Longs : 495 Shorts, which fits a 1 : 1 ratio (χ^2 is 1·9525 for 1 degree of freedom). Five Mids from the L × M progeny were selfed; one gave only Mids and Longs and four gave a quarter Shorts, altogether 150 out of a total of 561 plants grown (χ^2 is 0·9037 for 1 degree of freedom).

Although the proportion of Shorts obtained from the reciprocal cross first mentioned is more than a quarter ($\chi^2 = 7·9362$ for 1 degree of freedom) the occurrence of any Shorts suggests that this form is recessive. Had there been any doubt that some unknown factor was influencing this ratio, it would have been removed by the performance in the following year. These data also show that Longs and Mids can be either homozygous or heterozygous at the S locus. Of the fifteen plants tested, four were homozygous where a third were expected. This situation is in complete contrast to that which exists in *O. valdiviensis*. On the other hand, both species are similar in that the short gene, whether dominant as in *O. valdiviensis* or recessive as in *O. articulata*, is epistatic to Mid. It is remarkable that two such different modes of inheritance of the short-style form should exist in the same genus.

O. articulata segregates for pink and white flowers and also has a diluting factor which has no discernible effect on white petals. Linkage of the Short locus and that for pink flower colour has been found. In 1954 eight pink Mids known to be in repulsion (Sp/sP) were crossed to white Shorts (sp/sp). Six of the progenies obtained gave 333 recombinants out of a total of 1,289 plants. The other two progenies were heterogeneous, and, therefore, are not included for the purpose of estimating the recombination fraction. Using the method of maximum likelihood, we find this is 25·8 ± 1·2 per cent.

The situation at the Short locus is similar to that found by von Ubisch[3] in *O. rosea*, although, rather confusingly, she used the dominant symbol for the short allele. She also showed that the loci for short style and pink flowers are linked with 25 per cent crossing-over. Other species tested in this Department are *O. hirta* L., form *E*, *O. tragapoda* Salter and *O. bowiei* Lindl. These three species have been found to have a dominant Short as in *O. valdiviensis*. The results may be summarized as follows:

Dominant Short	Recessive Short *
O. valdiviensis	*O. rosea*
O. hirta L., form *E*	*O. articulata* Savign.
O. tragapoda Salter	
O. bowiei Lindl.	

A more extensive publication elsewhere will be delayed so that inheritance of the Mid form in O. *articulata* may be included. I wish to thank Captain T. M. Salter for collecting and sending the South African species mentioned together with many others, and Sir Ronald Fisher for his constant help and encouragement.

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Moult Adaptation in Relation to Long-distance Migration in Petrels

Meinertzhagen[1] has described in South Greenland eas (*c.* lat. 60° N.) flocks of wing-moulting, and often temporarily flightless, great shearwaters (*Puffinus gravis*) which migrate trans-equatorially northward from their Tristan da Cunha breeding grounds lat. 37° 6′ S.). He suggests that it "needs to be explained why the Great Shearwater moults in its winter quarters, whilst the Fulmar (*Fulmarus glacialis*) moults while the young are hatching". (The fulmar, of course, breeds locally.)

In the course of a study[2] of the breeding cycle in elation to the trans-equatorial migration of the hort-tailed shearwater (*Puffinus tenuirostris*) we have accumulated data that have bearing on the point raised above.

Many widely unrelated species undergo a postnuptial moult involving the uninterrupted and more or less serial replacement of the feathers of tail, wings, body and head (for example, the rook, *Corvus rugilegus*)[3]. In other species, such as the fulmar, body moult comes first, immediately followed by the hedding of wing-quills[1,4,5].

During our investigation of *P. tenuirostris* on its Tasmanian breeding grounds, we found that all fifty-hree sexually mature examples examined in the post-uptial phase moulted only on the head and body. Although ovulation occurred in November, flight- and ail-feathers were not replaced before the shearwaters departed in April on their long migration into North Pacific and Arctic waters. It was concluded hat the annual replacement of the feathers most nvolved in flight must be delayed until the termination of this long journey.

Examination of the literature showed that this is ndeed what happens. *P. tenuirostris* has been collected while moulting its wing- and tail-feathers in orthern waters in June and July[6,7]. Further, two ther shearwaters of broadly comparable trans-quatorial movement pattern exhibit a similar post-migratory wing moult. Thus, *P. griseus* has been bserved moulting in wing and tail in the northern hemisphere summer[8,9] and *P. gravis* (as mentioned bove) has been similarly observed by a number of uthors[1,10–13]. An especially remarkable divergence n moult-timing probably occurs even between subpecies. Thus, while *P. puffinus mauretanicus* (which reeds in the Balearic Islands and undergoes only restricted migration or dispersion) carries out the whole of its post-nuptial moult without delay[14], there is a suggestion that *P. p. puffinus* delays the replacement of its flight (but not most of its body) feathers until after crossing the equator to its southern hemisphere 'wintering' grounds[15].

From the above data there emerges clear evidence of the evolution of a moult adaptation related to the migratory requirements of species that undergo a long post-nuptial migratory movement. Moult in all adult shearwaters probably begins during the nesting period; but in trans-equatorial migrants there is a hiatus that allows the retention of the wing- and tail-feathers until after the completion of their post-nuptial journey.

Once the flocks reach their contra-nuptial quarters the moult is completed in a short, sharp burst. The sea is then bestrewn with moulted feathers[7,8] and in the case of one species at least some individuals may be temporarily unable to fly[1]. But the long, arduous journey is now behind them.

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The Langmuir Paradox in Discharge Plasmas

In a recent communication, Gabor, Ash and Dracott have described the detection of oscillations in a positive ion sheath separating a section of wall from the positive column plasma of a low-pressure arc in mercury vapour[1]. The oscillations were studied by passing a pencil of cathode rays through the sheath, and were found to have two main components, one with frequencies of up to about 100 kc./s., and the other with frequencies of the order of 100 Mc./s. We have been investigating the fluctuations of similar discharges by the alternative method of withdrawing oscillatory energy through the main electrodes (anode, cathode) and probes to tuned detectors, and have obtained what appear to be comparable experimental results. Our method does not permit of observation over individual periods of a few hundredths of a microsecond, as does Gabor's, but yields a long-time Fourier analysis of the fluctuations.

Accounts have already been published of the lower-frequency band[2]. It has some nearly monochromatic components, but consists mostly of 'noise' with an almost flat spectrum of intensity per unit frequency band versus frequency. The latter can be accounted for by the occurrence of pulses of ionization with appropriate time-constant superposed on the main steady ionization in the discharge. It can be largely prevented from reaching a probe by making the latter negative. It originates where sections of the discharge are unstable, particularly in the cathode sheath when this contains a potential minimum[3]. Its presence does not appear essential for maintenance of the discharge.

The high-frequency band has also been found to have a nearly flat spectrum, between about 15 Mc./s., below which it is usually masked by the more intense lower-frequency noise, and 120 Mc./s., the highest frequency we have studied. The energy which can be withdrawn is almost independent of probe potential, and roughly of the order of magnitude to be expected from the random thermal motion of electrons in the plasma ; we have not been able to make an exact comparison with the electron-thermal noise, owing to uncertainty as to what equivalent resistance is to be attributed to a plasma in this connexion. This high-frequency 'noise' may be related to the sheath oscillations reported by Gabor *et al.*, the fields of which have maximum amplitude at the wall, that is, in our case, the probe surface. They remark that both the amplitude and the frequency of the oscillations were variable, particularly the former, and that the oscillations were not necessarily coherent over an area of wall sheath ; the frequency spectrum will therefore be broad, although it is not certain that it would be as flat as we have found the high-frequency 'noise' spectrum to be.

It seems to us uncertain that a 'Langmuir paradox' necessarily arises near a hot cathode, where fast primary electrons from the thin space-charge sheath on this electrode are present. These may regenerate the high-energy tail of the main plasma group of electrons in two ways if this is being lost to the wall : first, by collisions with the gas molecules, and secondly and possibly more efficiently, by means of high-frequency oscillations in the primary beam and volume of the plasma. Whatever the mechanism of these oscillations may be, they are definitely associated with considerable randomizing of the primary beam in both energy and direction[4].

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Isosterism and Molecular Fourier Transform : Crystal Structure Determination of 2-4-Dihydroxybenzoic Acid as related to that of 2-Hydroxy-4-aminobenzoic Acid

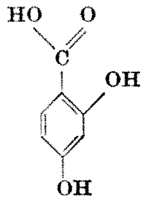
ISOSTERIC organic compounds, that is, compound differing only in the nature of one more atom o substituent groups, often crystallize in quite differen lattices. Using the older X-ray techniques, knowledge of the crystal structure of one member of a isosteric pair may thus be of little help in solvin the structure of the other member ; but the ne Fourier transform techniques[1] allow the investigato to take full advantage of such a situation. This i especially easy if the molecules happen to be plana and centrosymmetric, or if they associate to for centrosymmetric groups.

Table 1

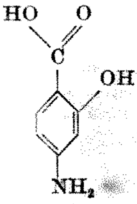
	a	*b*	*c*	*α*	*β*	*γ*	*Z*	Space group
2-4-Dihydroxybenzoic acid*	7·05	9·67	11·81	98° 50′	109° 28′	91° 43′	4	C^1_i–$P\bar{1}$
2-Hydroxy-4-aminobenzoic acid	7·28	3·82	25·33	—	103°	—	4	$C^5_{2h}P2_1/c$

* A number of water molecules ranging between ½ and 3 per mole of compound is given in the literature (see "Beilstein", **10**). W have, however, been unable to find any water in the crystal. This result has been confirmed by analysis, and it seems likely that the loss of weig due to the easy decarboxylation of this compound might be responsible for the erratic results reported in the literature.

An example of this method of analysis is th determination of the crystal structure of 2-4-dihydroxybenzoic acid (I), a compound which is isosteric with 2-hydroxy-4-aminobenzoic acid (II).



(I)



(II)

The crystal structure of the latter had already bee established[2] when it was decided to investigate th structure of the former. The unit cells of these tw compounds are quite different (Table 1), (II) bein monoclinic and (I) triclinic. Structure II had bee found to contain centrosymmetric dimers linke together by hydrogen bonds. The same pairing wa therefore also expected to occur in (I), in which cas the space group was likely to be $P\bar{1}$. This was con firmed, first by the absence of any piezoelectri effect, and later by plotting the intensity distributio of $0kl$ reflexions ; this distribution was of the hype centric type[3], actually indicating the presence centres of symmetry additional to that required b the space group $P\bar{1}$. As there are four molecules i the unit cell, this implies two centrosymmetric dime related by the centre of symmetry of the space grou

To find the arrangement of the molecules in th unknown structure (I), the Fourier transform of th known molecular structure (II) was calculated b sampling the electron density distribution projecte on 010 and correcting it for the tilt of the dim with respect to this plane. Two weighted reciproc lattice sections were now prepared from the $h0l$ an $0kl$ intensities of (I). With the help of a simple devi (described elsewhere by one of us[4]) the calculate transform was projected in turn on each of the

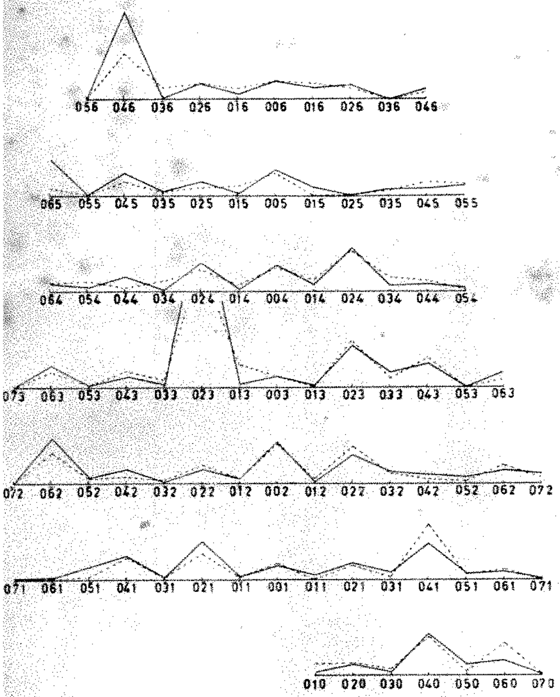
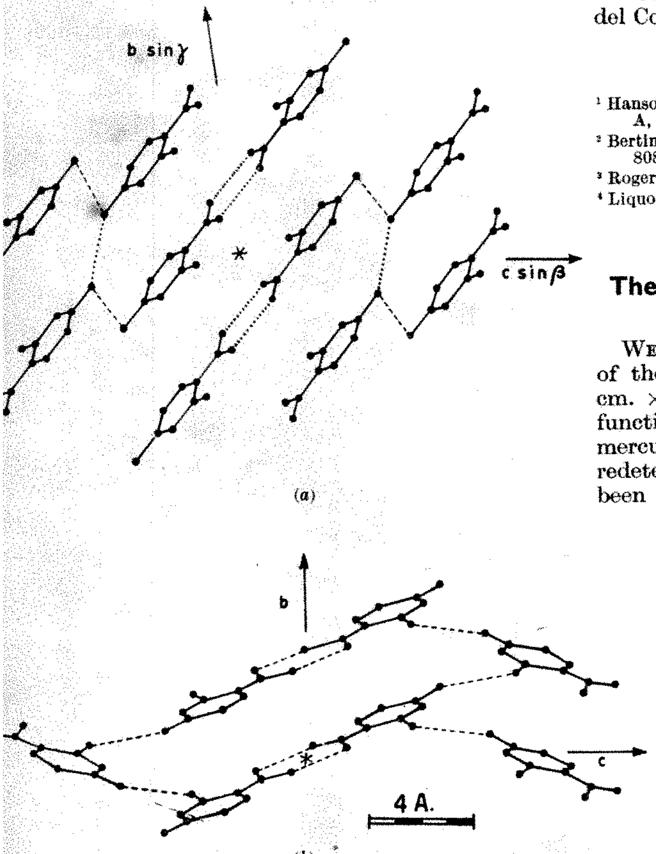


Fig. 1. Comparison between experimental amplitudes F_{0kl} (dotted line) and sampled values of the Fourier transform corrected by the fringe function (full line)



(a)

(b)

Fig. 2. Schematic drawing of the packing of molecules in the unit cell of (a) 2-4-dihydroxybenzoic acid and (b) 2-hydroxy-4-amino-benzoic acid

sections, and molecular orientations giving the best fit were found by trial. At the same time the nodes of the fringe function relating the centres of the two dimers could be recognized from a characteristic trend of the $0kl$ reflexions, giving these centres the approximate co-ordinates of $0\ \frac{1}{4}\ 0$; $0 - \frac{1}{4}\ 0$. On further refinement the centres had to be displaced slightly from these positions. After this had been done, and the sampled transforms had been corrected by a suitable fringe function, the agreement shown in Fig. 1 was obtained for the $0kl$ reflexions, which may be considered good enough to establish the packing of the molecules in the unit cell with a fair degree of accuracy (Fig. 2).

The packing turns out to be quite different in the two isosteric compounds, despite their common tendency to form hydrogen-bonded pairs. Further analysis of the differences between the two structures was not pursued, because considering the similarity in their physico-chemical properties, such differences would be expected to be very small.

We wish to thank Prof. Giacomini for putting at our disposal an apparatus to test the piezoelectric effect, and the Rockefeller Foundation for a grant to one of us (A. R.). We are also indebted to Dr. M. F. Perutz for a critical reading of the manuscript.

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The First Townsend Ionization Coefficient for Hydrogen

We have completed independent measurements of the first Townsend coefficient α/p_0 (ionizations/cm. × mm. mercury at 0° C.) for hydrogen as a function of the parameter E/p_0 (volts/cm. × mm. mercury at 0° C.). In view of the several partial redeterminations of this quantity that have recently been reported, we feel that early mention of our results may be of interest.

The results are shown in Fig. 1, where α/p_0 is plotted against p_0/E. Those by Rose are taken at pressures $0{\cdot}5 < p < 45$ mm. mercury, and those by De Bitetto and Fisher at pressures of 100 and 200 mm. mercury. Throughout the range $0 < p_0/E < 0{\cdot}045$, α/p_0 can be represented within the experimental error (± 2 per cent) by the function:

$$\alpha/p_0 = 5{\cdot}1 \exp(-139\, p_0/E)$$

Outside this range, the curve passes through the following points: ($0{\cdot}050$, $4{\cdot}6 \times 10^{-3}$); ($0{\cdot}055$, $2{\cdot}1 \times 10^{-3}$); ($0{\cdot}060$, $8{\cdot}9 \times 10^{-4}$); ($0{\cdot}065$, $3{\cdot}6 \times 10^{-4}$).

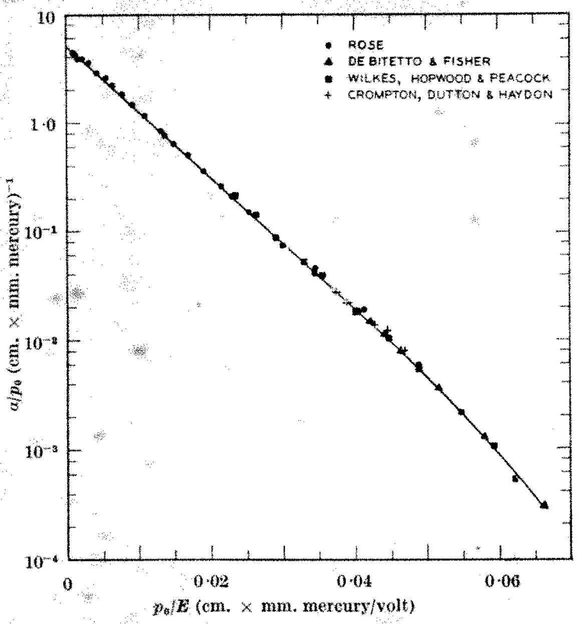

Fig. 1. The first Townsend coefficient α/p_0 (ionizations/cm. × mm. mercury at 0° C.) for hydrogen as a function of p_0/E (mm. mercury at 0° C. × cm./volt)

It is interesting to compare our results with those already published. Before doing so, it is essential that all be reduced to the same temperature, such as 0° C. In this connexion, it is unfortunate that the temperature at which the results are meant to apply is not always explicitly stated.

In the range $0 < p_0/E < 0{\cdot}025$, the present results agree fairly well with those of Ayres[1]; but at larger p_0/E, his results lie substantially above ours. At $p_0/E = 0{\cdot}06$, for example, Ayres gives $\alpha/p_0 \approx 1{\cdot}8 \times 10^{-3}$. Observations taken by Hale[2] extend throughout the range $0 < p_0/E < 0{\cdot}04$; they are higher than ours at both extremes, and lower by a factor $\approx 1{\cdot}8$ at $p_0/E = 0{\cdot}01$. We find excellent agreement with the recent results reported by Wilkes, Hopwood and Peacock[3] ($0{\cdot}027 < p_0/E < 0{\cdot}062$), and also with those reported by Crompton, Dutton and Haydon[4] ($0{\cdot}037 < p_0/E < 0{\cdot}046$). However, results at higher p_0/E reported by Crompton, Dutton and Haydon in an earlier communication[5] lie considerably above ours.

Complete discussions of these and other related observations will appear elsewhere. That part of the work performed at New York University has been supported by the U.S. Office of Naval Research.

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Tensile Strength of Liquid Helium II

The tensile strength of a liquid is defined as th maximum negative pressure (P) that a liquid in a isothermal metastable state can sustain before return ing to a two-phase system. Mathematically, thi might be expressed as the value of P at whic $(\partial P/\partial V)_T = 0$, where V represents the volume of th liquid at temperature T. According to Temperley[1] if Van der Waals's equation of state be assumed t hold for a liquid and the condition that $(\partial P/\partial V)_T =$ be applied, the tensile strength may be calculated Benson and Gerjuoy[2], in working with the reduce form of this equation, arrived at :

$$\varphi^3 - \frac{9}{4\theta}\varphi^2 + \frac{3}{2\theta}\varphi - \frac{1}{4\theta} = 0 \qquad (1$$

where $\varphi = V/V_c$, $\theta = T/T_c$, $\pi = P/P_c$ and the sub script c stands for critical value, by applying th condition :

$$\frac{V_c}{P_c}\left(\frac{\partial P}{\partial V}\right)_T = \left(\frac{\partial \pi}{\partial \varphi}\right)_\theta = 0 \qquad (2$$

Values may be assigned to θ and the resulting cubi in φ will give rise to a real root which may in tur be substituted in

$$\pi_{\text{min.}} = \frac{3}{\varphi^2} - \frac{2}{\varphi^3}$$

to give reduced values of the tensile strength.

Consider, for example, the case of nitrogen, whic has $T_c = 126{\cdot}06°$ K. and $P_c = 33{\cdot}5$ atm. Accord ing to equations (1) and (2), the tensile strength shoul be about 109 atm. at 69·3° K. This value is muc higher than that found experimentally both b Misener and Hedgcock[3] in 1953, and by Misener an Hébert in the present work. However, as Temperle points out, this could be due to (*a*) the presence o impurities in the liquid, (*b*) the possibility of variatio with temperature of the constants in the Van de Waals's equation, that is, departure of the equatio of state from a true representation of the state o the liquid.

For helium, with $T_c = 5{\cdot}26°$ K. and $P_c = 2{\cdot}2$ atm., the tensile strength at 1° K. becomes 25·9 atm This value again is much higher than that foun by us.

As Misener and Hedgcock pointed out in 1953, i would seem reasonable that a static method o measuring tensile strength should give rise to tru values, since these are essentially static in characte Accordingly, a modification of their bellows arrange ment, which in turn was an adaptation of Vincent' apparatus[4], was constructed. The apparatus show in Fig. 1 was the working section at the end of 1¼-in. german silver tube suspended in a doubl Dewar flask arrangement. The circular plates, 4 an 5, along with their three interconnecting rods, pro vided a rigid support for the top of both bellows Three more brass rods fixed the lower plates 1 and so that they could move together. When liquid fro the innermost Dewar flask was allowed to fill th top bellows, it could be sealed off by means of th needle valve 6. The latter was controlled from outsid the Dewar assembly by the rotation of a vertica hollow Monel tube welded at the top to a stainle steel threaded shaft. The required seal about th shaft was effected by means of an O-ring. Gas fro a source at controlled pressure was fed through th Monel tube 7 into the lower bellows. As the pressu

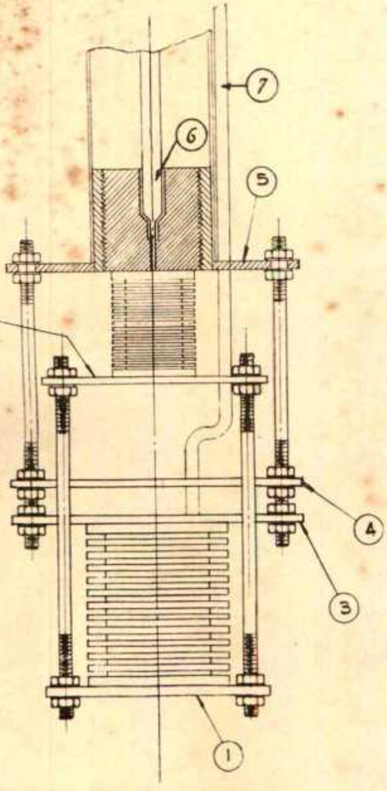

Fig. 1. Pressure-loaded bellows apparatus for tensile strength of liquids

as slowly increased, the level of 2 remained station- y until the maximum negative pressure on the quid in the upper bellows was reached. Beyond is pressure, plate 2 suddenly moved downwards observed through the telescope of a cathetometer. ne value of this maximum pressure was taken to the tensile strength of the liquid in the upper llows.

Since the values obtained in the readings of the s supply were the pressure values above zero-level the lower bellows, the problem of determining the fective cross-section of each bellows was of import- ce. Proceeding in a fashion quite similar to that Vincent, a load F was attached to the lower llows, the upper bellows was left open to atmo- heric pressure, and the load vs. tension found to be 1·37 kgm./ m. Next, gas under known essures replaced the load and a libration of pressure P vs. ex- nsion gave approximately 0·16 m./cm.²/mm. Obviously the ective cross-section A, from F/P, ve 8·56 cm.². As this value rresponded fairly closely to that lculated from the mean outer and ner radii of the bellows (8·73 cm.), was assumed that for purposes of e present experiment, the calcu- ed values of the effective cross- tion of the upper bellows would correct. It followed then that e excess pressure applied to the ver bellows, multiplied by 1·95, uld give the required values of e tensile strength.

As a preliminary experiment, the tensile strength of liquid nitrogen was measured between 64° K. and 76° K. The tensile strength increased with decreasing temperature and the numerical values were substantially in agreement with those found by Misener and Hedgcock, namely, about 3·5 atm. at 71° K.

In liquid helium II at a number of temperatures between 2·147° K. and 1·092° K., no 'break' in the motion of the upper bellows could be observed. As soon as the working pressure was applied, the bellows began to elongate. The rate of elongation was too large to be accounted for by any possible 'film flow' through the closed needle valve. It is concluded, therefore, that if there is any tensile strength at all for liquid helium II, its value as measured by this bellows method is less than 0·3 atm.

We wish to thank the Physics Department of the University of Toronto for the use of the facilities of its Low Temperature Laboratory for this investigation. We would like to thank particularly Dr. H. Hallett and his staff, both for their encouragement and their assistance during the experimental work.

A. D. Misener
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Feb. 29.

[1] Temperley, H. N. V., *Proc. Phys. Soc.*, **59**, 199 (1947).
[2] Benson, S. W., and Gerjuoy, E., *J. Chem. Phys.*, **17**, 914 (1949).
[3] Misener, A. D., and Hedgcock, F. T., *Nature*, **171**, 835 (1953).
[4] Vincent, R. S., *Proc. Phys. Soc.*, **53**, 126 (1941).

Examination of Fossil Coccoliths in the Electron Microscope

Recently, the use of the electron microscope in investigating the form of fossil coccoliths has been reported by Deflandre and Fert[1], and a preliminary revision of the taxonomy has been given by Braarud, Deflandre, Halldal and Kamptner[2]. The published electron micrographs show little more than the outline of the coccoliths and must be supplemented by examination at lower magnifications with the optical microscope. This unsatisfactory situation is due to the coccoliths being opaque to the electron beam. The difficulty has been overcome by examining shadowed replicas of the coccoliths, which give

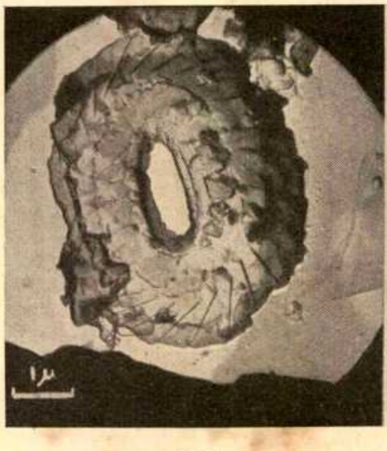

Fig. 1

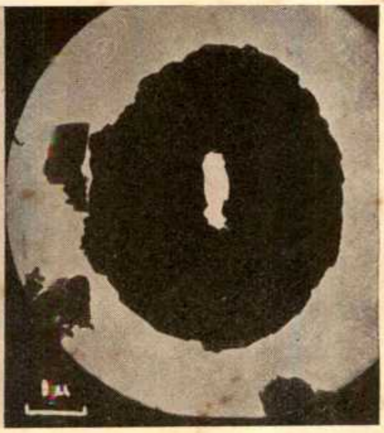

Fig. 2

excellent information about the relief as well as the outline of the coccoliths. The accompanying illustrations compare a shadowed replica (Fig. 1) with a similar coccolith photographed in the transmitted beam (Fig. 2).

The method used in preparation is similar to the silica transfer technique applied by Hall[3] to the study of protein crystals. The replicas of coccoliths were made by dispersing coccoliths, obtained by scraping the rock, in distilled water and supporting this dispersion on a 'Formvar' film. The whole was then coated with a thin evaporated carbon film and the 'Formvar' dissolved in acetone. Finally, the coccoliths were removed with dilute hydrochloric acid and the remaining replica shadowed with gold–palladium.

The method has been applied to coccoliths from the White Band of the Kimmeridge Clay of Kimmeridge, Figs. 1 and 2 being of the dominant coccolith type present. The structure of spirally arranged calcite crystals and central perforation is clearly seen in Fig. 1. It is felt that adequate descriptions of coccoliths should require similar illustration, and that re-examination of existing types by this technique is imperative to establish a satisfactory classification.

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R. W. K. Honeycombe
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University of Sheffield.
March 2.

[1] *C.R. Acad. Sci., Paris*, **234**, 2100 (1953).

[2] *Micropalæontology*, (1), **2**, 157 (1955).

[3] *J. Biol. Chem.*, **185**, 45 (1950).

Modification of the Bulk Mechanical Properties of Water by Complex Formation in Dilute Solution

A solution of 75 per cent aqueous glycerol shows considerable viscosity (six times that of water) but no structure, so that small bubbles rise to the surface slowly but at a rate predictable from Stokes's law. A 0·07 per cent solution of agar, on the other hand, is only about 4 per cent more viscous than water; but eddies in it are destroyed as rapidly as in the glycerol. Air bubbles rise to the surface in characteristic jerks, and if small enough become trapped. Clearly a certain critical stress has to be exceeded in order to break the molecular framework.

It has now been found that a solution of 0·01 per cent cetyl trimethyl ammonium bromide and 0·005 per cent β-naphthol, added in that order to tap water, resembles the above-mentioned agar solution in its mechanical properties. Its viscosity is only about 2 per cent greater than that of water, eddies are rapidly destroyed and bubbles become trapped. A new feature, however, is the considerable elasticity shown, so that an eddy is not simply damped out but is reversed. Most of the life of a swirl set up in volumes of 500 ml. or less is, in fact, spent in motion in the reverse sense to the initial. With c as the concentration of cetyl trimethyl ammonium bromide in p.p.m., the β-naphthol being at $c/2$ throughout, and t the time in seconds before motion first stops, it was found that the relation $\log t = 0{\cdot}42 + 28/c$ was obeyed between $c = 50$ and 500. The size of the eddy was defined by using 50 ml. of solution in a bottle of 4·3 cm. internal diameter, a rapid swirl being timed with a stop-clock.

When distilled water is used, more material i required, the efficiency of tap water (London) bein part of a general salt effect, probably due to anio adsorption by the complex. Details of the chemistr of this and similar systems are being submitted else where, but the easily controlled 'thickening' of larg volumes of water in this manner should be of interes in hydrodynamic and sedimentation studies.

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"Zoonoses in East Africa"

In the report of the recent conference in Kampala Uganda, "Zoonoses in East Africa"[1], I was quote as suggesting that *Trypanosoma rhodesiense* had de veloped from *Tr. brucei* by repeated passages throug *Glossina pallidipes*. My thesis was, in fact, almos the exact opposite of this. I emphasized that a the evidence so far shows that the property o infectivity to man which alone distinguishes *T* *rhodesiense* from *Tr. brucei* is an extremely stabl one and that there has never been a known case o interconversion of these two. On the other hand I pointed out, in any area where *Tr. rhodesiens* had appeared, either it could be traced to direc introduction by infected human beings from a know source, or the other human infective 'species', *T* *gambiense*, had been known to be present in the are for some time.

I stressed the association of *Tr. gambiense* wit the *palpalis* group of *Glossina* and of *Tr. rhodesiens* with the *morsitans* group and indicated that *G* *pallidipes* was consistently present in areas wher *Tr. rhodesiense* had appeared some time after *T* *gambiense*. There are several areas in which, thoug the appearance of *Tr. rhodesiense* might conceivabl have been due to direct transport, it also might hav been due to the conversion of *Tr. gambiense* into th more virulent form, *Tr. rhodesiense*. Such areas ar Busoga in Uganda, Buvuma Island in Lake Victori Uganda, Central Nyanza in Kenya and North Mar in Kenya. *G. pallidipes* occurs in all these area Further, *Tr. rhodesiense* is believed to have originate from the Luangwa Valley in Northern Rhodesia the end of the first decade of this century, whe *Tr. gambiense* was known to have been introduce in the previous two or three years. This area is o of the largest in eastern Africa of a mixed popul tion of *G. pallidipes* and *G. morsitans*.

At the Kampala conference I put forward th hypothesis that *Tr. rhodesiense* has always originate from *Tr. gambiense* and made the tentative suggestio which is supported by small pieces of other evidenc that the conversion to the more virulent huma infective form may have been due to repeate transmission by *G. pallidipes*.

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Organization,
P.O. Box 96,
Tororo, Uganda.

[1] Daves, J. N. P., *Nature*, **177**, 406 (1956).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, May 22

Wright-Fleming Institute of Microbiology (at St. Mary's spital Medical School, London, W.2), at 5 p.m.—Prof. F. W. gers Brambell: "Transmission of Passive Immunity"* (Almroth right Lecture).

Tuesday, May 22—Friday, May 25

Textile Institute (in the Winter Gardens, Blackpool)—Confer- ce on "New Yarns and Fabrics".

Wednesday, May 23

Royal Society of Medicine, Endocrinology Section (at 1 mpole Street, London, W.1), at 5 p.m.—Annual General Meeting; lowed by a discussion—"Dwarfism and Some Nutritional Factors". ening Speaker: Prof. A. C. Frazer, followed by Dr. C. E. Dent d Dr. S H Taylor.

Eugenics Society (at the Royal Society, Burlington House, cadilly, London, W.1), at 5.30 p.m.—Dr. F. M Martin: "Home ckground and Selection for Secondary Education".*

British Institution of Radio Engineers (at the London School Hygiene and Tropical Medicine, Keppel Street, Gower Street, ndon, W.C.1), at 6.30 p m.—Dr. K. Froome. "The Measurement the Velocity of 'Light' by Electronic Methods".

Society for Analytical Chemistry (joint meeting with the od Group of the Society of Chemical Industry, at the Chemical ciety, Burlington House, Piccadilly, London, W.1), at 6 30 p.m.—ientific Papers

Thursday, May 24

British Institute of Radiology, incorporated with the Rontgen ciety (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), 8 p.m.—Annual General Meeting. 8.30 p.m —Ordinary Meeting, lowed by Prof. F W. Spiers: "Radioactivity in Man and His vironment" (Presidential Address).

Thursday, May 24—Monday, May 28

British Mycological Society (at Flatford Mill)—Spring Foray.

Friday, May 25

Biochemical Society (at Rothamsted Experimental Station, rpenden, Herts), at 10.45 a.m.—Scientific Papers.

ociety for Analytical Chemistry, Physical Methods Group int meeting with the Photoelectric Spectrometry Group, in Physical Chemistry Laboratory, South Parks Road, Oxford), at 0 p.m —Meeting on "Nuclear and Para-Magnetic Resonance".

British Psychological Society, Education Section (at the iversity of London Institute of Education, Malet Street, London, C.1), at 7 p.m.—Mr. H. E. O. James: "Ethnic Prejudices and ir Reduction by Educational Means".

Royal Institution (at 21 Albemarle Street, London, W.1), at p.m.—Prof. Cyril S. Smith: "The Structure of Metals as Seen der the Microscope".

APPOINTMENTS VACANT

pplications are invited for the following appointments on or ore the dates mentioned:

ranslator/Abstractor (with a knowledge of engineering subjects l ability to translate accurately and speedily from at least two eign languages) at the Central Electricity Authority Head-rters, London, S.E.1—The Director of Establishments, Central ctricity Authority, Winsley Street, London, W.1, quoting Ref. /809 (May 25).

ecturer (with a first- or second-class honours degree in chem-y, and special qualifications in physical chemistry) in the School Chemistry—The Director, Robert Gordon's Technical College, erdeen (May 26).

enior Laboratory Technician for work in the Chemistry, ysics and Biology Laboratories—The Secretary, Paddington hnical College, Saltram Crescent, London, W.9 (May 26).

esearch Assistant (with special qualifications in physical mistry, and preferably previous experience in some branch of ymer science) in the Department of Chemistry—The Registrar, University, Manchester 13 (May 28).

hysicists (2) (one with experience in electronics and the other radiotherapy), to work in a laboratory engaged in experimental routine work for the medical staff—The House Governor, King's lege Hospital, Denmark Hill, London, S.E.5 (May 29).

epartmental Demonstrator in Cytology, and a Research ficer in Cytology—Prof. C. D. Darlington, Botany Department, University, Oxford (May 31).

ppenheimer Geological Fellows (suitably qualified graduates recognized universities and institutions) in the Institute of ican Geology—The Registrar, The University, Leeds 2 (May 31).

esearch Assistant to take charge of Electron Microscopy (in-ling electron diffraction)—Prof. R. M. Barrer, F.R.S., Imperial lege, London, S.W.7 (June 1).

Osborne Reynolds Research Fellow (with experience of research in hydraulics and capable of independent work) in Engineering—The Registrar, The University, Manchester 13 (June 2).

Physicist or Mathematician (with a first- or second-class honours degree or equivalent, and preferably with a good knowledge of physical principles underlying engineering design) at a Ministry of Supply Research and Development Establishment near Sevenoaks, Kent, for general physico-mathematical work in relation to the performance and instrumentation of armament components—The Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.163/6A (June 2).

Physicist (with a good honours degree or equivalent) at the National Coal Board's Coal Survey Laboratory in Cardiff, to initiate studies of the physical and mechanical properties of South Wales coal seams—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/266 (June 2).

Assistant Lecturer in Mathematics—The Registrar (Room 9, O.R.B.), The University, Reading (June 4).

Lecturer or Assistant (Grade B) (with teaching and research experience) in Geology up to B.Sc. (Special) standard—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 4).

Research Assistant in Chemistry (Organic) in connexion with a grant from the British Empire Cancer Campaign Committee, for work on the organic chemistry of nucleotides—The Registrar, The University, Manchester 13 (June 4).

Assistant Lecturer or Lecturer (with special interests in petrology) in the Department of Geology—The Registrar, University College, Singleton Park, Swansea (June 5).

Senior Lecturer (with a research interest in a branch of applied mathematics) in Mathematics—The Secretary, Royal Technical College, Glasgow (June 6).

Lecturer in Bacteriology—The Secretary of University Court, The University, Glasgow (June 9).

Shell Students in Chemical Engineering—The Registrar, King's College, Strand, London, W.C.2 (June 9).

Tutorial Research Student in Mathematics (pure or applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (June 9)

Assistant Lecturer in Organic Chemistry—The Secretary, The Queen's University, Belfast (June 11).

University Lecturer (preferably specialized in statistics) in Mathematics—The Secretary of the Appointments Committee of the Faculty of Mathematics, The Arts School, Bene't Street, Cambridge (June 13).

Sessional Lecturer (preferably specialized in historical, cultural and Eurasian geography) in the Department of Geography—The Chairman, Department of Geography, McMaster University, Hamilton, Ontario, Canada (June 15).

Technician in the Department of Zoology—The Registrar, University College of Wales, Aberystwyth (June 15).

Lecturer in Psychology—Joint Clerk to the University Court, College Gate, St. Andrews (June 16).

Lecturer in Mathematics at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 23).

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, University College of Wales, Aberystwyth (June 30).

Plant Physiologist; Statistician (Biometrician); Assistant Sylviculturist; and an Assistant Entomologist in the Wattle Research Institute of the University of Natal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (South Africa, June 30)

Scientific Assistant (with some knowledge of biological, preferably horticultural, research and the ability to make abstracts in clear English from several foreign languages)—Commonwealth Bureau of Horticulture and Plantation Crops, East Malling, Maidstone, Kent (June 30).

Waite Chair of Agricultural Chemistry—The Registrar, University of Adelaide, Adelaide, South Australia (June 30).

Lecturer (with British university qualifications or equivalent, and some experience in teaching geology in a university department of geology and geography) in Geology, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, July 15).

Director (with wide research and administrative experience and ability to co-ordinate research in the various divisions of the Institute) of the Central Electro-Chemical Research Institute, Karaikudi, South India—High Commission of India, Establishment Department, Aldwych, London, W.C.2, quoting 4/104A (July 22).

Research Assistants (2) (with a good honours degree in physics and adequate research experience) in the Department of Physics, to undertake research on the preparation and properties of infra-red emitting phosphors, under the direction of the Head of the Department—The Registrar, The University, Hull (July 31).

Assistant Master (with a good honours degree) to teach Physics up to advanced and scholarship levels—The Headmaster, Nottingham High School, Nottingham.

Bacteriologist to assist with the control and investigation of sterile procedures in the Blood Products Laboratory—The Secretary, Lister Institute, Elstree, Herts.

Director (with at least a second-class honours degree, or equivalent, with extensive experience in any branch of freshwater biology, biochemistry or soils chemistry) of the Fish Culture Research and Training Institute, Malacca, to be responsible for the overall administration of the Institute and for the direction of the research programme including research into the fundamental processes underlying pond culture, genetics, physiology of breeding, etc.—Director of Recruitment, Colonial Office, London, S.W.1, quoting Ref. BCD.65/23/02.

Experimental Physicist (preferably with a degree in physics or mathematics and previous laboratory experience, or at least G.C.E. advanced level in science subjects, or equivalent), to take charge of the construction and operation of a neutron velocity selector for the new research reactor DIDO—Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 546/34.

LECTURER IN AERODYNAMICS—Head of the Aeronautics Department, Imperial College, London, S.W.7.

LECTURER IN INORGANIC CHEMISTRY and a LECTURER IN ORGANIC CHEMISTRY, at the Wolverhampton and Staffordshire Technical College—Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

LECTURER (with a good honours degree and able to prepare students for the B Sc. (Special, London, External) and A.R.I.C. examinations) IN ORGANIC CHEMISTRY—Clerk to the Governors, Luton and South Bedfordshire College of Further Education, 63–69 Guildford Street, Luton, Beds.

LECTURER (with a good honours degree and teaching experience) IN EDUCATION—The Principal, The College, Chester.

LECTURER (with a special interest in organic chemistry, and with research experience) IN CHEMISTRY (Ref. S.1); and an ASSISTANT (Grade B) (preferably with teaching experience) IN CHEMISTRY (Ref. S.2)—The Principal, Hatfield Technical College, Roe Green, Hatfield, Herts.

LECTURER (with good academic qualifications and experience in the food industry) IN FOOD SCIENCE—The Secretary, Royal Technical College, Glasgow.

MASTER (with a good honours degree) TO TEACH MATHEMATICS to advanced and scholarship levels, with some subsidiary physics—The Headmaster, Queen Elizabeth's Grammar School, Blackburn.

METALLURGIST OR PHYSICIST (with an honours degree in metallurgy, physics or related subject) for research in problems of liquid metals, intermetallic compounds, and alloy transformation phenomena as they are related to behaviour in nuclear reactors—Prof. J. G. Ball, Department of Metallurgy, Imperial College, London, S.W.7.

PHYSICIST OR ENGINEER (with a first- or second-class honours degree or equivalent in physics or engineering, and considerable research and development experience in the instrument electronics field or related systems of engineering in the aircraft industry), at the Royal Aircraft Establishment, Farnborough, Hants, to lead a small team on the assessment of guided weapons systems, with particular concern for radar and guidance aspects—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.176/6A.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree, and preferably research experience) IN THE GENERAL PHYSICS DIVISION, for research on controlled thermonuclear reactions—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 532/34.

SENIOR PHYSICS MASTER—The Headmaster, Ellesmere College, Shropshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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Technical Education. (Cmd. 9703.) Pp. 44. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d* net. [93

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Ministry of Works. Post-War Building Studies. No. 33: Basic Design Temperatures for Space-Heating. By a Study Committee convened by the Councils of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Gas Engineers and the Institution of Heating and Ventilating Engineers. Pp. vi+89 (London: H M Stationery Office, 1955) 3*s*. 6*d*. net. [93

Weed Control Handbook 1956: Recommendations and Information concerning the Use of Chemical Weedkillers. Pp. ix+130. (London: British Weed Control Council, 1956.) 5*s*. [93

International Association of University Professors and Lecturers. *Communication*, No. 24: a General Account of the Eighth University Conference, Vienna, 9th to 14th September, 1954, including the Secretary-General's Report on the work of IAUPL in the period 7th April, 1953 to 8th September, 1954. Pp. 96. (London: International Association of University Professors and Lecturers, 1955.) 3*s*. [93

Royal Institute of Chemistry. Directory of Independent Consultants in Chemistry and Related Subjects. Third edition. Pp. ix+46. (London: Royal Institute of Chemistry, 1955.) [93

National Smoke Abatement Society. Proceedings of the 22nd Annual Conference, Bournemouth, September, 1955. Pp. 132. (London: National Smoke Abatement Society, 1956.) 12*s* 6*d*. [93

Church Prospect. By the Rev George F. Macleod. (Alex. Wood Memorial Lecture, 1956.) Pp. i+22. (London: Fellowship of Reconciliation, 1956.) 1*s*. 6*d*. [93

Curtis's Botanical Magazine Index, with a revision of the names of the plants depicted from the beginning in 1787 to the end in 1947, Volume 1 to Volume 164, to which is appended a brief history of the magazine (and an appendix giving the titles and numbers of the plates from Volume 165 to Volume 170). By F J. Chittenden. Pp. v+282. (London: Royal Horticultural Society, 1956.) 42*s*. [93

Royal Geographical Society: a Record 1931–55. By G. R. Crone. Pp. ii+37+1 plate. (London: Royal Geographical Society and John Murray (Publishers), Ltd., 1955.) 3*s*. [93

Department of Scientific and Industrial Research. Forest Products Research. Special Report No. 11: The Blunting of Wood-Cutting Edges. By H. J. Endersby. Pp iv+15+8 plates. (London: H.M. Stationery Office, 1956.) 2*s*. net. [93

Noble Metal Thermocouples. By H. E. Bennett. Pp. i+3
(London: Johnson, Matthey and Co., Ltd., 1956.) [

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Chemical Manufacturers, 1956.) [

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Fellowships offered in 1956. Pp. 15. (London: Agricultural Resear
Council, 1956.) [

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No 7: The Monotypic Genera of Cichlid Fishes in Lake Victoria.
P. H. Greenwood. Pp. 295–333 10*s*. Vol. 3, No. 8: A Revision
the Hydroid Genus *Perigonimus* M. Sars, 1846 By William J. Re
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Aprasia; Its Taxonomy and Temperature-Correlated Variation.
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Brachyopod Labyrinthodonts. By Prof. David Meredith Sea
Watson. Pp 315–392+plate 39. 20*s*. (London: British Muse
(Natural History), 1956.) [

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United States Department of Agriculture. Leaflet No. 399: Hor
worms on Tobacco: How to Control Them. Pp. 6. Farmers' Bullet
No. 2004: Controlling the Japanese Beetle By Walter E. Flemin
Pp. 13. 15 cents. Farmers' Bulletin No 2086: Growing Pumpki
and Squashes. By Ross C. Thompson, S. P. Doolittle and D.
Caffrey Pp. 30. 15 cents. (Washington, D.C.: Government Printi
Office, 1955 and 1956.) [2

University of Illinois Engineering Experiment Station. Bulle
No. 433: A Design for Non-Sticking Plug and Ring Gages and Locato
By Prof. Lawrence E. Doyle, Bernard R Better and Prof. Bei T
Chao. Pp. 28. (Urbana, Ill.: University of Illinois, 1956.)
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By Lloyd William Stephenson. Pp. iii+53–98+plates 4–7. 75 cen
Professional Paper 247-E: Owl Creek (Upper Cretaceous) Foss
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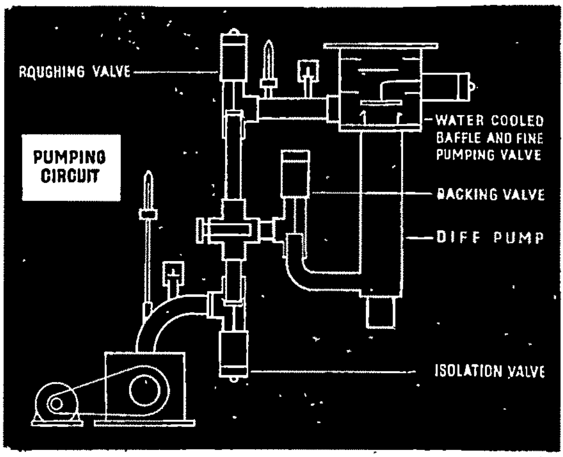

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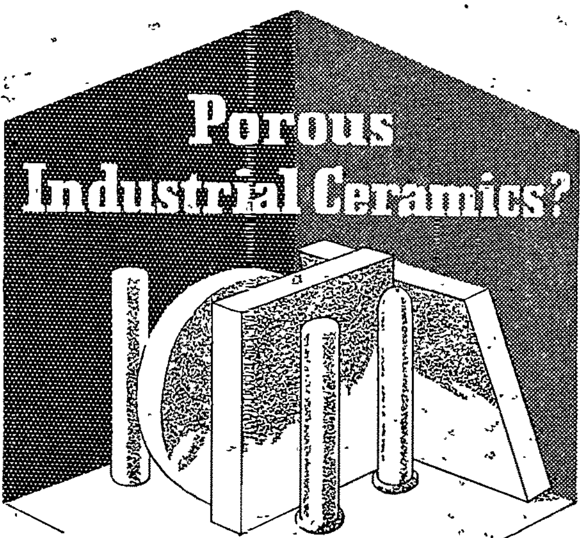
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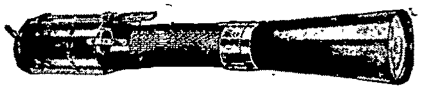

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HUMAN MOTIVES IN FUNDAMENTAL RESEARCH

DR. VANNEVAR BUSH'S reports as president of the Carnegie Institution of Washington, besides oting outstanding features of the current research vork of the Institution, have frequently discussed mportant general questions of wide interest such as he relation of the Institution to the Government or he place of the independent research institution. On etiring from the presidency of the Institution at the nd of last December, Dr. Bush devoted the whole f his final report* to considering the real motives in undamental research, asking why we pursue such esearch at all and what it is that unites us in common ffort and urges us on. When we have a group of trong and able men, capable of desiring acclaim and eward from the world in other ways, yet who choose o pursue the path of science, though the individual teps of their advance are often appreciated only by heir immediate associates and the pecuniary rewards r their effort are small, we must look deep for the rue motives.

Emphasizing first that he is concerned with ındamental science—with seeking out the facts of ature and their inter-relations without attempting o apply them immediately to the needs and desires f man for physical comfort, power to control the rces of Nature or freedom from disease—Dr. Bush oints out that the very fact that the pursuit of ndamental science offers side-paths for those who ould follow them is one true and worthy motive beind all that we do. There may be a long interval etween such fundamental work and its practical pplications; but we are conscious, he said, of the roblems with which humanity will struggle long fter present fundamental researches have been erged in the general advance of science, and we are nfident that later generations will complete the ork. Dr. Bush reminds us that we are only just ow learning how the simple organisms, the interplay f which with our organic structure affects our whole ves, operate, and that there is a long path towards complete grasp of their biochemistry and structural ganization, offering many fascinating opportunities r research. Beyond the study of such organic echanisms lies the problem of man's mind itself, s chemical, electrical and structural elements, underanding of which is an essential preliminary to any ue knowledge of ourselves, our possibilities and our mitations.

Dr. Bush goes on to indicate more precisely the ide horizons of fundamental science. Looking at an's present material progress, we can see that he is eaded for catastrophe unless he mends his ways and kes thought for the morrow. It is not simply a atter of the use to which man may put atomic sion or fusion, or a trained virus, and that these omentous questions must be resolved by other patterns of thought than those of long-range fundamental science; or again, that the scientist's deep interest in them is primarily as a citizen and member of the community. His background in science may enable the scientist to counsel wisely with those who apply science or other disciplines; but even apart from wars, Dr. Bush thinks man is still heading for trouble. The world's population is increasing at a rate which renders distress, famine and disintegration inevitable unless we learn to hold our members in check. The resources of the world are being used up at an appalling rate, and new methods of extending the food supply can only postpone the crisis; perhaps they will allow time for communication and education to produce the general understanding essential to a sound solution. While demands for energy can probably be met for a long time to come, the situation is very different with mineral resources, and it will be necessary to place geology, for example, on a firmer scientific basis if we are to continue to find and exploit natural deposits.

It is not suggested by Dr. Bush that in all this we find the sole, or even an effective, motive for fundamental science. Much research, he comments, is done as a matter of habit—a remark which has implications that should be continually examined if effort in research is not to be wasted. Dr. Bush goes so far as to assert that many a research programme is conducted in which the investigator has no clear idea just what he is trying to find out, or what it would mean if he found it, and that men may work for years without stopping to examine critically the relevance of their effort. That is a danger in research against which some precaution should be taken, for to do so is not to banish curiosity as a motive, or even emulation or competition. Indeed, it may well give both a more effective place in scientific motivation by bringing it to some extent under control.

For all this, in Dr. Bush's view, the prime motivation in scientific effort extends far beyond casual and monetary reasons, and even beyond the thought that what we do may, in its small way, benefit the human race in its struggle to control itself and its environment. The scientist, he argues, lives by faith quite as much as the man of deep religious convictions, and he has no doubt that nearly all scientists believe in free will. Although they have built a magnificent structure of materialism, to admit free will into the rigid systems postulated by materialism is to abandon materialism altogether, and in building a theoretical universe based on a system of experiment, observation and logic, the scientist assumes freedom of choice as an act of faith.

No one, Dr. Bush believes, looks on the current scene with more freedom of spirit than the scientists, whose vision is both broad and deep but who at all times must understand the limitations of their methods if they would avoid fallacy and the false application of those methods where they inherently do not apply. Thus, behind all other motives there is, he suggests, a deeper and more powerful one, which for the present can only be expressed in the faith that man can learn to know and to understand, and that it is good to exercise that power and to strive for the extension of our wisdom. This is the primary faith that carries men of science forward in their great adventure, and no other faith is essential. This faith and this sense of participation, acknowledged by scientists only in their rare thoughtful moments, leads them forward, just as it is faith of some kind that has caused men of all callings in all times to strive and to hope.

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* Report of the President of the Carnegie Institution of Washington the Year ending June 30, 1955. Pp. 9. (Washington, D.C.: Carnegie stitution of Washington, 1955.)

Dr. Bush's interpretation of scientific motivation will be read with respect and with deep interest even by those scientists who do not entirely agree with his interpretation ; and not the least for the moving passage in which he takes leave of his colleagues and, in wishing them the luck which is an essential ingredient of successful scientific careers—C. V. Boys once put it as high as thirty per cent—displays the warm interest, expectation and confidence with which he will continue to watch their work. There, indeed, he hints at a motive that explorers like Scott and Shackleton and Younghusband have notably found among men of science—the spirit of adventure —and Younghusband has put this into words similar to those of Bush. "The human race will never be satisfied until it has completed its knowledge of its surroundings. We want to know everything about this planet, even its furtherest confines, because we not only have to adapt ourselves to our surroundings but in the true spirit of man we have to master them. And we cannot master them until we have full knowledge of them."

This element of adventure alone suffices to impart one of luck or chance, and in considering the organization of fundamental research it is well, therefore, to take account not merely of the factors or conditions which strengthen the motives urging the scientist on his quest but equally those which reduce chance or luck to a minimum by providing the most favourable atmosphere for creative, original work. That is in effect to seek to provide the conditions in which the scientist can most effectively pursue his search for truth. While Dr. Bush does not come very close to Sir Edward Appleton's plea to the British Association for the intrinsic value of science as one of the great human experiences and in that sense rank it among the motives of the scientist, we are brought to much the same conclusion. His address, moreover, has some points in common with discussion of design and chance in discovery and invention by Prof. René Taton, of Paris, in the December 1955 issue of *Impact*. The conditions which stimulate discovery and invention may well be those which promote the free flow of ideas and facilitate, if not new ideas, at least the recognition or reception of new ideas.

Prof. Taton in this article is not concerned with motives, except in so far as they affect the organization of creative scientific and technological work so as to provide the most effective stimulus for the harmonious and fruitful development of science; to this he suggests we ought to be giving very careful consideration. It is obvious that anything we can do to foster or strengthen the motives of scientific research, either fundamental or applied, and still more generally the scientific spirit and outlook, should be an important factor in increasing the numbers of scientists and technologists so widely needed. It might well offer some contribution towards relieving the shortage in Britain of science teachers, which is one essential factor in any long-term expansion seeking to draw in more of the early school-leavers and to direct both boys and girls from the arts side to science.

Prof. Taton's penetrating paper is the more valuable in that, while he gives due weight to the role of chance and accident and even to error, he never over-estimates that part, and he examines even more carefully those antecedents of discovery that are often neglected. Here, and in examining the various types of failure and the influence of philosophical, political, social and economic factors in the environment of the scientist on discovery and invention, Prof. Taton is most stimulating, and his observations stress the conditions which we should seek to ensure for creative work. He suggests, fo example, that it would be worth while for psychologists to study more closely the way in which excessive concentration on a single line of research a preoccupation with ends which obscures possible avenues of reasoning, or the almost unconsciou adoption of a worthless hypothesis or of an unduly sceptical philosophical point of view, have contributed to the failures of even great scientists.

Prof. Taton thus emphasizes a line of inquiry akin to one indicated by Dr. Bush ; but his comments on the obstacles encountered from scientific o philosophical prejudices, and the difficult and unequa struggle in which the authors of many really fruitfu discoveries have had to engage before they could wi recognition, have implications in the social and economic conditions of to-day which need mor attention than they have yet received. At this poin at least, Prof. Taton comes near to discussing motives and, although he does not accept the Marxist theory in suggesting that the choice of a line of researc may be influenced by economic and social factors at least to some extent, he is admitting that motive play a part in selection. Moreover, here he bring out more specifically than Dr. Bush the influence o team-work in research, both fundamental and applied

Only by team-work can much essential research b undertaken or brought to completion to-day. Th task here is to ensure that the conditions in whic creative work is most fruitful and in which scientif motives have full play are preserved and encouraged and that the conditions on which Prof. Taton comments are avoided. Prof. Taton has wisely emphasize some of the dangers which must be minimized i order that the process of discovery and inventio and the flow of new ideas may not be hindered. D Bush, in his valedictory address, however, seems go even deeper, and to reveal the primary faith a motive which it is for the scientist himself to cheris whatever the respect the community may care show for the motives of scientific research.

EXTENSION OF MICROCHEMISTRY

Handbuch der Mikrochemischen Methoden

Herausgegeben von Prof. Friedrich Hecht und Prof. Michael K. Zacherl. Band 2 : Verwendung der Radioaktivitat in der Mikrochemie. Radiochemische Methoden der Mikrochemie. Von Dr. E. Broda und Dr. T. Schönfeld. Messung Radioaktiver Strahlen in der Mikrochemie. Von Dr. T. Bernert, Dr. B. Karlik und Dr. K. Lintner. Photographische Methoden in der Radiochemie. Von Dr. H. Lauda. Pp. iv+423. (Wien: Springer–Verlag, 1955.) 486 chillings ; £6 18*s*. ; 81 D. marks ; 83 Swiss francs ; 9.30 dollars.

SINCE the early days of radioactive studies it was obvious that the new methods allowed physicists o extend their investigation to invisibly small quantities of matter ; the scintillation screen, or the Wilson chamber, made the effects of one single atom isible. A little later it was shown that various ranches of chemistry also could greatly benefit from he sensitivity of radioactive measurements, especially fter the knowledge of the practical inseparability of sotopes could be made use of. A further decisive npulse was given by the artificial production of adioactive isotopes of nearly every chemical element. It is no exaggeration to say that by these advances n entirely new chapter of microchemistry has been pened up, and it is only fitting that the editors of he "Handbuch der Mikrochemie", now in course of ublication, have decided to devote to it the large olume here under review.

The main part of the book is filled by an exhaustive urvey of all the different ways in which radioactive methods have been applied to microchemical studies. ecause of the great range of subjects, the relevant apers are to be found in a great variety of contexts nd in very different journals ; but the two authors ave wielded the scattered material into a clear gical pattern using as the basis of their arrangement ot the nature of the scientific problems investigated, ut—as it should be in a treatise on chemical methods —the techniques applied. Several tests have coninced the reviewer that in this framework every iginal paper in which radioactivity was used for a icrochemical problem has found its proper place, nd that the authors deserve no less praise for the are with which they have collected the material than r their well-thought-out presentation. Considering he number of papers summarized nobody will expect find in their survey many experimental details ; e reader ought to be satisfied to have been guided all relevant original publications. Besides the ble of contents and the index of names and subjects here are, after each of the eleven chapters, surveys the literature discussed which will be a further lp for quick orientation in the vast material.

Although primarily meant as a guide for readers who are looking for the best radiochemical methods solve a special problem, there seems to the reviewer doubt that thanks to the strict logical presentation nd pleasant style of writing this treatise may also used by students who want to acquaint themselves a general way with this extension of microemical methods ; they will find it very helpful that e discussion of the particular methods ('isotopic lution', 'activation' etc.) is preceded by two introctory chapters on "Radioactivity as a Basis of crochemical Methods" and "The Chemistry of dioactive Matter". The authors have achieved the difficult task of writing a comprehensive 'Handbuch' which may also serve as a text-book.

The two much shorter articles which follow the main part of this volume fully maintain the high scientific standard ; they are a very useful supplement on the technical side, as they explain the various methods for the investigation of radioactive rays. In addition to such widely known apparatus as the Geiger–Muller counter, several new devices are described which have probably not yet found their way into many chemical laboratories and of which the scintillation counter is at present the most important. The editors are to be thanked for having enlisted the help of competent physicists in spreading a knowledge, through the medium of this book, of these new pieces of apparatus among chemists. The last chapter, on the employment of photographic methods in radiochemistry, serves the same very useful purpose.

F. A. PANETH

NUMERICAL ANALYSIS

Numerical Analysis

With Emphasis on the Application of Numerical Techniques to Problems of Infinitesimal Calculus in Single Variable. By Prof. Zdeněk Kopal. Pp. xiv+556. (London: Chapman and Hall, Ltd., 1955.) 63*s*. net.

THIS is a stimulating and timely book. Broadly speaking, it covers most of that part of the field of numerical analysis which depends on approximation by polynomials to a function of a single variable—there is no attempt to deal with matrix manipulations, the solution of equations, linear, algebraic or transcendental, or with functions of two or more variables. The book has defects, some of which will be mentioned later, but first it seems desirable to stress the particular merits of the book.

Prof. Z. Kopal goes to considerable lengths to place before the reader all the available methods of attack known to him, without presuming to dictate which formula should be preferred ; this means that the full range of methods is exhibited to a user with unusual requirements, and he can make his own choice. In these days, with the rapid development of automatic computers of various designs, this is an extremely valuable feature. Others who will appreciate this are teachers and instructors of budding numerical analysts.

The attention to the literature of the subject is impressive ; the author has investigated with obvious care a very wide range of references and has incorporated the results of his searches with considerable skill. Then again, the author has noticed a number of outstanding gaps in the development of the subject, and has made notable efforts to fill these or to initiate research on the problems raised. The result is that even experienced numerical analysts will find many things of interest, whether entirely new or offering a new and illuminating approach. For example, I found the description and use of the Hermite interpolation formula, which uses values of function and derivative at *n* points (see pp. 31, 354), and the discussion on the optimum interval for use in the evaluation of derivatives (see p. 104) to be of considerable value. The sections (IV–J, K) on the solution of differential equations by successive extrapolation give another example of the author's own researches, where he is at pains to find recurrence relations, approximating to given differential equations, which shall not introduce—as may so easily happen—accidental complementary solutions that eventually swamp the wanted solution.

Such instances could be multiplied; but it is also of interest to mention some points where I disagree with the author. Often the disagreement is the result of a discussion stimulated by the book, and this is one of its major merits—that it provokes discussion.

On p. 19 the Weierstrass approximation theorem is quoted as a blanket protecting all the methods outlined, with insignificant exceptions. It seems, however, that, when dealing with arguments x at equal intervals, functions such as $(1 + x^2)^{-1}$ or $\exp(-x^2)$ can scarcely be regarded as "insignificant exceptions", and for a fuller understanding of such cases, the cardinal function theory of E. T. Whittaker is needed. On p. 147, it is quite easy to introduce an extra $n!$ in the denominator on the right of (IV–F–13); this can make the difference between a finite and unlimited range of applicability. The preceding two misapprehensions are shared by earlier well-known works. On p. 243, since the equation (V—B—1) is homogeneous, the choice of boundary conditions (V—B—5) as $y(x_0) = y(x_1) = 0$ "for simplicity" is remarkable—it converts an ordinary problem of finding a solution to pass through two points into an eigen-value problem.

The numerical example on pp. 476 *et seq.*, dealing with the numerical solution of integro-differential equations, is unsatisfactory in a number of respects. The table on p. 479 has all values in the last column multiplied by 2; the values in the third column, taken from Chandrasekhar's paper, apply to 4-term Gaussian quadrature, and not to 2-term as stated (non-linearity of the table is obvious on inspection); and in any event comparison of "2-point Gauss" results with "Trapezoidal rule" results is inappropriate—the Trapezoidal rule uses only one point on the average to each interval. Again the table ignores $\mu < 0$, where disagreement is poor, and the discontinuity at $\mu = 0$. Nevertheless, the point to be made is a valid one, provided that there is some way whereby the high accuracy attained for values at the Gauss points can be used adequately in a final computational stage—ordinary interpolation with n points will not do, for it cannot adequately use $(2n-1)$th degree accuracy; the author is not unaware of this.

A further comment concerns Appendix 2 on "Optimum Interpolation". This is a most valuable account which includes a certain amount of current practice not previously available in published form. This appendix has given rise to considerable discussion, from which it has emerged that the statement on p. 61 concerning the modified Chebyshev–Everett formula is not, in fact, unassailable. The assertion by L. Fox, that the factor $-0{\cdot}184$ (or $-0{\cdot}18393$) is usually best, even for Everett-type interpolation, is correct. This question, a rather subtle one, cannot, however, be fully discussed in a review. Another misstatement concerns the so-called—and well-named—"Royal Road" formula. This is on p. 138 after (IV—D—13), where it is stated that "the desired second difference of $y(x)$ at $x = a_{-1}$ turns out to be expressible in the form of a rapidly converging sequence of backward differences of $y^{\text{II}}(x)$ of even orders". In fact, "even differences only" is associated exclusively with central differences, and such a central difference form provides a basis for the well-known methods studied by Gauss, Jackson, Numerov and others. Th backward difference form involves differences of al orders after the fourth, and seems to be new—an what a good idea!

These few points will serve to indicate the man merits of the book, and show that even the errors ar able to provoke healthy discussion.

In my view, the place for this valuable book is o the shelves of general libraries and of the smalle ones attached to computing establishments of al kinds, including those having automatic computers Those who teach or study numerical analysis especially, cannot afford to be without this book—i is a book for teachers and the rather specialist learner The reader will not find many numerical illustrations for these he should use Hartree's "Numerical Analysis"; but this book will not show the wide choice o methods exhibited by Prof. Kopal. The book i very readable, though prolix in parts where it stresse the obvious (it was based originally on lecture notes and this is detectable); in other parts very clos attention is needed. It is a book well worth consulting—and possessing.

J. C. P. MILLER

IMAGE AND ORIGINAL

Operational Calculus based on the Two-Sided Laplace Integral

By Dr. Balth van der Pol and Dr. H. Bremmer
Second Edition. Pp. xiii+415. (Cambridge: A the University Press, 1955.) 60*s.* net.

LET $h(t)$ be a given function defined on the whol interval $-\infty < t < \infty$. The linear functiona

$$L[h(t)] = f(p) = \int_{-\infty}^{\infty} pe^{-pt}h(t)dt \qquad (1)$$

is the *two-sided* Laplace transform or 'image' of th 'original' $h(t)$, as contrasted with the *one-sided* transform got by writing zero instead of $-\infty$ as the lowe limit of the integral. In terms of Heaviside's uni function $U(t)$ (defined to be zero when t is negativ and unity when t is positive) the one-sided is obtaine from the two-sided transform by putting $U(t)h(t)$ i place of $h(t)$ in (1). The domain of p is a strip o the complex plane bounded by two abscissæ, eithe or both of which may be infinite. The main technique of the operational calculus consists of replacin operations on the original by operations on th image. If, for example, this process leads to a expression for the image $f(p)$, the original $h(t)$ i inferred by inverting the integral in (1).

The subject of the book is the two-sided transfor for which the authors claim the following advantages (1) the class of functions suited to an operationa treatment becomes much larger; (2) the transformation rules are considerably simplified; (3) th entire treatment becomes more rigorous than th usual presentation of the one-sided integral in technical books. As to (3), much has been achieved b introducing concepts such as functions of bounde variation, upper and lower limits, and so on, usuall unfamiliar to the engineer and which here recei careful explanation and illustration. The omissio of proofs of some of the basic theorems has bee compensated for by giving references to other boo where they may be found. By such devices exposition a high standard of rigour has been pr served while still allowing room for an astonishingly large amount of illustrative work. Indeed, more than half the text is devoted to applications to differential equations, ordinary and partial, to electric circuit theory, difference equations, integral equations and other topics.

The chapter headings are as follows: (1) general introduction; (2) the Fourier integral as basis of the operational calculus; (3) elementary operational images; (4) elementary rules; (5) the delta or impulse function; (6) questions concerning the convergence of the definition integral; (7) asymptotic relations and operational transposition of series; (8) linear differential equations with constant coefficients; (9) simultaneous linear differential equations with constant coefficients; electric-circuit theory; (10) linear differential equations with variable coefficients; (11) operational rules of more complicated character; (12) step functions and other discontinuous functions; (13) difference equations; (14) integral equations; (15) partial differential equations in the operational calculus of one variable; (16) simultaneous operational calculus; (17) 'grammar'; (18) 'dictionary'.

The first edition was published in 1950. Into the second edition the following new paragraphs have been introduced: rules for the treatment of correlation functions; a note on the theory of distributions; a note on the Wiener–Hopf technique.

The book is written with exceptional lucidity and can be recommended alike to the mathematician and the engineer. L. M. Milne-Thomson

INTERPRETER OF SCIENCE

Science makes Sense

By Ritchie Calder. Pp. 192. (London: George Allen and Unwin, Ltd., 1955.) 12*s.* 6*d.* net.

Mr. Ritchie Calder's latest book can be commended to the participants in the current discussion on scientific language. It is more than a competent and readable piece of journalism; it is a demonstration that the nature and implications of scientific advance can be explained in non-technical language which the ordinary person can readily comprehend, and that this can be done by one who does not himself claim to be a scientist. Moreover, the conditions that must be observed for this to be done successfully are made clear: the scientist must take the trouble to explain to the non-scientist what he is doing and in terms not too specialized; the expositor, for his part, must be willing to listen and must have sufficient background to ask the significant questions. Where this is not done, the attempt breaks down, as may perhaps be seen in the present volume when Mr. Calder is tempted to quote chemical nomenclature. His inaccuracies will irritate the chemist, but they are not serious. They do, however, display a failure on the part of the chemist to convey accurately to Mr. Calder the significance of his jargon and on Mr. Calder's part a failure to consult which is tantamount to neglect of the maxim: "Always verify your references".

Such minor blemishes apart, the book is a real contribution to the popular understanding not only of the great scientific advances of the past half-century but also of the way in which they were achieved. It is an admirable exposition of the nature of scientific thought and method. Moreover, while Mr. Calder's style is lively and picturesque, he holds his imagination in check: in gaining his reader's attention he does not lose a sense of proportion or perspective. The balance and emphasis are almost invariably correct, in spite of the wide field over which he ranges—from the Lunar Society of the mid-eighteenth century to the impact of science and technology on industry and society and the home life of to-day. Five chapters on great discoveries show how they were made, and do so in a way that refutes decisively the idea of magic with which popular thought often clothes the scientist and science.

For that alone the book is worth while. There are minor blemishes: here and there a quantity is false, a wrong note is struck, a word or a phase jars, or (more rarely) a proposition or interpretation could be challenged; these things are not the result of Mr. Calder's flair for the picturesque or of any failure in interpretation, though they may sometimes be due to a sense of values on which opinions may differ. The book should interest the scientist, through the competence of its technique of exposition and scientific and technical accuracy, as much as the story it tells will fascinate the non-scientist. R. Brightman

HISTORY OF ASTRONOMICAL INSTRUMENTS

The History of the Telescope

By Dr. Henry C. King. Pp. xvi+456. (London: Charles Griffin and Company, Ltd.; Cambridge, Mass.: U.S.A. Sky Publishing Corporation, 1955.) 50*s.*

The 456 pages of this excellent book are evidently the result of a truly tremendous amount of research by Dr. H. C. King. The fact that more than sixteen hundred page references are given in nearly as many individual publications further shows the thoroughness and completeness of the factual data.

He starts, in a most satisfying manner, with the earliest device known for the positional observation of the Sun—the sundial—and from there carefully examines each facet of each stage of the optical and instrumental development which culminated in the large present-day telescopes. His style throughout is easy and, in spite of having to be concise, never gives the impression of jerkiness. The book is quite definitely a history of telescopes rather than a history of astronomy, although the two are obviously closely related. As the author points out in the preface, ". . . instrumental improvements receive more attention than the discoveries made through them. The description of Sir William Herschel's 20-foot reflector, for example, occupies more space than his theory of stellar distribution, and far greater importance is attached to the introduction of silvering processes than to the discovery of, say, the planet Neptune".

It would be supremely easy in a book of this sort to dwell at undue length on certain aspects of the subject about which the author is particularly interested or is particularly knowledgeable. Alternatively, it would be simple to become tainted by insularity and make it a book of British achievements in telescopic design, with one or two chapters to cover the efforts of other countries. The author has done none of these things. His review of the subject appears to be very well balanced, the efforts of the scientists and instrument makers of the United States, Britain and the different Continental countries each receiving their due amount of space. It is ironical, but no fault of Dr. King, that the largest two working telescopes in Britain at the time of his going to press were so lacking in novel features that they have correctly received no mention except: "Other large Grubb–Parsons instruments of the thirties are the 36-inch reflectors of Edinburgh and Greenwich . . ."

There are very few points to which the reader can take exception. Perhaps the most obvious of these is the incompleteness of the index. A book of this nature, packed with facts which frequently cannot be placed in chronological order, needs not only a complete index but also one with every possible cross-reference. In particular, it seems that references to instruments in British observatories are least complete. A second point is the omission of a summary of the important dates and events, together with a fairly complete list of observatories with their instruments. Otherwise, I have only noticed trivial errors in the text.

Perhaps naturally, there is little scope for humour in such a book. Consequently, the following remark produced a smile when in another context it might have been overlooked: "After Colby's survey of Scotland, the instrument [a portable zenith sector] was placed for safety in the Tower of London, where it was destroyed in the fire of 1841".

It is difficult to decide whether a history book should stop with the chronicling of all known relevant facts. Historical facts are of the greatest importance; but they become of even greater interest if they are accompanied by a critical examination of events. Why, for example, do certain developments take place at a certain time while other seemingly obvious developments have to wait for many years? Possibly Dr. King feels he has done his part by assembling the facts, and that the deductions are better made by the reader. Of this I am not so certain.

Dr. King deserves the very highest praise for bringing so much work to a stage where one has to look hard indeed to find any adverse comment. The book is well printed on good paper and has just the right number and choice of illustrations and diagrams. The price is not excessive by modern standards, and there is every reason to believe that the future will find this book on the library shelves of all concerned with astronomy, optics or scientific instruments. H. E. Butler

ANALYSIS OF WEATHER CHARTS

Principles of Meteorological Analysis

By Walter J. Saucier. Pp. xvi+438. (Chicago: University of Chicago Press; London: Cambridge University Press, 1955.) 75*s*. net.

Not long ago there were two schools of thought in meteorology: one school held that weather has its origin in the higher atmosphere and is only a by-product of more important events there; the other maintained that the irregular distributions of land and sea, mountain and plain, and heat and cold on the Earth's surface produce our weather systems and that these react on the atmosphere above with an intensity that diminishes progressively with height. Meteorologists now know that changes occur at the top of the troposphere as rapid, as frequent and as violent as those near the surface and are related to them: though the bulk of differential heating and the friction in the atmospheric engine occur at the bottom, the main cogs and flywheels are higher up But no one yet knows how the parts fit together.

Strictly, as a man of science, the meteorologist should eschew attempts to forecast the behaviour of the atmosphere until he has a coherent and properly tested theory of its mechanism: but the optimism of his predecessors, based on inadequate knowledge of the real intricacies of their task, and perhaps also the occasional successes of the weather-lore man, have forced his hand: the meteorologist has had to work empirically, using his hypotheses for forecasting as he goes along. Circumstances have now given him his chance to put things right. To cope with the flood of information about conditions up to great heights that is needed several times a day for aviation, he has sought the help of high-speed computing machines, and to use them he has had to devise models in mathematical terms for describing the simpler features of the atmosphere. These models have already been used with promising results for forecasting the changes of the next day or two; but until the potentialities of the newer processes are thoroughly explored, the forecaster will still need to analyse his own charts. Now this in itself is a complex task. It demands a long training in constructing a three-dimensional picture of the atmosphere from separate charts of horizontal and vertical sections, and also in accounting for the changes from one set of observations to the next.

But although analysis is an essential stage in the preparation of any forecast, the writing of the first text devoted wholly to the subject has been left to Prof. W. J. Saucier, associate professor at the Agricultural and Mechanical College of Texas, and formerly instructor in meteorology in the University of Chicago. In every respect Prof. Saucier has produced an excellent book—clear and comprehensive, with enough diagrams and physical explanations to make the reading easy, and with the right amount of mathematics for rigorous stiffening. The first third is concerned with the necessary tools and techniques —the atmospheric variables and their physical relationships, stability, the characteristics of the various kinds of chart and diagram, and the theory and practice of scalar analysis. In the main business of the text, the author discusses analysis of surface charts and isobaric and isentropic charts for higher levels, vertical cross-sections of the atmosphere and the kinematics of airflow; the chapters on each of these sections should make rewarding reading for the experienced forecaster as well as for the trainee, and will take him over a wide range of up-to-date thought on the functioning of the atmosphere from the forecaster's point of view. As befits their nature and their place in a book of this scope, large-scale and local features and charts for tropical regions are treated more sketchily (forty pages in all) in the last three chapters.

The text is well documented both by footnotes on each double-columned page for particular references, and at the end of each chapter for more general reading. Throughout the work the author has succeeded in combining a sound treatment of the physical processes with his account of the empirical principles of analysis, and he has striven to treat the atmosphere as a single system the parts of which interlock through great depths and over wide areas even though the mechanism is not yet fully understood. J. M. Stagg

Atlas du Ciel

Par Vincent de Callatay. Pp. 151+11 photographies. (Bruxelles: Les Éditions de Visscher, 1955.) 450 Belg. fr.

THIS is a star atlas for amateurs. The author certainly succeeds in catching the eye by a series of maps of considerable beauty in which the stars appear white and the sky black. The maps are not obscured by printing further information on to them; instead, the constellation names and boundaries, star names, co-ordinates and further information are added by means of subsidiary maps and tables.

There are nine maps depicting a full hemisphere from various aspects, and in these there is no differentiation of the magnitudes of the stars shown. Then follows the main series of twenty-seven rectangular maps each covering a region of about 70° × 50°. For these the magnitudes (down to the fifth) are differentiated, but not very clearly. Those maps referring to the northern and equatorial regions of the sky have north at top, while the southern maps have south at top. Running through the book is a useful description (in French) of the various types of object in the sky and of other astronomical matters, but this text matter is not particularly connected with its nearby map. At the end there are twelve fine photographs chosen from the Mount Wilson–Palomar list of celestial objects.

The arrangement is not a very convenient one for those who wish to use the book as a working star atlas. It is somewhat difficult to locate the appropriate map, and then it is necessary to look elsewhere (sometimes over the page) to interpret it. Some minor inconsistencies and inaccuracies can be detected.

C. W. Allen

Semi-Micro Organic Preparations

By Dr. J. H. Wilkinson. Pp. x+94. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 8*s.* 6*d.* net.

DR. J. H. WILKINSON joins the growing band of chemists who have published their methods of preparing organic compounds on the so-called 'semi-micro' scale. Since one of his recipes requires 50 c.c. of one reagent and 4·5 c.c. of another, 'small-scale', which many favour, would seem to be the better term.

In an opening section of eleven pages, the author describes his techniques, which include not only customary small-scale types but also pieces of apparatus of his own design. In the remaining pages he gives clear instructions for a variety of preparations ranging from the simple esterification to catalytic hydrogenation, and to the more elaborate exercise requiring the use of a reagent such as aluminium *iso*propoxide. He blends with his instructions valuable comments on the reaction in question and directs attention to significant points of theory.

The experiments do not run in a sequence and do not cover any particular syllabus, the intention being to show what can be done on the small scale. As with other enthusiasts, Dr. Wilkinson occasionally overworks an innovation. Thus he uses a special apparatus for the preparation of tribromaniline, when surely a drop of each reagent brought together on a watch-glass would suffice. Nevertheless, this is a helpful book for those desirous of becoming acquainted with these economical and time-saving methods.

G. Fowles

The Science Masters' Book

Series 3, Part 2: Chemistry. Arranged and edited by G. Fowles, with the assistance of E. H. Coulson and Charles Holt. (Experiments selected from Nos. 68–128 of *The School Science Review.*) Pp. xi+286. (London: John Murray (Publishers), Ltd., 1955. Published for The Science Masters' Association.) 17*s.* 6*d.* net.

THIS book contains selected experiments, apparatus and teaching devices from the *School Science Review* of the past eighteen years, divided into six parts which vary by design from the very elementary to the more advanced work of a sixth form. Throughout the book the lesson of what improvisation has meant to the schoolmaster is plain to see, and, if for this reason only, the book should be stimulating for teachers of any experience.

Of course, the selection is bound to meet with criticism; but it is a little difficult to understand why in some cases more pruning was not carried out, so leaving space for other experiments—three ways of showing the action of steam on magnesium are given, when the last and simplest would have sufficed. In all cases the essential details are given, and the diagrams are very clear; but here again some of the latter might well have been omitted without loss of clarity. As more than a hundred authors have contributed to this book, it is only to be expected that the standard of clear and concise English has not always been maintained; but the use of the word 'treat', the first person, and some asides are to be deplored.

A new departure is the introduction of theoretical comments and a list of references, and this is most pleasing and helpful. The later sections are very well done, particularly those on electrochemistry and small-scale work. The book as a whole should be a welcome addition to any science teacher's bookshelf.

J. C. Stredder

University Physics

By Francis Weston Sears and Mark W. Zemansky. Second edition, with Supplementary Problems. Pp. viii+1031. (Cambridge, Mass.: Addison-Wesley Publishing Company, Inc., 1955.) 10 dollars.

THIS book covers the whole of physics up to approximately ordinary-degree standard. It is lavishly illustrated with well-thought-out diagrams, 'multiflash' photographs of moving bodies in dealing with mechanics and sound, and one two-colour diagram. It should be very useful to the students to whom it is addressed. It is doubtful, however, whether it would fit in with the British university system; it is too elementary as an introduction for students who have passed Advanced Level physics at school and, in spite of its size (and weight), it does not include all that is usually dealt with in an ordinary-degree course. Rigidity and the twisting of rods, for example, are not included, nor the relationship between the elastic moduli.

The rationalized M.K.S. system of units is used for dealing with magnetism and electricity. Despite its obvious practical advantages, the reviewer thinks that it is not a suitable system for introducing the subject to elementary students, with its arbitrary introduction of the factor 4π, and the premature disclosure of the role of the velocity of light.

On the whole, however, the book contains many novel and interesting ways of presenting the various branches of physics, and university teachers in Britain may well profit by its study.

MINING RESEARCH ESTABLISHMENT, ISLEWORTH, OF THE NATIONAL COAL BOARD

By Dr. L. C. TYTE, C.B.E.
Director

THE Mining Research Establishment was founded by the National Coal Board in July 1952 within the Scientific Department under the director-general, Dr. Idris Jones. It is the first research unit of any size to be assembled in Britain for the study of mining problems other than those directly related to safety. The purpose of the Establishment is to carry out research aimed at increasing the efficiency of coal production, in which health and safety considerations are implicit, and it works in very close touch with the Board's Central Engineering Establishment at Bretby, which is responsible for engineering development.

The site selected for the Establishment was the former British Lion Film Studios at Isleworth, Middlesex; it covers an area of some six and a half acres and is situated in pleasant surroundings in the London area. Reconstruction of the existing buildings has been in hand over the past four years, and the present scheme will be completed before the end of the year. This will provide extensive modern laboratories, working spaces for large-scale technical experiments and adequate workshop and other ancillary services.

The initial plan was for an Establishment with a staff of 350, of whom 230 would be scientists and scientific technical officers, and having an annual revenue expenditure of about £300,000. Unfortunately, through the national shortage of scientists and technologists, this size has not yet been attained. Although the investigations are primarily of a physical and mechanical engineering nature, the range and complex nature of the work are such that it is usually advantageous to employ teams of staff trained in different disciplines. Thus, in addition to physicists and mechanical engineers, mining and electrical engineers, metallurgists, mathematicians, geologists and chemists are all making valuable contributions to the solution of the urgent national problems of coal mining.

Coal Winning

The most important task assigned to the Establishment is research into methods of improving techniques of coal winning, with prime emphasis on mechanization. This objective provides an interesting example of the constant interplay there must be in this work between laboratory experiments and underground field trials. Machines for winning coal from the seam employ cutting tools ranging from small, rapidly moving picks to large, massive, slowly moving wedges which may be applied continuously or impulsively. The machines are required to operate in a wide variety of conditions depending on the mechanical properties of the coal substance, the thickness, gradient and other geological features of the seam, and the nature of the roof and floor rocks and the forces and constraints which they impose on the seam. It will be appreciated that mechanical breaking down of the coal from the seam is not enough, but that mechanical means of loading the won coal on to the face conveyor system is an essential to increased mechanized productivity and is a feature of modern cutter-loader machines.

One of the lines of attack followed in the laboratory has been the examination of the mechanical properties of coal, including measurement of the elastic constants and a study of coal breakage. This work is complicated by the fact that, as a bedded material, coal behaves differently to forces normal and parallel to the bedding planes. Moreover, it is intersected by planes of weakness normal to the bedding planes which on the larger scale are known as cleats. Coal is also, petrographically, a very mixed substance. Hence, in order to restrict the total number of variables while still retaining a representative cross-section, nine coals have been selected for all experimental work. In spite of these difficulties, progress is being made in building up an understanding of coal breakage.

In parallel with these experiments, measurements are being made on the forces required to pull tools through blocks of coal and the influence of such factors as depth of cut, blade angle, direction of cleat to the direction of cut, the coal used, size of product, etc., on the peak and mean forces required. From earlier experiments of this kind, it was observed that the force required to draw a tool through hard coal was not uniform but rose to peak values at places of high resistance, afterwards dropping to low values when fracture of the coal had occurred at these points. This observation led to the idea of applying percussion to a plough blade, which would only be called into operation when the blade encountered locations of high resistance increasing the tension on the haulage chain. This had the advantage of reducing the peak loads on the haulage chain, thereby improving the stability of the plough, and gave promise of a machine capable of cutting coals too hard for attack by conventional static-bladed ploughs and of working in thin seams, for which there is currently an urgent need. Experimental models of such an 'auto-percussive' plough have been made and used underground, and this work is being prosecuted vigorously.

Coal is, of course, also won by blasting it from the solid, or undercut seams. As a means of improving safety in the use of explosives and of reducing the dust hazard mentioned below, the idea of blasting coal by explosive charges placed in holes already filled with water under pressure has been advanced and is in use experimentally in certain pits. Research is in hand to examine in detail the basic factors entering into this technique.

Strata Control

Almost all mechanized cutter-loaders requir 'prop-free' fronts; that is, coal faces without prop more or less up to the coal face but with the roo supported in this region by cantilever roof bars Increased output calls for increased rates of advanc of mechanized faces, and the trend will be to roo support systems advanced mechanically, and ulti mately automatically, rather than by manual resetting of props. To extend these techniques with safety, much more knowledge is required of the conditions they have to meet. Hence the first objective of the research on strata control has been to devise experimental methods for measuring underground the loads which props are called upon to withstand and the convergence and lateral movement between roof and floor.

The problems so far discussed are only concerned with the immediate protection of men working in the coal face; there is also the important problem of ultimate support of the overlying strata in the waste area which controls surface subsidence and the workability of other adjacent coal seams. Again, there is a wide field for pressure measurements both in packs built in the waste and also in the virgin rock before the coal has been extracted.

These measurements, important though they are, are only the first steps to obtaining an understanding of the stresses and movements in the strata induced by the operations of mining.

Driving of Tunnels

While much of British practice follows the procedure of making roadways in the coal seam, it is an essential feature of opening up new districts and developing new mines that tunnels and drifts should be driven through rock. The speed with which this can be done is of importance since, by this means, new coal resources can be made more quickly available for production and the capital cost of new workings reduced. Much can be done in this direction by studies of organization and management. This, however, is outside the scope of the Establishment, and is being carried out by the National Coal Board's Production Department; research is being devoted to the actual mining processes. Rock drilling is an important aspect of tunnelling and extensive investigations are being made. One of these is concerned with the incidence of 'clogging' with rotary-drill tools by the debris created in making the hole. Conventional twist-drill bits, both with streamlined and non-streamlined bit-rod connexions, Continental-type bits and hollow-type bits deriving from earlier work in the Establishment, have been compared.

The new technique of percussive-rotary drilling has been examined in a preliminary way, and the results indicate such promise that the work will be extended to find the most suitable combination of variables for coal-measure rocks.

In parallel with the experiments on drill design discussed above, a study has been made of the metallurgy of hard tool tips for drills. The relative parts played by abrasive wear and by chipping have been established, and although much work remains to enable the optimum cobalt content and grain size to be established for any particular purpose, it has been possible to draft a provisional specification for tungsten carbide drill-tip materials. Similar questions arise in determining the proper material to use for coal-cutting tools; but this is only one class of the many metallurgical problems arising in the ndustry, which is one of the biggest users of steel n Britain.

Underground Conveyance of Coal

When coal has been won at the coal face, it has then to be transported to the pit shaft. One of the steps in mechanization of pits during the past fifty years has been the introduction of belt conveyors for this purpose, and now more than 90 per cent of the coal raised is moved in some part of its journey to the pit bottom by conveyor. The Creswell Colliery disaster of 1950 directed attention to the fire hazard of rubber conveyor belting, and, following research, P.V.C. (polyvinyl chloride) belting is now obligatory for all new purchases of belting. However, although the introduction of P.V.C. has eliminated the inflammability of belting as an underground hazard, it does not mean that the perfect belt has been produced. Investigations are in hand to determine the optimum design and materials for the belt to have a long life of efficient service. Such factors as flexibility, distribution of load between the various plies and frictional properties of the surface are being examined; but for use in some situations in the pit, it would appear that random damage such as holing or edge tear are the most important factors to be considered.

Environmental Conditions

A consequence of working or disturbing coal and the surrounding rock strata is the emission of methane. This is well known to offer a serious explosion hazard. Research at Isleworth in this field is directed to improved instruments, both portable and fixed, for providing both an alarm or cut-out system when the percentage of methane in the mine air exceeds a prescribed level and also to give a continuous monitor record of the methane content. In addition, instruments are being devised to measure high methane concentrations required in connexion with methane-drainage schemes.

When coal or rock is broken, it is inevitable that some fine dust is formed. If this becomes airborne, the respirable portion (that is, less than 5 microns in size) presents a serious health hazard as the cause of pulmonary diseases. This has long been a matter of serious concern to the National Coal Board, which has devoted a great deal of effort to combat the scourge of pneumoconiosis. The part played by the Establishment is in dust assessment and study of means of suppressing it. The conception of the elutriator to eliminate the collection of dust larger than the size range required has simplified the counting of slides to determine dust concentrations, while the recent development of the 'long-running thermal precipitator', which will record the mean airborne dust concentration over a working shift, will do much to assist the determination of dustiness of working conditions. The problem of suppression of airborne dust has proved far less tractable. Experiments and theoretical considerations have shown that gravity water sprays are valueless for removing airborne dust in the respirable range from mine air, although, of course, this does not mean that water sprays may not be useful for consolidating dust before the coal reaches transfer points and hence reducing the amount of dust made airborne. However, studies in dust suppression by water and wetting-agent solutions have suggested that the particular coal concerned plays an important part in the effectiveness of such measures, and the problem is receiving further close attention. The difficulties of dust suppression underline the fact that the real solution is to minimize the dust produced rather than to attempt to deal with it once it has been made, and hence studies have been made on the production of dust by different methods of coal breakage and by technical methods of working such as drilling.

It is opportune to remark that fine dust coarser than the respirable faction is also a hazard in mining, since a cloud of such coal dust can participate in an explosion initiated by a methane gas explosion, augmenting the force of this latter explosion to a very marked degree. Work on this, as on all explosion problems, is done by the Safety in Mines Research Establishment and not by the Mining Research Establishment. Close touch and interchange of views is maintained between the two Establishments.

Although most British pits are fairly dry, the use of water for dust suppression increases the relative humidity of hot workings. The combined effect of high temperature and high relative humidity has a deleterious effect on the physical and mental working capacity of men. At the moment, this problem arises principally in headings, but future exploitation of deeper coal measures will make the problem more acute. A preliminary study is being made of the sources of heat to underground workings, of which one of the chief is heat flow from the virgin strata surrounding the opening, and of means of ameliorating working conditions.

Ventilation plays an important part in controlling the environmental conditions from whichever of the three sources discussed above the noxious effects arise. Again, the prime problem from the research angle is the precise measurement of the quantities concerned, such as air pressure, mass flow, temperature and humidity of the air stream.

Instrumentation

A recurrent need in all fields of mining is for more measurements and for instruments with which to make them. Due to the explosion hazard, all instruments must either be intrinsically safe or housed in a flameproof box. Instruments existing commercially to make the measurements required by the current research programme with the necessary degree of accuracy are virtually non-existent. Hence a considerable portion of the effort of the Establishment is devoted to devising and designing pitworthy instruments which will do their job safely under exacting conditions. There are advantages in using transistors as a substitute for valves, and a number of instruments are in the course of development which employ these devices.

Not merely are measurements required for the study of environmental conditions and the behaviour of strata but also to give a precise picture of the performance of a coal-winning machine underground. This is an entirely new field, and instruments are at present being devised and constructed to give comprehensive information on the forces encountered by, and the performance of, the 'auto-percussive' plough when working in a seam. This technique should give most valuable information for the design of new and improved machines of all sorts. The need for adequate instrumentation in environmental studies has already been mentioned; but it should be emphasized that this phase is only the provision of the tools to attack the main problems in those fields which are concerned with the improvement of underground working conditions.

Mining is a traditional industry in Britain and, as such, is one on which it is difficult for research to make an immediate impact. However, it is bristling with complex problems requiring urgent solution, and it is therefore a stimulating challenge to scientists and engineers. No doubt, in many cases, careful work will merely establish that current practice, resulting from an intuitive approach and long experience, is in fact soundly based. But the coal-mining industry must advance and is in fact advancing in its technique at an ever-increasing pace; and here scientific research will make its fullest contribution and reap its reward by helping the advance of national prosperity.

THE PLACE OF SCIENCE AND THE HUMANITIES IN EDUCATION

A DEBATE on the motion "That Science can provide as Good an Education as the Humanities" was organized by the Fine Chemicals Group of the Society of Chemical Industry, and was held in the Senate House of the University of London at 7 p.m. on April 20. Sir William Ogg was chairman of the debate, which was attended by some five hundred people. Speakers for the motion were the rector of the Imperial College of Science and Technology, London, Dr. R. P. Linstead, and Prof. A. R. Ubbelohde, also of that College. Speakers against the motion were the vice-chancellor of the University of Nottingham, Mr. B. L. Hallward, and the headmaster of Winchester College, Mr. H. D. P. Lee. After these speeches, brief contributions from members of the audience were made at the invitation of the chairman.

In the course of the debate, it was evident that there was some shift of targets, according to whether the speakers on either side were thinking of education chiefly at the school-level, or whether higher education was included and even specifically aimed at.

With regard to public school and secondary education, Mr. Hallward said that to include an even greater proportion of scientific subjects than heretofore, so as to produce more young technicians trained in science on something like the reputed Russian plan, could have grave objections with regard to their other opportunities and duties in adult life. Mr. Lee stressed the practical difficulties from the point of view of an already crowded school timetable. When essential school subjects such as English language and literature, geography and history have been provided for, and highly desirable subjects such as at least one foreign language and mathematics have been included, the distributable periods for more science or for other subjects are in practice quite limited. Furthermore, not much physics can be usefully taught at school before sufficient mathematics has been mastered.

These considerations were not really in conflict with Dr. Linstead's practical formula that everyone should acquire a very good knowledge of their own language and of mathematics, at least one foreign language (preferably living), general science and history and geography—chronology and the globe in Locke's words. Subsequent specialization in the arts or the sciences may occupy, say, two years at school and three at the university; but premature specialization is deplorable both for scientists and for non-scientists.

Prof. Ubbelohde said that though all would agree about the strength and grace contributed to the spirit of man by the new learning of the Renaissance, certain grave sources of weakness arise from the more mechanical practices of humanistic school teaching. Instead of giving real access to Greek and Roman civilization, all too often there is a prolonged and clumsy fumbling with rules of grammar and composition, and the mechanics of constructing Greek and Latin verses. Instead of teaching living foreign languages, schools often teach lists of words, irregular verbs and grammatical rules. Instead of teaching history as a living perspective of human thought and action, schools often concentrate on kings and queens and concubines and sometimes on archbishops and heretics.

Each of the speakers also dealt with broader philosophical aspects of education in science and in the humanities, and with higher education at the universities. Dr. Linstead quoted the "fanaticism of veracity" for which scientists were praised by Huxley; though this is only partly compensated for by the greater appreciation of beauty which may be attributed to humanists, the main influences which affect the moral and social education of a man come from outside his formal instruction and are essentially ndependent of the choice of his main subjects of study. A university student specializing in science, particularly for an honours degree, has to work very hard to master a large amount of factual material, and to complete the practical courses required. Particularly in the early years of a scientist at a university, these heavy demands on time leave far ess opportunities for general reading, for games and even for gossip. At first, science students appear to become more narrow, more specialized and even rather duller than their humanistic contemporaries; but at the postgraduate stage, after this novitiate in science, a great breadth of interests is discernible; comparisons at this level are by no means unfavourable to a scientific university education. In the research laboratory, both the critical faculties and creative power of students receive their maximum encouragement. This stimulation of the restless spirit of inquiry, and its real satisfaction by research, is an unforgettable educational experience. A positive advantage is the large element of practical work involving skilled use of the hands, which is an undoubted source of satisfaction to so many scientists.

Mr. Hallward and also Mr. Lee stressed the large gaps in an education specializing in pure science. Chief of these is that the sciences do not give access o judgments of value. In particular, science is amoral. It may provide just that knowledge which is required for automation, but science fails to give an understanding of human motives which are equally important for automation—for example, in dealing with trade union problems.

To focus this part of the debate, Mr. Hallward gave a list of some of the most compelling problems of our age, in order to point out that an education based exclusively on science could make the best ontribution to their solution in only very few instances. These were: (*a*) the spiritual and moral risis of Western civilization; (*b*) the conflict between Christianity and materialism; (*c*) international tension; (*d*) the growth of the power of the State and the tendency to sacrifice liberty for equality; (*e*) the evil power of certain dictators or oligarchs over men's minds, with the possibilities of 'brain washing'; (*f*) industrial strife, with special reference to current policies of 'beggar my neighbour' and certain aspects of trade union politics; (*g*) world population and food supplies; (*h*) education for leisure, shortening of the working day, the development of automation; (*i*) the triumph of ugliness and Philistinism.

Those opposing conceded that science trains the quantitative measuring faculty in the broadest sense. It develops human capacities for observation and experimentation, especially in the quantitative fields of experience. Popular use of the word 'scientific' to mean 'rationally argued' is, however, very superficial. Even where science can provide or suggest solutions to current problems, scientific training does not develop the faculty of arguing about opinions, or of persuading human behaviour. Both the emotions and the artistic sense are highly important for sound living, and are left wholly uneducated by science.

Prof. Ubbelohde stressed that an excessive preoccupation with specialized knowledge in either the arts or the sciences will fail to develop social faculties in a man or woman. But science has a real social contribution to make in the sense that even the humblest learner begins to understand by the earliest steps of his progress that he belongs to a house of many mansions, built by the labours of many workers and honouring named heroes from all over the world. Science gives one of the most direct entries to important activities that transcend national differences. So far from sensing barriers between the learning of various nations, scientists are keenly and indeed desperately aware of the interdependence of the peoples of mankind. To form a part, however humble, in an international advance upon ignorance and human helplessness is a social privilege which belongs naturally to scientists.

A second important educational fact about science is that many people find natural phenomena highly interesting. For example, Sir Walter Raleigh, Charles II and Dr. Johnson had all found solace from other troubles in a concentration on practical chemistry. Education to be effective must harness and guide real, substantial and perennial interest. Furthermore, since interest in natural phenomena can be developed and cultivated at various levels, scientific education tends to cement together rather than to separate various classes in the community.

A unique contribution to education made by science is in its approach to knowledge by experiment. This highly distinctive practice is quite modern. To utilize the full educational force of science, it is not sufficient to teach abstract sciences of the mind, such as mathematics. The mind must grow by learning to humble itself before objective facts of observation. By degrees it must learn to submit even the most forceful and imposing mental constructions to external tests. Almost in spite of itself the intellect learns that much human knowledge incorporates progressive experience. Knowledge inherited from precursors is important, but training particularly in the experimental sciences cannot induce complacency with inherited knowledge. Notwithstanding our shrunken world, the vast realm of knowledge remains wide open to scientific exploration. This maintains a freshness of outlook in scientific education; as is only natural, for humanistic learning the educational enthusiasm which was at its flood at the time of the Renaissance has by now undergone considerable attrition.

Each of the speakers, whether for or against the motion, made it clear that no support should be given to a humanistic education without access to science and the experimental method, or to an education that was wholly scientific without access to a training in values. Even from the strictly vocational point of view, the technological climate we now live in makes demands on education that are not fully met by past practice. Power on a very extensive scale has been placed in human hands during the past fifty years—as always in things human, power and knowledge for good or for evil.

We simply cannot allow anyone with any vocation of leadership or of effective service to remain wholly ignorant of science. In order to judge and to direct important policies, perspectives of action need to be viewed rightly; this includes judgments of potential contributions from science and technology. It is equally foolish to attribute our current malaise wholly to the ignorance of humanists at odds with forces they do not understand, or wholly to the rashness of uneducated scientists acting under the impulse of monstrous powers they should never have released. A new educational synthesis between humanism and science seems called for.

In this connexion, an important observation was made by one of the audience, Mr. J. A. Ratcliffe. The current forms taken by science teaching at schools and still more at the universities are determined by a strong vocational demand. By the time scientists or engineers or medical men or many othe university graduates leave the university, they ar expected to have acquired effective training in thei speciality. Teaching courses in science contain i themselves many of the benefits claimed for scientific education; but their need to provid effective specialized training makes it necessary t include features not in themselves of high educationa value.

A similar comment can probably be made abou specialized courses in humanistic subjects when thes aim at giving effective specialized training. It ca likewise be argued that the influence of the Renaissance grammarians still unduly affects education i classical subjects at school; unconsciously this i still organized to give a training which was of grea importance for those who needed accurate professional use of Greek and Latin. By thinking ou afresh the content of a course in general science a the university-level, including access to the experimental method, it should prove possible to mak even fuller use of the educational possibilities o science and to promote a new 'Greats' course combining humanities and sciences effectively.

With all this new 'tailoring', it is not yet clea whether the specialists in either camp will be able t impart the vital academic experience of study i depth of selected subjects to students of new hybri courses. The debaters did not enlarge on such doubts but were content to agree that appropriate access t the humanities and to the sciences is a necessar part of good education at the present time.

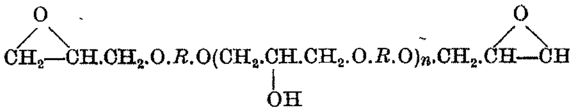
A. R. Ubbelohde

EPOXIDE RESINS

Under the title "Epoxide Resins, their Chemistry and Structure in Relation to their Properties and Applications", the Plastics and Polymer Group of the Society of Chemical Industry organized a symposium during April 11–13, which was held in the Beveridge Hall of the Senate House, University of London. About four hundred scientists registered for the conference, including forty overseas representatives of the United States, the Netherlands, Switzerland, Germany, Italy, Belgium, France and Sweden. Preprints of most of the papers presented were available before the meeting, so that authors needed only to summarize their contributions, with the result that ample time was available for discussion. Dr. S. H. Bell, chairman of the Group, acted as general symposium chairman; Dr. J. J. P. Staudinger, the late Dr. S. Whitehead and Dr. N. J. L. Megson took charge of the individual sessions, which were all well attended.

The considerable interest aroused by such a specialized subject as epoxide resins is to be attributed to the comparative newness of the materials, which have been commercially available for only a few years, combined with the outstanding properties of the products and a lack of detailed knowledge of their chemistry. They already hold a firm position as excellent adhesives, and they show great promise in the glass laminating field and for the potting and encapsulating of electronic equipment. Furthermore, as some of the papers showed, they are capable of extensive modification to yield products of potential value in other applications.

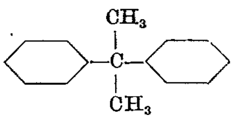
The reaction of epichlorhydrin with a phenol t give an epoxide derivative has been known for abou a hundred years, but the exploitation of the metho in the production of a polymer is a recent invention Epoxide resins were developed simultaneously b Ciba in Switzerland and by Davoe and Raynolds i the United States, and were first made on an industrial scale in 1950. The essential step is the reactio of epichlorhydrin with a bifunctional phenol, of whic diphenylolpropane (2 : 2-*bis*(4-hydroxyphenol) propane) is the commonest example. The type o molecule obtained can be represented by formula I



$$\overset{O}{CH_2\text{—}CH}.CH_2.O.R.O(CH_2.\underset{OH}{CH}.CH_2.O.R.O)_n.CH_2.\overset{O}{CH\text{—}CH}$$

(I)

where R is



The value of n will depend on such factors as rati of reactants and time of condensation. If n is unit or greater, then the characteristic structure is tha of an aliphatic aromatic polyether containing termin epoxy groups and pendent hydroxyl groups. Th molecule can be cured or hardened by the additio of dibasic acid anhydrides, such as phthalic anhydrid or of aromatic or aliphatic polyamines or relate compounds. The curing conditions and properties of the final resins will depend on the molecular weight of the original uncured resin and on the type of curing agent used.

As pointed out by Mr. E. S. Paice, commercial production depends on the large-scale availability of epichlorhydrin. This compound is now made as an ntermediate in the synthesis of glycerin through the hot chlorination of propylene, and production is ikely to be undertaken in Europe later this year.

The fourteen papers of the symposium, although very varied in character, can conveniently be grouped into four main categories: chemical aspects, including hardeners (five papers); modified resins (three papers); applications (two papers); and special aspects (four papers).

Chemical Aspects

Difficulties associated with hardeners were disussed by F. J. Allen and W. M. Hunter, with special reference to resins containing no free hydroxyl groups formula I, $n=0$). Hardeners such as phenolic resins may react in three ways, all of which lead to the ormation of a potentially reactive hydroxyl group. Epoxide/phenolic resin mixtures are stable for coniderable periods, and as a result are useful for making laminates, since impregnated sheets can be tored safely for several weeks. Acid anhydride hardeners are frequently used, but suffer from the defect that they are insoluble in the epoxide resin at room temperatures, so that mixing and curing have o be carried out at high temperatures and for xtended times.

Aliphatic and aromatic amines are more favoured because they can induce hardening at low temperaures. Furthermore, if polyfunctional amines are used, they can cause ready cross-linking. They may act catalytically, causing polymerization through poxide groups, or they may function by reacting with the resin. Tertiary amines or monofunctional secondary amines are typical of catalytic hardeners, which bring about ionization of epoxide groups.

Typical polyfunctional aliphatic amines are diethylnetriamine and triethylenetetramine. The disadvantages of such amines include development of a igh exotherm during hardening, whereby bubbling s caused in the resin; toxic properties; short pot-ife of resins made with them; and critical nature of esin/amine ratio. Some of these drawbacks can be vercome by using adducts or reaction products of the amines with other compounds, including the resin tself, acrylonitrile and ethylene (or propylene) oxide. uch adducts increase pot-life and reduce exotherms ut tend to bring about some deterioration in proerties of the cured resin. For general use, aromatic mines such as *m*-phenylenediamine and 4 : 4′-iaminodiphenylmethane are satisfactory, leading to igh heat-distortion temperatures and good mechancal properties.

Dr. W. Fisch, with Dr. W. Hofmann and Dr. J. Koskikallio, described chemical investigations on the ardening of resins (formula I, $n=1$ or more) with hthalic anhydride. Previous work had shown that the anhydride reacted with pendent hydroxyl groups o yield monoesters, and that the carboxyl group thus formed reacted with an epoxy group to give a diester and a further hydroxyl group, which could tself react with anhydride. Analytical studies of the reaction revealed the surprising fact that epoxy roups decreased much more rapidly than the diesters increased, and it therefore appeared that epoxy groups must take part in other reactions, for example, with hydroxyl groups. It was further found, surprisingly, that the reaction of anhydride with hydroxyl groups leads to an equilibrium which is strongly dependent upon temperature. Fisch concluded that a cured resin contains anhydride, monester and hydroxyl groups even after complete reaction of the epoxide groups.

Novel types of curing agent, namely, aniline-formaldehyde resins of low molecular weight, were described by Dr. R. E. Bishop. Such resins may be considered as closely related to aromatic amines of more conventional types, and in fact they yield cured resins having properties similar to those obtained by the use of 4 : 4′-diaminodiphenylmethane. The resins have advantages in being relatively cheap and in not possessing bad dermatitic properties.

The use of infra-red spectroscopy as a tool in following the curing of resins formed part of the subject of a paper by Dr. L. A. O'Neill and C. P. Cole. The results suggest that hardening of a resin with ethylene diamine proceeds through interaction of epoxy and primary amine groups, followed by reaction of an epoxy group with the secondary amine thereby formed. When highly complex polyamides are used as curing agents, cross-linking occurs at an earlier stage of reaction, although the resins are then somewhat softer. From chemical studies, O'Neill and Cole conclude that the esterification of epoxide resins with long-chain fatty acids (for example, from linseed oil) consists of a rapid attack of epoxy groups followed by a somewhat slower reaction with hydroxyl groups.

This last finding was confirmed by Dr. P. Bruin, who pointed out that since esterification by long-chain fatty acids uses up most of the epoxy groups, final curing has to proceed without making use of these groups. Dr. Bruin also discussed the mechanism of hardening with amines, as well as the potential use of phenolic resins (see Allen and Hunter, above). He pointed out that it is essential to strike a proper balance to prevent interaction of methylol groups in such resins, before the phenolic hydroxyl groups can react with the epoxide resin.

Modified Resins

The so-called 'polyepoxide' resins were described by Miss M. G. Ivinson, B. R. Howe and F. M. Karpfen. These materials are essentially phenolic resins in which the hydroxyl groups have been combined with epoxy residues. They yield a rigidly cross-linked system and, compared with normal epoxide resins, cure much more rapidly with primary amines.

A different type of modification can be made by making polyamides, derived from dimeric fatty acids. react with epoxide resins. A paper by D. E. Floyd, D. E. Peerman and Dr. H. Wittcoff devoted much attention to the mechanism of dimerization, it being uncertain whether the reaction is of Diels–Alder type or whether it occurs through Farmer's suggested conjugated free radical. The resins themselves are recommended by Wittcoff for surface coatings, adhesives, castings, tools and dies, potting and encapsulation, and for reinforced laminates; the outstanding properties are claimed to be low shrinkage, low exotherm, low volatility and low toxicity, combined with excellent adhesive and 'wetting' properties, and good dielectric strength.

Dr. T. F. Mika discussed the use of rubber-modified epoxide resins. Nitrile rubbers containing sulphur react through thiol groups, whereby mixed polymers are formed. The epoxide resin constituent acts as a reinforcing agent and confers improved solvent resistance and increased tear-strengths.

Applications

Mr. H. G. Manfield gave a comprehensive account of the use of epoxide resins in the potting and encapsulation of electronic equipment. The resins have special value in that they have good sealing properties. Manfield considers that their greatest future outlet lies in transformers, but pointed out various difficulties in this field. Supported by Dr. A. J. Warner, he made a plea for closer liaison between users and resin manufacturers, particularly from the point of view of electrical properties over a range of frequencies and temperatures.

The possible use of epoxide resins as stabilizers for polyvinyl chloride (P.V.C.) was discussed by Dr. E. C. A. Horner. When used with other compounds, not necessarily good stabilizers themselves, a synergistic effect is observed, whereby the resulting stabilization is better than that expected from either component separately.

Special Aspects

A paper by Dr. L. B. Bourne, a medical officer attached to a large organization, raised much interest since it dealt with handling precautions. Dr. Bourne stressed the toxic nature of many of the curing agents employed, and the necessity for extreme care in large-scale use. He considered, however, that the use of good barrier creams to reduce skin contact, efficient ventilation and the reduction to a minimum of quantities handled at any one time, combined with good training of personnel and the use of cautionary notices, could be adequate. He gave details o desirable treatments in case of need.

The important role of glass fibres as reinforcing agents was covered by Mr. K. J. Brookfield, who outlined the methods of production of fibres and described the special treatments now provided to improve adhesion of resins. These treatments include the use of methacrylato chromic chloride vinyl trichlorosilane and a new compound based on the interaction of allyl trichlorosilane with resorcinol.

The fundamentals of adhesion, with special reference to epoxide resins, were most lucidly presented by Dr. N. A. de Bruyne. Experiments on monomolecular films, determination of dipole moments and influence of chemical structure all lead to the conclusion that hydroxyl groups are largely, but not entirely, responsible for the good adhesive properties Measurements of differential strains in aluminium joints similarly suggest that the rise in breaking stress with hydroxyl content is associated with a fall in the residual stress.

The place of epoxide resins in industry was discussed by Mr. E. S. Paice in the final paper. Basing his conclusions on estimates in the United States he thought that, by 1960–62, the market in Great Britain should be between 7,000 and 10,000 tons a year. Of this amount, 55 per cent would be absorbed in surface coatings, and the remainder would go to 'potting' of electrical equipment, press tools, structural laminates, adhesives and miscellaneous uses Although increase in production would naturally lead to a reduction in price, he considered that epoxide resins would remain inherently more expensive than existing resins; nevertheless, he believed their special properties would ensure them a prominent place in industry.

N. J. L. MEGSON

OBITUARY

Mme. Irène Joliot-Curie

ALTHOUGH the health of Madame Irène Joliot-Curie had given cause for anxiety for several years, her death on March 17 came as an unexpected shock to those outside her immediate circle, not only to those who had known her personally but also to all who have worked or studied in the field of radioactivity. She was born in the stirring days of radioactivity when her parents were making their great discoveries, she grew up with radioactivity, and all her working life was devoted to its study. She bore an honoured name, to which she added lustre by many contributions of great importance in radioactivity and in the development of nuclear physics.

Irène Curie was born on September 12, 1897, the first child of Pierre and Marie Curie, *née* Sklodowska, a few months before the publication of the papers announcing the discovery of polonium and of radium. Her early training was interrupted by the First World War; during part of which she served as a radiographer, and afterwards she became 'préparateur' to her mother at the Laboratoire Curie of the Institut du Radium in Paris. Here she received a thorough grounding in all aspects of radioactivity, both physical and chemical, which gave a secure basis for her future work. Her first important paper was on the α-rays of polonium, presented for her doctor's thesis in 1925. In 1926 she married Frédéric Joliot, who had joined the Institut du Radium a year or two earlier as special assistant to Mme. Curie, and there began a collaboration of husband and wife in scientific work rivalling in productive genius even that of her parents. Equal in the partnership, each was a fitting complement to the other, and together they published some remarkable work. The most outstanding of their joint papers were published in the years 1932–34. In the first of these, on the radiation excited in beryllium by α-particles, they reported a very strange effect which provided the clue to the discovery of the neutron. Then, after studying the conditions of excitation of neutrons by the impact of α-particles on various elements, they turned for a time to the 'materialization' of positive electrons through the action of γ-rays of high energy This was followed by a systematic study of the radiations emitted from the lighter chemical elements under the impact of α-particles, which through the light of intuition—and good technique—led them, in early 1934, to their beautiful discovery of artificia radioactivity. An interesting feature of this discovery is that it was so long in coming; for the phenomenon of artificial radioactivity had been expected, and sought for, since the earliest days o radioactivity. For this discovery the Joliot-Curie were awarded the Nobel Prize for Chemistry in 1935

About two years later, Mme. Joliot-Curie was appointed by M. Blum as Under-Secretary of State for Scientific Research. This office and her numerous other duties must have absorbed a great deal of her time and attention; moreover, her health was showing signs of having been affected by her exposure to radiation during years of work with strongly radioactive materials. But her scientific work continued without abatement. With P. Savić, she examined in detail the artificial radioelements produced by the irradiation of uranium by slow neutrons, analysing the products and identifying them chemically, and she came within a hair's-breadth of recognizing that the phenomenon involved in the production of these elements was that of fission. Then came the Second World War and the German occupation of France, during the last year or two of which she retired to Switzerland with her two children.

When the French atomic energy project was started in late 1945, she was appointed one of the four scientific commissioners, the others being F. Joliot-Curie, P. Auger and F. Perrin. When Joliot was dismissed in 1950 on account of his Communistic activities, she retained her post and served the full term of five years; but on the reorganization of the Commission early in 1951 she was no longer included. During these years she was the chief link between the Commission and the Institut du Radium and the University of Paris, and she served as the Commission's representative on several committees. She continued at the same time to publish work on various aspects of radioactivity, for her ardour for scientific research was such that neither administrative duties nor failing health could keep her from her laboratory.

Her parents were both persons of strong and independent mind, and Mme. Joliot-Curie inherited much of their character as well as their scientific genius. She had a powerful personality, simple, direct and self-reliant. She knew her mind and spoke it, sometimes perhaps with devastating frankness; but her remarks were informed with such regard for scientific truth and with such conspicuous sincerity that they commanded the greatest respect in all circumstances. In all her work, whether in the laboratory, in discussion, or in committee, she set herself the highest standards and she was most conscientious in the fulfilment of any duties she undertook.

She leaves with her husband two children—a daughter Hélène, married to a grandson of the late Prof. P. Langevin, and a son Pierre.

J. Chadwick

NEWS and VIEWS

New Foreign Member of the Royal Society: Prof. R. B. Woodward

Robert Burns Woodward, professor of organic hemistry in Harvard University and recipient of many honours, has now been elected a foreign member of the Royal Society. In 1937 he was awarded the degree of Ph.D. at the Massachusetts nstitute of Technology and shortly afterwards moved to Harvard University. His work there has ranged over almost the whole field of organic hemistry, and has had an outstanding influence pon the development of the subject, particularly during the past decade. His most important contributions have been concerned with the elucidation f the structure of natural products and their total ynthesis, and in this his views on biogenesis have been of great value. His synthesis of quinine 1944), followed by his brilliant work culminating in the first total synthesis of the steroids (1951), has reated a new era in synthetic organic chemistry. He has regarded the complexity of some natural products as a challenge, and this he has met by applying in masterly sequence the methods now available to the modern organic chemist. His recent otal synthesis of strychnine will always be regarded as a classical achievement. His work on the elucidation of the structure of natural products is characerized by the use of physical methods which are uitably complementary to the chemical methods of tructural investigation. He was a pioneer in the use f ultra-violet and infra-red spectroscopic techniques in structural work, and the present popularity of these methods is in some measure due to his influence; his rules concerning the ultra-violet spectral properties of various chromophoric systems are of great value. Many natural products have been forced to reveal the secrets of their molecular architecture as a result of Woodward's attentions, and these have included patulin, sempervirine, terramycin, aureomycin, magnamycin, ajmaline and cevine and related veratrum alkaloids.

Astronomy in the Australian National University: Prof. Bart J. Bok

Dr. Bart J. Bok, who has been appointed to succeed Dr. R. v. d. R. Woolley in the chair of astronomy at the Australian National University, will take to Mount Stromlo a detailed knowledge of the problems of galactic structure and stellar statistics, to which he can apply observations obtained with the new 74-in. reflector of the Commonwealth Observatory. At Harvard, Bok was closely associated with Harlow Shapley, and Bok himself took a particular interest in the problems of the southern hemisphere, visiting the Harvard Observatory at Bloemfontein, South Africa, to secure observations with the 60-in. reflector. As a consequence of the closing down of the Harvard Southern Station, Bok has recently turned his attention to radio astronomy, and his appointment to the chair at Canberra will no doubt strengthen the contact between astronomy at Mount Stromlo and the radio astronomy work of the Radio Physics Laboratory of the Commonwealth Scientific and Industrial Research Organization at Sydney.

Beit Memorial Fellowships for Medical Research

The following Beit Memorial Fellowships for Medical Research have been awarded for research work at the places indicated. *Fourth-Year Fellowship* (£1,000 a year): Dr. Evelyn E. B. Smith, synthesis of hyaluronic acid and of specific polysaccharides in pneumococci (Departments of Bacteriology and Biochemistry, University of Glasgow).

Junior Fellowships (£800 a year): Dr. R. J. Shephard, changes in the dynamic pressure volumes and in the vital capacity of the lungs in man, with the view of elucidating various types of dyspnœa (Department of Physiology, Guy's Hospital Medical School, London); Dr. J. R. Tata, normal and abnormal pathways of metabolism of the thyroid hormones (National Institute for Medical Research, Mill Hill); Dr. V. C. Abrahams, physiology and pharmacology of the hypothalamus, particularly in relation to the control of water balance (National Institute for Medical Research, Mill Hill); and T. F. Slater, enzymic constitution of the mammary gland in relation to lactation and, in particular, the synthesis of milk proteins (Department of Biochemistry, University College, London).

Institution of Mining and Metallurgy: Awards

THE Council of the Institution of Mining and Metallurgy has made the following awards: *Gold Medal of the Institution*, Dr. J. A. Bancroft, in recognition of his long and distinguished services to the mineral industry in southern Africa and in the advancement of the science and practice of economic geology; *Honorary Membership of the Institution*, the Hon. C. A. Banks, in recognition of his services to the mining industry, with particular reference to his pioneering work in the introduction of air transport for the equipment of poorly accessible mineral properties; the Right Hon. Viscount Chandos, for his services to metallurgical industries in the United Kingdom; and Mr. G. F. Laycock, past-president of the Institution, for his services to the mineral industry and to the Institution; *Consolidated Gold Fields of South Africa, Limited, Gold Medal* for the session 1954–55, Mr. J. F. G. R. Heywood, for his paper entitled "Pressure Manifestations at Great Mining Depths on the Witwatersrand" (*Trans. Inst. Min. Metall.*, 64); and *The Consolidated Gold Fields of South Africa, Limited, Premium of Forty Guineas* for 1954–55, Dr. J. J. Brummer, for his paper entitled "The Geology of the Roan Antelope Orebody" (*Trans. Inst. Min. Metall.*, 64); *William Frecheville Student's Prize* for the session 1954–55, Mr. F. M. Vokes and Mr. W. G. Jeffery conjointly for their paper entitled "The Geology of New Consols Mine, Cornwall" (*Trans. Inst. Min. Metall.*, 64).

Avogadro Centenary Commemoration in Rome

THIS year is the centenary of the death of Amedeo Avogadro, the Italian chemist and physicist whose discovery of one of the fundamental laws concerning the behaviour of gases brought him universal fame. To mark the occasion, the Accademia Nazionale dei XL, of which Amedeo Avogadro was a member, is organizing a commemoration ceremony which will take place on June 6 in Rome at the Capitol in the presence of representatives of the Italian Government and of foreign countries and prominent personalities from Italian cultural life. Appreciations of Avogadro's work will be given by Prof. Francesco Severi, president of the Accademia dei XL, Sir Cyril Hinshelwood, of the University of Oxford, president of the Royal Society, Prof. Linus Pauling, of the Institute of Technology, Pasadena, and Prof. G. B. Bonino, of the University of Bologna.

International Control of Pelagic Fisheries

AFTER discussion for several years, the International Law Commission last year agreed on rules to allow coastal States to prevent the fisheries near their own shores being exploited to the point of extermination by larger States. On May 2, *The Times* reported an attempt by representatives of Mexico and India to delete the provisions for compulsory arbitration included in the draft for the settlement of disputes. There are some resources such as oil, non-migratory fish, guano, weed and other marine products for which local jurisdiction seems reasonable. Others, such as whales, seals, salmon and other migratory fish, can be fished just as successfully in the deep ocean a thousand miles away. They are the same stocks as are fished at the coast and can be conserved only by international agreement. The work and success of the International Whaling Commission and the North Pacific Fur Seal Agreement are striking examples of how regulation and international co-operation can be achieved. It is clear from the report in *The Times* that the Law Commission and the General Assembly of the United Nations, while prepared to support well-founded claims, will not favour the general establishment of frontiers on the high seas. To the marine scientist such divisions of the ocean will be particularly objectionable. The usefulness of the seas and oceans to the small States as well as to the principal maritime powers depends ultimately on international co-operation in their study and use. The international councils, unions, and United Nations organizations will do more to improve the fisheries than is likely to be achieved by imposing too many local restrictions. There would soon be no whales off any coast in the southern hemisphere if it were not for active international co-operation in the Antarctic. The same co-operative spirit will eventually be needed in other pelagic fisheries.

Colonial Advisory Council of Agriculture, Anima Health and Forestry

THE Secretary of State for the Colonies, Mr. Alan Lennox-Boyd, has amended the terms of reference o the Colonial Advisory Council of Agriculture, Anima Health and Forestry which was first set up in 1929 and its membership has been altered to bring it in line with its new functions. The new terms of reference are as follows: (1) to keep under review the genera conditions of agriculture, animal health and forestry in the Colonial Empire and to maintain contact with the work of the Colonial Governments in these spheres of development; (2) to advise the Secretary of State or individual Colonial Governments at thei request upon general policy and development o particular aspects of policy and development in the fields of agriculture, animal health and forestry (3) to bring to the attention of the Committee fo Colonial Agriculture, Animal Health and Forestry Research in broad outline such problems in these fields on which research or investigation is required (4) at the request of Colonial governments to visit o make arrangements for visits by other than member of the Council.

The membership of the Council is as follows Lord Lloyd, Parliamentary Under-Secretary of Stat for the Colonies (*chairman*); Mr. W. B. L. Monson Assistant Under-Secretary of State, Colonial Offic (*vice-chairman*); Prof. W. I. B. Beveridge, professo of animal pathology, University of Cambridge; Mr. W. H. Cashmore, director of the National Institut of Agricultural Engineering; Mr. C. Clark, directo of the Institute for Research in Agriculture Economics, University of Oxford; Sir Geoffrey Clay agricultural adviser to the Secretary of State for the

Colonies; Mr. F. S. Collier, forestry adviser to the Secretary of State for the Colonies; Prof. M. McG. Cooper, professor of agriculture and rural economy, King's College, University of Durham; Dr. W. Davies, director of the Grassland Research Institute; Prof. A. N. Duckham, professor of agriculture, University of Reading; Sir Frank Engledow, professor of agriculture, University of Cambridge; Mr. G. Lacey, adviser on drainage and irrigation to the Secretary of State for the Colonies; Mr. D. Martin, of Unilever, Ltd.; Mr. R. S. Marshall, adviser on animal health to the Secretary of State for the Colonies; Mr. D. Rhind, Secretary for Colonial Agricultural Research; Sir William Slater, secretary of the Agricultural Research Council. The technical secretary of the Council is Mr. L. Lord, assistant agricultural adviser to the Secretary of State for the Colonies, and the secretary is Mr. A. S. Gann, of the Colonial Office.

Shortage of Scientific Workers in Great Britain

A PAPER entitled "Technical Education—Shortage of Scientists, Technologists and Technicians", prepared for private circulation by Mr. John Wellens (24 Mossley Road, Grasscroft, near Oldham, Lancs), comments on the Government's recent White Paper, suggesting that the White Paper offers little that is new and effective and supporting Lord Simon of Wythenshawe's recent proposal for a Royal Commission of inquiry. Mr. Wellens suggests that a Commission should be established and directed to report within six months. It should examine such major problems as the distinction between technologist and technician, the training appropriate to each, and the practicability or otherwise of training both in the same institutions. Mr. Wellens stresses that a number of questions demanding urgent examination are glossed over or ignored in the White Paper, and thus the Commission should also consider the quantitative demand and its relation to the demands of other sections of our national life, the extent of the existing wastage and its prevention, the avenues and opportunities of co-operation between education and industry in technical education, apprenticeship and its problems, the utilization of technologists, and the purpose and place of the technical schools. The Commission as a result would prepare a national policy or plan and recommend the type of agency required to see that the plan is put into operation.

Mr. Wellens does not refer to the 'sandwich' scheme of courses; but he himself recommends that the proposed central agency should be so equipped, staffed and financed as to have additional functions, such as research, the continuous collecting and dissemination of information and consulting services. It should be responsible for keeping permanently in touch with appropriate agencies in other countries and should function continuously and actively. Those universities with a major interest in technology should establish chairs of industrial education to promote independent research. Mr. Wellens's concern appears to be to obtain as a matter of urgency constructive answers to the vital questions which he indicates and which the Government has largely ignored.

History of Science in India

AT a meeting of the Council of the National Institute of Sciences of India, held in May 1955, the question of compiling a history of science in India was considered (*Sci. and Cul.*, 21, No. 8; February 1956). It was decided that this history, when written, should be divided into three periods, namely, the earliest years up to A.D. 1200, the medieval period A.D. 1201–1800 and the British period A.D. 1801–1950. It was also decided to invite the views of existing institutes and academies in the country which are in a position to undertake this type of work. These include the Bhandarkar Institute, Poona, and the Asiatic Society, Calcutta. The idea of writing such a history of science was first mooted in November 1951 at a symposium on the history of sciences in South Asia, held in Delhi under the joint auspices of the National Institute of Sciences of India and Unesco. At the symposium the National Institute was invited to convene a group to study the history of science in India. In view of the expenses which will be involved, the National Institute has decided to approach the Government of India for a grant under the Second Five Year Plan to undertake the project it has in mind.

Virus Transmission by Aphids

M. F. DAY has reported on experiments undertaken with the view of determining the mechanism of the transmission of the potato leaf-roll virus by aphids (*Austral. J. Biol. Sci.*, 8, 4, 498; 1955). He states that the virus causing potato leaf-roll can be recovered from the hæmolymph of *Myzus persicae*, the aphid vector. Infective virus has also been separated from the bodies of infected vectors. The virus can be transmitted by an aphid after a moult, and infectivity is retained for at least eight days; during this time the aphid is able to infect many plants. *M. persicae* is a much more efficient vector than *Macrosiphum euphorbiae*. Experiments suggest that the virus multiplies to a limited extent in *M. persicae*. When this vector feeds on a plant containing a low concentration of virus there is generally a latent period (of approximately 20 hr. at 25° C.) between the acquisition feed and a successful inoculation feed. When the vector feeds on a source of high virus concentration, occasional transmission is obtained with short (approximately 2 hr.) acquisition and inoculation feeds. However, the percentage of transmissions under these conditions with the local strain of *M. persicae* is lower than that reported by American workers. No clonal differences in vector efficiency were found. Attempts to isolate strains of leaf-roll virus with different vector relationships were unsuccessful. The relevance of these results to the mechanism of transmission of viruses by insects is discussed. It is suggested that the occurrence of a latent period in a virus vector is indicative of the passage of the virus from the midgut into the salivary glands via the hæmocœle, and the multiplication of the virus in that vector.

National Research Council, Canada: Awards for 1956–57

THE National Research Council, Canada, has made 269 awards for 1956–57, totalling 345,500 dollars in value. They include 65 bursaries (800 dollars each) and 155 studentships (1,200 dollars each), tenable in Canada. Of the awards for study abroad, twenty-seven special scholarships, worth 2,000 dollars each, have been granted which will be held in the following countries: fifteen in Great Britain, nine in the United States, two in Sweden and one in France. Twenty-two postdoctorate overseas fellowships, worth 2,500 dollars each, have been granted for work in the following countries: fourteen in Great Britain, three each in France and Switzerland, and one each in Germany and the Netherlands.

Second International Congress on Acoustics, Cambridge, Massachusetts

The Second International Congress on Acoustics will be held during June 17–23 in Cambridge, Massachusetts—at Harvard University and the Massachusetts Institute of Technology. At the same time the Acoustical Society of America will hold its fifty-first meeting. The Congress is sponsored by the International Commission on Acoustics, which is part of the International Union of Pure and Applied Physics. The main programme of the Congress will be based on three themes: bioacoustics and noise control—human responses to sound (including hearing, psychological response and biological effects) and methods of noise control based on these responses; architectural and musical acoustics—the production of music and speech sounds and the design of enclosures for good conditions of hearing; and physical acoustics and sonics—acoustical studies of matter, propagation of sound, and application of acoustical techniques to technical problems. There will be special demonstrations of speech analysis and synthesis, and a number of exhibits by scientific, technical and manufacturing organizations. Further information can be obtained from the secretary of the Congress, John A. Kessler, Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

The Night Sky in June

New moon occurs on June 8d. 21h. 29m., U.T., and full moon on June 23d. 06h. 13m. The following conjunctions with the Moon take place: June 1d. 00h., Mars 8° S.; June 7d. 18h., Mercury 5° S.; June 10d. 05h., Venus 3° N.; June 13d. 15h., Jupiter 7° N.; June 20d. 11h., Saturn 3° N.; June 29d. 14h., Mars 10° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Aldebaran on June 23d. 08h., Mercury 2·5° N. Mercury is too close to the Sun during the greater part of the month for observation, but at the end of the month it rises at 2h. 45m.—an hour before sunrise—and may be seen for a short period, its brightness being greater than that of a first-magnitude star. Venus sets at 23h. 30m. at the beginning of June, but draws closer to the Sun and on June 30 sets only half an hour after sunset; its stellar magnitude varies from −4·1 to −3·4, and the visible portion of its illuminated disk decreases from 0·140 until it is in inferior conjunction with the Sun on June 22d. 06h. Mars rises at 0h. 45m., 0h. 10m. and 23h. 25m. on June 1, 15 and 30, respectively, and has an eastward movement in Aquarius; it increases in brightness during the month owing to a small increase in the visible portion of its illuminated disk and also to its distance from the Earth decreasing from 76 to 58 million miles. Jupiter, visible soon after sunset, sets at 0h. 25m., 23h. 30m. and 22h. 40m. on June 1, 15 and 30, respectively; its stellar magnitude varies between −1·5 and −1·4 owing to its distance from the Earth increasing from 520 to 557 million miles. Towards the end of the month it is close to Regulus. Saturn, in Libra, sets in the early morning hours—at 3h. 30m. on June 1, one hour earlier on June 15 and two hours earlier on June 30; its stellar magnitude varies from 0·3 to 0·5 owing to its distance from the Earth increasing by 20 million miles. No occultation of stars brighter than magnitude 6 occur in June. Summer solstice occurs on June 21d. 10h. 24m., and the total time of sunshine in the latitude of Greenwich is then approximately 16h. 40m. A total eclipse of the Sun occurs on June 8 and is visible as a total eclipse only in the South Pacific Ocean, maximum duration 4m. 45s.; it will be seen in New Zealand at sunrise as a partial eclipse.

Announcements

Dr. Lloyd P. Smith, at present chairman of the Department of Physics of Cornell University, has been appointed president of the Research and Advanced Development Division and vice-president of the Avco Manufacturing Corporation, of New York. The Corporation manufactures a wide range of electrical and electronic goods, including defence equipment for the United States Government.

The Ford Foundation has given two grants of 4,250 dollars (£1,517) each to the University of Cambridge to assist the work of Prof. M. Fortes, William Wyse professor of social anthropology, and of Mr. E. R. Leach, lecturer in the Department of Archæology.

The following three new members have been appointed to the Board of Regents of the Smithsonian Institution, Washington, D.C.: Dr. E. L. DeGolyer, a petroleum geologist and senior member of the firm of DeGolyer and McNaughton, Dallas, Texas; Dr. C. H. Greenewalt, a chemical engineer and president of E. I. du Pont de Nemours and Co.; Dr. C. P. Haskins, a research biologist and president of the Carnegie Institution of Washington. The Board of Regents of the Smithsonian Institution is by law composed of the Vice-President of the United States, the Chief Justice of the United States, three members of the Senate, three members of the House of Representatives, and six citizen members.

The second display of instruments, organized by the Scientific Instrument Manufacturers' Association at the Instrument Centre, 20 Queen Anne Street, London, W.1, was opened on May 22 and will continue for three months.

The Hydrocarbon Research Group of the Institute of Petroleum is arranging a symposium on "Vapour Phase Chromatography" during May 30–June 1, to be held at the Institution of Electrical Engineers, Savoy Place, London. During the meetings there will be an exhibition of apparatus. Further information can be obtained from the organizing secretary and treasurer, Mr. H. C. Rampton, c/o The British Petroleum Co., Ltd., Chertsey Road, Sunbury-on-Thames, Middlesex.

An exhibition of fishery equipment, including echo-sounders, has been arranged in connexion with the fourth meeting of the General Fisheries Council for the Mediterranean, to be held in Istanbul during September 17–22 (see *Nature*, May 5, p. 831). Exhibition space will be available, free of charge, and special arrangements have been made for the temporary import, duty free, of equipment for display. Firms wishing to exhibit equipment should write, before July 15, to Mr. Cihat Renda, Meat and Fish Office (Et ve Balik Kurumu Umum Müdürlügü), Selanik Cad. 78, Ankara, from whom further information can be obtained.

NORTHAMPTON POLYTECHNIC, LONDON

OPENING OF EXTENSIONS

IT is exactly sixty years ago since the Northampton Polytechnic, in St. John Street, London, E.C.1, was first opened to students, and therefore it was fitting that in celebration of its diamond jubilee the Minister of Education, Sir David Eccles, should have been invited to declare open the new extensions. Since 1896 there has been a number of improvements both by way of alterations and additions to the original building (established on a site given by the fourth Marquis of Northampton—hence the name of the Polytechnic), and also by additional buildings, for example, the Connaught Building in 1932 and its annexe in 1939.

The present extensions form the first phases of a comprehensive scheme of expansion of the Polytechnic and have been concerned with the provision of new laboratories and workshops for a wide variety of subjects, including: aeronautics; hydraulics; production engineering; instrument manufacture; instrumentation and process control; heat engines; advanced applied physics; high-voltage testing.

Provision has also been made for a new and magnificent library known as "The Skinners' Library". The Worshipful Company of Skinners was a joint founder of the College, and its continuing interest has been maintained not only by its financial grants, but also through its representation on the governing body, the chairman of which has invariably been a 'Skinner'. The furniture and fittings in the Library have been provided out of a gift from the Company of £5,000.

Other amenities in the extensions include the Great Hall, which has a seating capacity of 700, and refectories for staff and students which will accommodate more than 400 at a sitting. The total cost of rebuilding and re-equipment is of the order of £400,000.

The reopening ceremony was held in the Great Hall at 3 p.m. on May 7. The speakers in order were Mr. Hamilton Fulton, chairman of the Governing Body, Sir David Eccles, Minister of Education, Mrs. Helen Bentwich, chairman of the London County Council, and Mr. Beresford Ingram, vice-chairman of the Governing Body.

After welcoming the Minister and the guests, Mr. Fulton spoke on the work of the Polytechnic and its place in the educational system of Britain. He emphasized particularly the value of its status as an aided institution; while acknowledging that the bulk of the financial support of the College was due to the liberality of the London County Council, the Governors did enjoy limited funds of their own, and this ensured for them that liberty and autonomy essential for efficiency and enterprise.

Mr. Fulton spoke of present students as "the life blood of our competitive capacity against production in other countries and the ability of our technicians and our technological institutions to cope with competition, provided they have the necessary support of organized labour".

Although the Governing Body could not have known it, the timing of the opening ceremony was but a few days too soon, as the Minister in his speech revealed by his guarded response to the chairman's demand for some information regarding the future status of the College under the Ministry of Education plans for higher technology. The Minister stated that while he could not say anything in anticipation of the forthcoming debate on the White Paper in the House on May 1, it was obvious that the White Paper had been misunderstood in regard to the number of colleges to be designated colleges of higher technology. A very much smaller number would be so designated to form, as it were, foundation members of this top level of the four-tier structure to be established. While the Minister could not say in which level the Northampton Polytechnic would be placed, he added: "It seems to me to be the Senior Engineering Institution in London and therefore a place to which we will have to pay great attention. . . . Here you have a remarkable College which I know has a great reputation, but it is the sort of college which must do something for technical education as a whole as well as for its own students. You are the kind of people who can raise the flag and it is flags that people follow".

The guests, who comprised local dignitaries, representatives of City Companies, donors of gifts, principals of colleges, headmasters, representatives of professional bodies and industry, old students, past members of staff, and the present members of the Polytechnic—governors, staff and students—were afterwards shown the various laboratories and workshops, where exhibitions and demonstrations were staged. Of particular interest was a colour film taken by the staff of the Ophthalmic Optics Department showing the fitting and use of contact lenses. Other exhibits included demonstrations in applied physics, applied chemistry, electrical engineering, heat engines, hydraulics, aeronautics, watch making and repairing, instrument making, materials testing, automobile engines and vehicle maintenance, etc.

The purpose of the present extensions has not been so much to increase the number of students it is possible to accommodate as to improve the facilities for the existing enrolment. Thus, laboratories which hitherto have had to perform a double function, for example, heat engines and hydraulics, have been replaced by separate laboratories with much more adequate space for each different function. In turn, this has made it possible to increase the amount of equipment in these laboratories. Something of the order of £65,000 worth of new equipment has been added in the past three years and a further £85,000 worth is expected over the ensuing three years.

The more important pieces of large equipment include: a Ferranti Pegasus computer for the Mathematics Department; a full-size anechoic room for the Acoustics Laboratory; a supersonic wind tunnel for the Aeronautics Laboratory; a variable-slope water channel for the Hydraulics Laboratory; an electrode boiler and a Rover gas turbine for the Heat Engines Laboratory; high-voltage testing equipment for the Electrical Department.

As an exception to the foregoing, the National College of Horology and Instrument Technology, which is housed within the Polytechnic, has gained three rooms for additional workshops and laboratories in order that more students may be accommodated.

TECHNICAL EDUCATION IN GREAT BRITAIN

ON April 29 the National Union of Students held a conference in London at the Polytechnic, Regent Street, to discuss the recent Government report on technical education. The conference was attended by representatives from industry, local education authorities, the student associations in technical colleges, and the staffs of technical colleges. There were short opening addresses in each of the three sessions; but the major part of the time was devoted to discussion, which was lively and stimulating throughout. The morning session was opened by Mr. A. A. Part, Under-Secretary at the Ministry of Education, who spoke on "Action on the White Paper". He said that though the report in the White Paper made rather few specific proposals, it did envisage a wide extension of all advanced work in both full-time and part-time day courses at technical colleges, that is, all work above the standard of the Ordinary National Certificate or the Advanced Level of the General Certificate of Education; it also implied that, although a limited number of colleges selected from those with 75 per cent grant would be made into colleges of advanced technology, the total number of technologists studying at an advanced standard must be increased beyond the capacity of the establishments designated as colleges of advanced technology, and thus there would still require to be a number of colleges receiving 75 per cent grant which would mainly do advanced work.

One of the chief developments would be in the greater use of 'sandwich' courses. It is hoped that larger firms might pay the apprentices, whom they send on such courses, and that students from smaller firms might be helped by extra State scholarships and major county awards, all of which would in future be tenable at technical colleges doing advanced work. (It was not made clear whether this would apply only to colleges of advanced technology or to all colleges with 75 per cent grant.) Mr. Part said that, to find the extra personnel for the advanced courses, we must tap the large reservoir of talent among those who have left school before eighteen and that we must provide ways for these students to equip themselves for proceeding either to sandwich courses or Higher National Certificate courses, both by persuading parents to keep their children at school until they are eighteen and by encouraging a far greater liaison between schools, industry and technical colleges. The intention is to approve a large building programme: £15 million will be approved now, and in June a further £15 million for the session 1958–59. Local education authorities are responding well in sending in building schemes.

Mr. Part also emphasized the need for increasing the number of trained technicians, and in the discussion this point was emphasized by a speaker, who said that it was a mistake to 'hive' off the training of technicians from the major technical colleges. Another speaker said that technical secondary schools must be taken out of major technical colleges because this leads to the local residents thinking of the technical college as a boy's school and also prevents the atmosphere in the college from being that of an establishment for adult students. Mr. Part, in reply, promised that the schools would be moved out in the near future.

In the afternoon the conference was addressed by Sir Harold Roxbee-Cox, vice-president of the National Council for Technological Awards (the Hives Council). He said that the report of the Council, which is to be published very shortly, will suggest provision of an award of second-class honours degree standard to students who are successful in an advanced course approved by the Council, but that this approval implies that a course will be recognized only in a college which has a high general standard both in the quality of its staff, facilities for research and in social amenities for its students.

The U.S.S.R. is training three times as many technologists per thousand of population as Britain, and it is only because the British I.Q. (by which Sir Harold meant "inventiveness quotient") is, he believed, higher than that of most other countries, that our shortage of numbers is not more serious. He has made inquiries from industrial firms employing more than 50 per cent of the trained technologists in Britain, and from their replies he estimates that these firms would like to increase their numbers of technologists by one-third now; he believes that, in view of developments in the U.S.S.R. and the United States, there will ultimately be a much larger demand in Britain. For this reason, the expansion envisaged in the White Paper is not enough, and Sir Harold hopes the Government will accelerate and expand the facilities offered. He thought that in time those now taking external degrees at the technical colleges would be drawn into taking a course for a 'Hives' award, but the national need is to train more technologists in addition to those now taking external degrees in any technology.

Mr. Roland Oliver, student secretary of the National Union of Students, spoke on "Counter Balancing over Specialization". He stressed the necessity for retaining a balance between science and the arts in a school course and the advisability of allowing the student at a technical college more time during his course for private reading and meeting other students. Many speakers afterwards pressed that schools should not only give those taking science subjects at advanced level some training in the humanities, but should also give those taking arts subjects some training in science. These speakers felt that the proportion of headmasters and headmistresses with an arts training is far too large, and that this tends to make boys and girls follow an arts course rather than a science or modern course, and also to make for a lack of appreciation of the value of a scientific education and of the importance of the work of the major technical colleges.

The teaching at technical colleges came under heavy fire from some student representatives, who maintained that there was not enough lecturing, that the students were treated like schoolboys, and that the hours of class attendance were much too large and permitted of little private study. Some university student representatives said that the hours were just as long in many science and engineering faculties in the universities and that this was inevitable in view of the laboratory work required. One felt that the truth probably lay between these two groups of speakers and that there was room for some shortening of hours and some modification of teaching methods, though not quite as much as some speakers proposed.

Students also maintained that the best way of liberalizing the education of a technical student is to combine the shortening of hours of class attendance with a great increase in 'union facilities'. It was pointed out how small are the union club rooms in most colleges compared with those in a university, giving as an example for comparison the new building of the University of London, and many speakers urged that the Ministry should insist that, in any approved scheme for the enlargement of a technical college, provision should be made for adequate rooms for student activities. One could not help being impressed by this demand, which would have the strong support of college authorities.

Dr. J. Topping, principal of Acton Technical College, who took the chair throughout the conference, said in his opening remarks that more had been written on technical education since the Second World War than on any other subject, and he hoped that we are now moving into an era of action. The present writer came away feeling that there was every hope that his optimism was justified. As Dr. Venables puts it in his recent book on technical education: "We shall make progress, so long as those, who believe that the next stage in technical education is an evolutionary process, realize that we have not all of geological time available in this rapidly changing world".

Mr. F. Copplestone, president of the National Union of Students, who thanked all the delegates for coming to the conference, said that it had been a success because of the contributions the delegates had made. This is true, but it is also true that this success could not have been achieved without the initiative of the National Union of Students, which is to be congratulated on providing this opportunity for all the partners in technical education to meet.

H. V. LOWRY

INSTITUTE FOR SCIENTIFIC RESEARCH IN CENTRAL AFRICA, BELGIAN CONGO

REPORT FOR 1953

THE sixth annual report of the Institute for Scientific Research in Central Africa*, covering the year 1953, includes besides the report of the director, M. L. van den Berghe, brief reports from the presidents of the various scientific commissions and sections, lists of the sections, committees and commissions, with their membership, and a list of papers published during the year by members of the staff of the Institute and associated investigators; this last-mentioned list is supplemented by brief summaries of the papers. M. van den Berghe emphasizes the contributions which the work of the Institute has already made in the region of Belgian Central Africa in the field of physical and social anthropology, population statistics, the physics of high solar altitudes, biochemistry of foodstuffs and the experimental zoology of invertebrates, and refers particularly to the participation of the Institute during 1953 in a number of scientific conferences in Africa. The second Anglo-Belgian seminar in the human sciences was held at Kampala during February 23–28, 1953, and a third conference was due to be held in 1955 at Astrida and Lwiro. The first Anglo-Belgian seminar on nutrition was also held at Kampala, during February 18–20, 1953, and was concerned particularly with the comparison and discussion of results obtained in the field of nutrition in Uganda and the Belgian Congo and with visits to laboratories and institutions in Uganda and the exchange of techniques. A second seminar was projected at Lwiro in 1955.

A meeting of experts nominated by the Scientific Council for Africa South of the Sahara for the co-ordination of social research in Africa south of the Sahara met at Kampala during February 28–March 2, 1953. The conference recommended the publication of a series of brief accounts of the existing organization for social research and the appointment of an inter-African scientific correspondent to visit the different institutions and survey the work in progress in this field. Two further conferences in 1955 covering demography and economics, psychology, linguistics, ethnography and sociology were also recommended. An international conference for the protection of the fauna and flora of Africa was held at Bakavu in October 1953, and also an Anglo-Belgian Government conference at Kigali on the tsetse fly, at which it was agreed that the Institute should immediately commence a detailed study in the region of Kakitumba, including research on both *Glossina* and trypanosomes and the determination of the fly-belt.

Construction of the central library of the Institute at Lwiro was begun in January 1953, and a new station at Ituri, two hours from Lwiro, designed for the general study of tropical forest at a medium altitude, was planned for construction in 1954. The work of the Institute during the year included studies of the entomology of Ruanda-Urundi and ethnological studies among the Balega, which were designed to provide a course of lectures for the Colonial School at Brussels on aspects of parentage, family life and political structure and associations among the Balega. Measurements of solar energy in the visible spectrum were continued, and the equipment at Lwiro was further extended. The systematic and ecological study of the molluscs of Tanganyika continued, and the fauna of the north-east border of Lake Tanganyika was also studied, while investigations were commenced on the birds of Lake Kivu, and particularly of the seasons of reproduction of birds living nearly on the equator. The electrophoretic method is being used for studying the proteinæmia among indigenous races in Ruanda-Urundi and also the evolution of serum proteins in infants up to two years of age. Special attention was given to the study of kwashiorkor at Kivu, and a study was commenced of the factors influencing the productivity of the African worker in the Belgian Congo and especially in agriculture. Linguistic studies included a systematic one at Tshumbe, in the region of Mondja, of the language known as Otatela. To facilitate the collection and collation of neuropathological material autopsy services for neurological cases have been organized. Numerous observations have been made on nutritional disorders, tuberculosis and sickle-cell anæmia; and researches were continued on *G. morsitans* and the biotopes of *Culex sylvestres* and particularly *Aedes simpsoni*, the transmitter of 'jungle yellow fever' in

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* Institut pour la Recherche Scientifique en Afrique Centrale. Sixième Rapport Annuel, 1953. Pp. 229+4 plates. (Brussels: Institut pour la Recherche Scientifique en Afrique Centrale, 1956.)

Uganda. Observations on *Caecobarbus geertsi* Blgr. in the grottoes of the Lower Congo were completed, and studies were commenced into the emigration of the Banyarwanda and Barundi in East Africa, and the institutions of Bukahê and Bugabire. A study of the geographical distribution of the fish of the basin of the Ruzizi was completed in the first five months of 1953, and investigations of the stratigraphy of the groups of Urundi and of Ruzizi led to some definite conclusions. Other investigations were concerned with the African *Histoplasma duboisii* Vanbreuseghem, 1952, with the science of malnutrition and kwashiorkor and with the paludism of mammals and their invertebrate hosts.

THE SMITHSONIAN INSTITUTION

REPORT FOR 1954–55

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1955*, which is accompanied by the financial report of the Executive Committee of the Board of Regents and by reports from the branches of the Institution as well as by those in the Library and on publications, welcomes the enactment of legislation providing for the planning and erection of a new museum building for the Institution. Congress has already appropriated 2,288,000 dollars for the immediate planning of this Museum of History and Technology, for which 36 million dollars are authorized, and the new Museum will house all the national collections that record and illustrate the political, cultural, industrial, scientific and military development of the United States. As planned, it will be both a museum of United States history and a museum of science, engineering and industry, and a series of modern halls illustrating the principal periods of that history from Colonial days to the present is planned, with other halls showing the development of particular devices or subjects, such as automobiles, mining, medicine, manufactures, engineering and science. It is hoped that construction will begin in 1957. Preliminary architectural studies were made during the past year for the projected new National Air Museum, and further progress was made in renovating major exhibits at the Institution.

Visitors to the Smithsonian Buildings totalled 3,895,017—nearly 250,000 more than in the previous year—and, with the estimated 3,476,584 visitors at the National Zoological Park and 814,932 at the National Gallery of Art, brought the total number of visitors to the Smithsonian Institution to 8,186,533. The Institution continues to administer the Bio-Sciences Information Exchange, which is charged with preventing the unknowing duplication of research support by the Armed Forces and other Government agencies; and the Exchange, which has developed techniques to maintain a rapid interchange of concise information on the support of research in the bio-sciences, reports that it has been able to supply adequate information in response to all requests. Among the 7,600,000 specimens received by the National Museum during the year were collections of mammals from Korea, Pakistan and Panama; birds from Panama; large collections of fishes from the Gilbert Islands, Liberia and the south-eastern United States; the W. N. Mann collection of ants; 3,200 polychæte worms, mostly from New England; four hundred corals from the Great Barrier Reef; plant collections from Mexico, Central and South America; thirty-five specimens of meteorites, two thousand Silurian and Devonian fossils from Canada; some three and a half million mounted foraminiferan specimens; an early Curtis steam turbine; the Dodrill–G.M.R. mechanical heart and important electrocardiograph equipment. Field work included an investigation of the plant mites and other types of small animal life in the Belgian Congo; an ornithological survey of Panama; and the collection of larvæ of small moths of the genera *Depressaria* and *Agonopterix* in Wyoming and adjoining States.

The Bureau of American Ethnology made progress with its archæological work on Southampton Island in Hudson Bay, and Dr. H. B. Collins continued to supervise the "Arctic Bibliography" which the Arctic Institute is preparing for the Department of Defence, Vol. 4 being issued in August 1954. Besides preparing his report on previous field researches, entitled "Modern Inter-tribal Organizations on the North-West Coast", Dr. P. Drucker initiated a programme of archæological research at the important Olmec site of La Venta, Tabasco, Mexico. Dr. F. H. H. Roberts continued to direct the River Basin Surveys, the field investigations under which consisted mainly of excavations; no palæontological studies were carried out. By June 30, 1955, archæological surveys or excavations had been made in 243 areas in twenty-seven States since field work was started in 1946; and, of the 4,345 sites located and recorded, 852 were recommended for excavation or limited testing. At the end of the fiscal year, 324 sites in forty-four reservoir basins in seventeen different States had been dug extensively or in part, and further details of the work of the three field parties operating in the Missouri Basin are given in the report as well as of field work in the Garrison Reservoir area.

The Astrophysical Observatory, in co-operation with the United States Weather Bureau, continued the calibration of Eppley pyrheliometers, and the simplification and automatic recording of silver-disk pyrheliometry. Solar radiation studies at the high-altitude station at Montezuma in Northern Chile were hindered by sky pollution due to smelting operations at copper mines, and at Table Mountain in Southern California a gradual increase in the amount of smog from the Los Angeles area has been noted for some years. The work of the Division of Radiation and Organisms on the photo-control of the formative and development processes in seedlings of the bean plant indicated that the far-red energy interferes with development by acting on a product of the photochemical reaction initiated by the red energy. In studies with the root-tip cells of broad bean (*Vicia faba*), it has been found that, if exposure to X-rays is preceded by exposure to red visible light, the incidence of chromosome damage brought about by X-rays is reduced by 30–50 per cent, but if exposure to X-rays is preceded by exposure to radiant energy from the far-red or near infra-red, the damage is increased by 30–40 per cent. Using differential centrifugation methods to fractionate avocado fruit tissue it has also been found that the fraction remaining after sedimenting cell walls, nuclear material, mitochondria, plastids and other particles within this size range, contains an enzyme system which, on the addition of auxin, markedly reduces the consumption of oxygen.

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* Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1955. Pp. ix+173+7 plates. (Publication 4320.) (Washington, D.C.: Government Printing Office, 1956.)

The National Air Museum participated in celebrations of the fortieth anniversary of the founding of the National Advisory Committee for Aeronautics, and nearly twenty-two thousand photographs pertaining to aeronautics were added to the Museum's library of reference materials. Besides improvements in exhibits, the information services have been extended and are now meeting requests which have multiplied nearly two and a half times in three years. Accessions to the National Zoological Park totalled 2,347 individual animals, and 1,917 were removed by death, exchange or return to depositees. Of six hundred visitors to Barro Colorado Island during the year, forty-three were scientific workers who used the facilities of the station for research, particularly in biology and photography.

During the year the International Exchange Service handled 1,146,972 packages of government scientific and literary publications, consignments being made to all countries except China, North Korea, Outer Mongolia, the Communist-controlled areas of Viet Nam and Loas and the Haipang Enclave. The Smithsonian Library received 71,179 publications and arranged about 650 new exchanges; its holdings now total 951,409 volumes, including 585,592 in the Smithsonian Deposit in the Library of Congress. Publications issued by the Institution during the year totalled seventy-one, including seventeen papers in the Miscellaneous Collections, eight Proceedings Papers of the United States National Museum, four Bulletins of the Bureau of American Ethnology, and Vol. 7 of the Annals of the Astrophysical Observatory; 192,108 copies of the publications and 226,178 miscellaneous items were distributed.

MALADJUSTED CHILDREN

A COMMITTEE was set up in 1950 by the Minister of Education to inquire into the medical, educational and social problems relating to maladjusted children, with reference to their treatment within the educational system. The Committee has recently issued its report* and, despite much thought and labour, not unexpectedly offers no novel insight into the nature of maladjustment, or new and revolutionary ideas about the way it should be treated. Fifteen years ago the term 'maladjustment' was not in common use, and too little is still known about maladjustment in children and the ways it can be successfully treated to generalize or offer ready-made solutions. Instead, the Committee adopted the wiser, if more pedestrian, approach of considering, against the background of normal development, what is meant by a maladjusted child and what arrangements are at present available for treating and preventing maladjustment. These arrangements have been considered in relation to the education service, which itself occupies a central position inasmuch as it has continuous contact with most children for ten vital years of their lives.

One of the main difficulties which the Committee had to face was the definition of maladjustment. No one—except, possibly, the completely maladjusted—is completely adjusted to his environment; continual adjustment and re-adjustment are necessary throughout life. Maladjusted people are not necessarily unruly nor need they come into contact with the law; educationally backward and mentally retarded children do not provide all the maladjusted; intelligent people are also affected. What is known of the maladjusted is that they are insecure and unhappy, tend to get on badly in their personal relationships and may have failed to come to terms with their work.

The worst effects of maladjustment are seen in mental hospitals, divorce courts and prisons. At the end of 1954, for example, two-fifths of the 480,000 hospital beds available in England and Wales were occupied by mentally ill or mentally deficient patients. Surveys of factory workers have shown that 10 per cent had suffered from definite and disabling neurotic illness and a further 20 per cent from neurotic illness. It has been estimated that neurotic illnesses cause between a quarter and a third of all absences from work due to illness of any kind.

Although the worst effects of maladjustment are seen among adults, it is during childhood that most can be done to prevent maladjustment or to treat it. If one child can be helped, it will not only benefit his family and the community but may also have repercussions on future generations; maladjustment begets maladjustment.

The attention of the Committee has rightly been focused on those agencies which affect children. The part which the education service, particularly the school, has to play in the prevention, discovery and treatment of maladjustment is of great importance. The education service does not work in isolation, however, but co-operates with many other agencies. Collaboration is particularly close between the school health service and the hospital service, which provides a number of child guidance clinics and makes available the services of psychiatrists for many clinics run by local education authorities. Co-operation between these two services and the maternity and child welfare service is also necessary if the problems of children under five are to be adequately tackled. It is often in these early years that the seeds of future trouble are sown or the first symptoms appear, even though they may not be noticed until a child goes to school. The Committee has considered these and other agencies and made suggestions which will enable the psychological, educational and medical treatment of maladjusted children to develop on lines which seem the most rewarding.

One of the main suggestions is concerned with the work of the child guidance service. Much of the work at present done by local education authorities is too compartmentalized. The school psychological service, the school health service and the child guidance clinic should work more closely together. The educational psychologist, for example, should, wherever possible, try to help, within the setting of the school, those children who have learning or behaviour difficulties. Instead, as so often happens, of being concerned only with selection tests for the 11+-examination, he should spend part of his time in the child guidance clinic. Nor should the facilities of a child guidance service be withdrawn from a boy when he leaves school. The Committee rightly recommends that the service should be available for boys and girls in or out of school until they have reached the age of eighteen, when they are officially recognized as mature. A valuable suggestion is that parents should have direct access to all child guidance clinics without their children having first been seen and recommended by some intermediary;

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* Ministry of Education. Report of the Committee on Maladjusted Children. Pp. vi+180. (London: H.M.S.O., 1955.) 6s. net.

this, fortunately, is already the case with the majority of clinics.

The Committee's recommendation for the educational provision of maladjusted children should be received with enthusiasm. It will not only save considerable money but will also be of greater service to maladjusted children than existing facilities. At present there are day special schools or classes specifically of maladjusted children in the areas of only three local education authorities. Over the country as a whole, little day provision has been made. Recent psychological findings indicate that there are obvious advantages in leaving a child in his own home during treatment. Since the restoration of harmony and understanding between parents and children must be one of the main purposes of treatment, it is most satisfactory to treat a child, if possible, while he remains in the natural environment of his own home. Treatment of him and of his parents can then go hand in hand; and there is no danger of a conflict being set up in his mind between the different standards of two environments. The co-operation of parents may be much easier to secure if their child can stay at home than if he is sent to a boarding establishment.

For maladjusted children local education authorities should make more use of day 'special' schools and part-time 'special' classes. No child should be sent to a boarding establishment if his education can be satisfactorily continued from home. The teachers should be allowed sufficient time for keeping in touch with the parents, the child guidance service and the ordinary schools from which the children come. All teachers of backward children will support the recommendation that staffing should be based on the principle that ordinarily a teacher cannot satisfactorily meet the needs of more than ten maladjusted children, and that for some purposes a group may need to be considerably smaller. No day or residential school should contain less than about twenty children nor more than about fifty. Strong support will be given to the recommendation that the Ministry of Education and local education authorities should constantly review the need for studying more maladjusted pupils over the age of eleven, "in particular boys with I.Q.'s below 85–90% and children suited to a grammar or a technical school course". Local education authorities should also consult with one another and other bodies to develop facilities for maladjusted children on a regional basis.

In the case of children whose activities lead to their appearance in juvenile courts, considerable care should be taken to see that the children are indeed maladjusted before being treated as such. A recent suggestion of the Magistrates' Association to the effect that meetings should be encouraged between magistrates, staffs of child guidance clinics and others connected with psychiatric work would be a valuable means of ensuring that court sentences would have greater prophylactic value. In general, too, support should be forthcoming for the Committee's recommendation that every child appearing before a juvenile court who is so handicapped as to need special educational treatment in a boarding school should be provided with residential treatment by the local education authority rather than be sent by the court to an approved school.

After outlining the size of the problem and practical measures needed to combat it, the Committee turns to the all-important but difficult task of developing a positive approach to mental health in the community as a whole. A number of its recommendations should be carried out forthwith. There should be, for example, close co-operation between child guidance clinics and child welfare centres. The function of health visitors should be modified, and they should be trained to advise parents on behaviour, nervous and other difficulties in children, as well as on matters of physical health. More clubs and discussion groups for parents should be established by schools, including nursery schools. Above all, the fundamental importance of the family as a whole should be borne in mind by those responsible for strengthening and developing the social services, and action designed to keep the family together should be regarded as one of the most important aspects of prevention.

The most valuable feature of this report is the way the Committee has made its way through the tangled mass of legislation and opinion which surrounds the problem of maladjusted children and has made recommendations which are practicable and attainable. Many of the recommendations will be very costly to carry out; but many of them will cost a lot more if they are not carried out. What is first needed is the building up of attitudes of mind required for the prevention and treatment of maladjustment. The five years taken to prepare this report will have been well spent if the thinking part of the community becomes familiar with its main arguments.

PSYCHOSOMATIC RESEARCH AND BEHAVIOURAL SCIENCE

It is not often that one has the opportunity of reviewing two new journals and finding them of excellent quality within their respective fields. Both are quarterlies. The first, the *Journal of Psychosomatic Research*[*], is to be devoted mainly to clinical studies if the present contents are an indication. These vary from such work as "Emotions and the Peripheral Vasomotor System" to "The Sedation Threshold as an Objective Index of Manifest Anxiety in Psychoneurosis". There are other papers on asthma and peptic ulcers. Such research should direct the attention of the obstinately organically minded to the importance of mental states, and the psychologically orientated to the fact that the mind does not work *in vacuo*.

The scope of the other journal, *Behavioral Science*[†], is stated in the introductory editorial. The editors ask: "Can the scientific method solve the larger, more pervasive questions about man as well as the smaller, more particular ones? Is the tool with which man has won his victories over the physical world applicable to uncovering the laws which govern man's conduct, the deepest causes of our strife and our harmony? If fragments of multiple sciences were brought together in a unitary behavioral science and all the separate skills focused on the study of human behavior, perhaps the time required to find the answers to these questions could be reduced. The uniformities among disciplines could be recognised;

[*] *Journal of Psychosomatic Research*, 1, No. 1 (1956). Pp. 96+2 plates. (London and New York: Pergamon Press, Ltd.) £5 (14 dollars) per year, or 70*s*. (9.80 dollars) for individual subscribers certifying that the journal is for their private use.

[†] *Behavioral Science*, 1, No. 1 (January 1956). Pp. 82. (Baltimore, Md., and Ann Arbor, Mich.. Mental Health Research Institute, University of Michigan.) 6 dollars per year or 1.75 dollars per issue

better communication among them established; generalities of findings magnified; additional benefits derived from comparing theories in diverse fields, explaining similarities and differences, and the validity and applicability of empirical work increased by planning individual studies as components of an explicit mosaic of research strategy."

The result of this wide plan has been, perhaps inevitably, that the papers tend to be mainly mathematical. This may be valuable since there is a limit to clinical research, and without the aid of other sciences psychology and psychiatry will reach an impasse. The papers here suggest that there is little danger of this. They range from "Biological and Cultural Evolution" to a "Critique of Stochastic Models for Learning". This journal will be a joy to the mathematician and no doubt will draw many into the study of behaviour who would otherwise treat it as too vague to be of interest.

CLIFFORD ALLEN

THE NEED FOR OBSERVATIONS IN THE OLDER BRANCHES OF ASTRONOMY

FOR his presidential address last year to the Royal Astronomical Society and since published (*Mon. Not. Roy. Astro. Soc.*, 115, 2; 1955), Dr. J. Jackson took as his subject "The Need for Observations in the Older Branches of Astronomy, especially Double Stars", and discussed three branches with which he has been associated for about forty years: double stars, stellar parallax and meridian astronomy. After the First World War Dr. Jackson did a considerable amount of work on double stars, collecting and discussing the observations made during the preceding thirty years. The observing programme at that time was largely restricted to the Struve stars, but now that many new double stars have been catalogued and that there has been a great decrease in the number of observers, it is necessary, said Dr. Jackson, to review the position. Sufficient knowledge regarding the average masses and distances of ordinary stars is now available to decide on those stars that are worth observing at intervals of twenty years and to distinguish them from those that cannot be expected to eveal orbital motion of more than a degree or two n a century.

The importance of this is shown by the following onsiderations regarding the Σ stars. These were all picked up during 1824–27 with a 9½-in. refractor from among the hundred and twenty thousand brightest tars north of Dec. − 15°, and while the original list contained more than three thousand double tars, after various adjustments and rejections there emained 2,659 brighter than about magnitude 9 nd with a separation less than 32″. Before these were put on the Greenwich observing list, most of them had been observed at several epochs, and when Dr. Jackson discussed them in 1922 he found as follows: relative motion was shown by 649, undoubted orbital motion by 449, mere optical doubles in 161 cases, and in 39 pairs showing rather large elative motion it was difficult to decide whether they ormed binary or optical systems; it is suggested that while the majority probably belonged to the atter class, some may have been true binaries with a rather large parallax which could be confirmed by trigonometrical observations. A very important point is that 2,010 of these stars showed no certain relative motion of the components, and the great majority of these must be real binaries with periods of many thousand years, as Dr. Jackson shows by an analysis of the figures. His conclusion is that the 2,010 stars which had shown no relative motion by 1920, although true binaries, scarcely need any further attention until the end of this century. The 449 showing orbital motion, and also the 39 for which the nature of the motion is uncertain, should, he thinks, be observed at intervals of ten or twenty years until an orbit can be computed or the pair proved merely optical.

Turning to the OΣ stars, which were discovered with the 15-in. refractor at Pulkovo mostly during 1841–42, Dr. Jackson said that, owing to the closeness of the components and relatively greater difference in brightness than those just considered, they are more difficult to see and observe accurately. Hussey re-observed them with the 12-in. and 36-in. refractors at Lick Observatory, and when Dr. Jackson discussed them in 1923 he found that 135 showed orbital motion, 15 were optical systems, 5 showed motion of uncertain nature, and 270 showed no motion. In spite of the fact that these stars had been observed over a shorter interval of time than the Σ stars and, in addition, accurate observation was more difficult, yet they contained a greater percentage of stars of importance for the future, a fact which is attributable to the stars being closer and the components brighter. Dr. Jackson's final remarks on the subject were: "I therefore conclude that one of the most urgent needs of observational astronomy at the present time is the systematic re-observation of important double stars for which we have already detected the beginnings of orbital motion. The position may not be quite so bad as it appears as there may be a number of measures of double stars not yet published, and the absence of a general catalogue giving observations later than 1927 makes it difficult to estimate the true position. Nevertheless the reports of the International Astronomical Union do indicate a steadily decreasing number of measures". (After preparing his address, Dr. Jackson became aware of the measures of many close double stars made by Dr. Muller, of Strasbourg, during a four months visit to Lick Observatory, and a footnote to the published address directs attention to this, with a short account of the first orbits calculated for thirteen double stars.)

The position with regard to parallax determinations is very satisfactory when compared with that about half a century ago. In Newcomb's book "The Stars", published in 1904, there is a list of seventy-two stars for which parallaxes were known; of these, there were fifteen about which it was noted that the results were subject to more doubt than usual, and one was stated to be entirely unreliable. In contrast to this, the Yale Observatory published in 1953 a "General Catalogue of Trigonometric Stellar Parallaxes", which gives the parallaxes of 5,822 stars from about ten thousand determinations; this is the outcome of the great international scheme, devised about forty years ago by Schlesinger, for the mass determination of parallaxes, and was taken up at a dozen observatories which had long-focus telescopes. Several of the telescopes which have completed their programmes are at present used for the intensive observations of the nearest stars in the search for companions which are too close or too faint to be discovered except by the periodic displacement of the centre of light. A number of stars have been found to have companions which move in orbits with periods of a year or two. It is suggested that parallax observations for the next few years may be confined to filling in the gaps made by the omission of stars of early and late types, to the observation of certain specific stars, such as double stars or Vyssotsky's stars with dwarf characteristics, and to unravelling some of the larger discordances.

In the final part of his address, devoted to meridian astronomy, Dr. Jackson pointed out that at present the Royal Greenwich Observatory alone in Britain carries out observations with the meridian instrument for determining stellar positions. Several factors have contributed to this diminution of meridian observations in different countries, among which the economy of photography is important, and some may ask what justification there is for meridian astronomy. The answer is that, while we need accurate positions of only sufficient stars for reducing photographic plates, we require the proper motions of as many stars as possible, of every degree of brightness, of every spectral type, of every kind of variability, and in all galactic longitudes and latitudes, and all this involves the positions at two or more epochs. To determine the average distances of groups of stars too far away for trigonometrical calculations, proper motions are necessary, and they are thus important in investigations concerning the content of the Milky Way system at distances exceeding a hundred parsecs, in addition to showing the systematic and random motions of the stars themselves. This led Dr. Jackson to a discussion of the fundamental systems used, of certain disadvantages inherent in some and also of various ideas for improvements. His address ended with a short account of a very important aspect of meridian astronomy—namely, accurate time determinations—in which the Royal Observatory plays a prominent part, and the results of the photographic zenith tube in action are awaited with interest.

BRITISH JOURNAL OF RADIOLOGY

SIXTIETH ANNIVERSARY

THE May issue of the *British Journal of Radiology* is its diamond jubilee number. The *Journal* is the direct descendant of the *Archives of Clinical Skiagraphy*, which was the first journal to be devoted entirely to radiology. Its first number was dated April 2, 1896; but apparently it is not clear whether it was actually published then or in May of that year.

The *British Journal of Radiology* has had a great influence throughout the world in the development of medical radiology in its widest sense, and the jubilee number includes a number of historical reviews of particular interest. Prof. G. Stead deals with the contributions of physics to the progress of radiology during the past sixty years. It is perhaps singularly fortunate that many leading physicists have always devoted a great deal of effort to the advancement of the applications of physics to medicine. The first presidential address to the Roentgen Society, given by Silvanus Thompson, was apparently a remarkable beginning. Sir Oliver Lodge published a course of six lectures specially designed for medical practitioners. In the present number, Sir John Cockc writes on "The Future Role of Atomic Energy Industry, Science and Medicine", Dr. Russell Reynolds reviews sixty years of radiology, and James T. Case summarizes the evolution of mod radiology. A point of historical interest is that 1879 Sir William Crookes, without realizing it, apparently obtained X-rays in the course of experiments and had sent fogged photographic pla which had been stored near his vacuum tubes, b to the manufacturers as defective. The account X-ray apparatus by Mr. Cuthbert Andrews is illu inating. On the historical side, he mentions t "bound in the 1897 volume is what is undoubte the forerunner of our modern successful suppleme —A Supplement to the Archives of the Röntgen R entitled 'Radiography in Marine Zoology— British Echinodermata', by Dr. Wolfenden". particular interest to radiotherapists are the revi by Dr. N. S. Finzi on radiotherapy and Dr. Lacassagne on radiobiology.

The development of British radiology has depen upon a number of factors. Among the most import of these are probably the recognition of the value consultation in medicine with special reference to many aspects of radiology, the applications of phy to both radiodiagnosis and radiotherapy and interest throughout the years shown by many clini radiologists in those aspects of fundamental scie now called radiobiology. It is clear that the *Bri Journal of Radiology* has played a great part facilitating these developments.

ROCKEFELLER FOUNDATION GRANTS

THE National Academy of Sciences, Washingt has initiated a study of the possible biologi dangers to present and future generations of expos to atomic radiation. 250,000 dollars has be awarded by the Rockefeller Foundation for t project. A biophysics research programme on cultivation of individual animal cells has be devised by Dr. Theodore Puck and his associates the University of Colorado, towards which Foundation has made an award of 85,000 dolla The Foundation has made a research grant of 60, dollars to Drs. J. J. Christensen and W. M. My for their work in the University of Minnesota connexion with wheat stem rust. Research on genetic factors of intelligence and emotional variati in dogs, directed by Dr. C. C. Little at the Roscoe Jackson Memorial Laboratory, Bar Harbor, Mai receives a first-quarter grant of 50,000 dollars.

Dr. Edwin D. Kilbourne, of Cornell Univers Medical College, is working on latency or activati of viruses, towards the expenses of which Foundation has granted 48,000 dollars. The Univ sity of Chicago is to receive 50,000 dollars for programme of training in statistics for scientis The State Institute for Human Genetics, Upsa Sweden, has been awarded 50,000 dollars. The wo will be shared with the University of Upsala and Royal Agricultural College. Prof. A. Rossi-Fanell work at the Institute of Biological Chemist University of Rome, will be supported over a peri of four years by a grant of about 30,000 dollars, a that of Prof. P. Desnuelle at the Institute of B logical Chemistry, University of Aix-Marseille, over a period of five years by a grant of 25,000 dollars.

Research in biomathematics under Dr. Irwin Bross, of the Cornell University Medical College, is to be supported by a five-year grant of 50,000 dollars.

Among other grants made by the Rockefeller Foundation for the first quarter of 1956 are the following: Prof. T. Park, University of Chicago, experimental ecology, 10,500 dollars; National School of Agriculture and Livestock, Managua, Nicaragua, laboratory and field equipment; Prof. F. Buchthal, University of Copenhagen, physiology, 14,000 dollars; Institute of Pharmacology, University of Padua, virology, 10,000 dollars; Prof. S. Bezzi, University of Padua, organic chemistry, 10,000 dollars; University of Florence, Institute of Botany, 9,000 dollars; University of Utrecht, Biophysical Research Group, 12,000 dollars; Prof. Per F. Scholander, University of Oslo, experimental biology; Royal Veterinary College, Sweden, equipment for animal physiology.

Numerous grants towards travelling and study expenses and towards the costs of various congresses were also made. Forty-five fellowships were awarded in the following subjects: agriculture (23), biology and medicine (5), humanities (5), medical education and public health (7), social sciences (5).

OVULATION DURING DELAYED IMPLANTATION AND OTHER REPRODUCTIVE PHENOMENA IN THE BADGER (*MELES MELES* L.)

By PROF. R. J. HARRISON

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AND

E. G. NEAL

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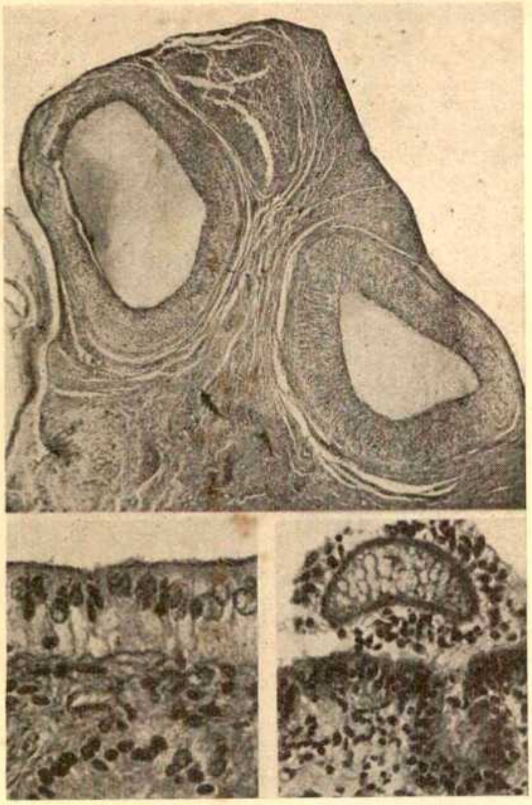
REPRODUCTION in the European badger has been the subject of controversy for many years, and one authority or another has made claims for each month of the year to be that of the mating season. Those investigators[1-3] who have recently examined the reproductive pattern comment at ength on the prolonged period of delayed implantation. Fischer[1] calculated from embryological data obtained from badgers in Germany that mating took place during July–September, that implantation delay of from 4 to 5 months) occurred in December and January and that cubs were born during January–March. Notini[2] stated that in Sweden mating occurred in May, that implantation was delayed for seven to eight months and that the cubs were born in March. Preliminary observations by Neal[3] in south-west England suggested that mating occurred not only in April and May, but also during July–September. Implantation usually occurred in December and parturition followed within sixty days. All these investigators have recovered blastocysts or mbryos at different times of the year, but none has made an exhaustive histological examination of the ovaries and reproductive tract, or counted the orpora lutea.

Since the date of the first report, Neal[3] and his ollaborators have maintained intensive observation f the numbers and behaviour of badgers at various ocalities in Gloucester and Wiltshire, but mainly n the Quantock Hills, Somerset. More than fifty nimals, cubs and adults, were obtained for disection as the result of being run over by motor-cars, illed by badger-diggers, keepers or pest-control fficers. The specimens were difficult to obtain, nd have taken nine years to accumulate, but he series covers the entire cycle and pregnancy xcept for July. The ovaries have been serially ectioned, and sections of the reproductive tract ave been examined. The uterus of each animal was carefully opened and searched or washed out for blastocysts, and serial sections were cut of the uterine tubes of those animals that had recently ovulated.

Examination of the fixed material indicates that the reproductive pattern in the badger is complex and variable. Maturing, mature and recently ruptured follicles are present in the ovaries in February and March, but the earliest date for recovery of blastocysts is April 30, 1955. During April–July the average number of blastocysts is 2·3 per animal (range 1–3); the number of corpora in these animals averages 4·0 per animal (range 3–6). The excess of corpora may be explained by not finding all the blastocysts or by loss due to degeneration. Twice as many animals (13) during this period had corpora in varying stages of development or retrogression (average 4·0 corpora per animal, range 2–7), but no ova, cleavage stages or blastocysts were found. In June, animals with blastocysts in the uterus and an equivalent number of corpora in the ovaries also possessed large, maturing follicles.

During the period August–December many differences can be detected; all but one of twenty adult females had blastocysts (average number 3, range 2–5) in their uterine horns. There is a significant rise in the average number of corpora to 6·2 per animal (range 2–11), and maturing follicles were also present in animals killed in late September. An adult female killed on October 16, 1954, gave an explanation for the findings. Four recently ruptured follicles and five retrogressing corpora lutea were present in the ovaries; of the latter, two corpora looked more degenerate histologically than the other three. Three healthy blastocysts were in the uterus, and in serial sections of one uterine tube there were two degenerate and apparently unfertilized ova. This and other similar examples indicate that the number of corpora increases during the period of delayed implantation due to ovulation during delay, and there is evidence from several animals that it can occur more than



(*Above*) Section of part of one ovary from a badger killed on October 16,1954, showing two young corpora and an older one. × 13. (*Lower right*) One of two degenerating ova present in the uterine tube of the same badger; there were three unimplanted blastocysts in the uterus. × 180. (*Lower left*) Tall columnar epithelial cells of the uterine mucosa during delayed implantation. × 440

once. Ovulation does not necessarily always occur for the first time in the spring, since evidence was found of sets of young corpora in June, September and even October, that were associated, in each specimen, with an equal number of blastocysts. Several animals killed in June, September and October showed thick, stratified and cornified vaginal epithelia, possessed maturing follicles, and had varying numbers of corpora and blastocysts. Others, sometimes killed on the same day as one of the above, lacked follicles, had only a low transitional vaginal epithelium, but possessed just as many corpora and blastocysts. During January and February a few pregnant animals were killed; the average number of embryos per animal was 3·1 (Fischer's material gives an average number of 2·7 and Notini's 2·5 per animal). Observations on the number of cubs after birth in south-west England give an average of 2·25 cubs per sow (8 singles, 22 twins, 8 triplets, 5 quadruplets). The average number of corpora lutea per animal during pregnancy is 6·5 (range 2–11). Thus no accessory corpora appear to be formed after implantation. The corpora present in each pair of ovaries from October to the end of pregnancy have similar characteristics, are twice as large as those of delay and are better vascularized. Rejuvenescence in the corpora lutea and the immediate pre-implantation changes in the uterus are heralded by increased vascularization and hyperæmia in these organs. Corpora lutea persist until the end of pregnancy, but show signs of involution at mid-pregnancy. They degenerate rapidly during lactation.

It therefore appears that the female badger in south-west England, having reached maturity during its second year, can either (*a*) ovulate for the first time in the early months of the year and have up to nine months delayed implantation during which up to three further ovulations may occur, (*b*) ovulate for the first time during the summer or autumn, perhaps exhibit further ovulations, and thus have a delay of implantation varying from two to six months.

There is no evidence of replacement of blastocysts, and little to suggest addition during the period of delay. The blastocysts exhibit similar characteristics throughout the period, with a large perivitelline space, and showing some evidence (as Notini[2] found) of slow but steady increase in size. The blastocysts are irregularly placed along the uterine horn during delay, and may even be found bunched together either at the proximal or distal ends of the uterine horn; spacing along the horn seems to occur just before implantation.

The uterine mucosa reacts scarcely at all to the ovarian events until implantation, and thus appears to be less sensitive to the prevailing hormonal environment than the vagina. Little secretory activity in the uterine glands can be seen, and the greatest detectable change is in the lining epithelium of the uterus, which appears to pass through cycles of changes from low cubical to high palisade, mucified columnar cells with the nuclei varying in position It is quite possible that it is these cells that are providing nutriment for the blastocysts during delay.

The histological and embryological findings fit in very interestingly with the observations of behaviour Sexual excitement is greatest during the period February–May, and at other times takes the form of short isolated nights with long periods in between where no interest of any kind is shown. From mid-May to mid-July the badger shows least sexual activity, and feeding occupies its activities. Mating has been observed by Neal and his collaborators during the main period of sexual excitement, late March–May, and again during July–September Attempted matings were observed during February and March and in early October.

It would appear that the corpora of delay are not active producers of progestins, and that there is no evidence to support an argument that corpora accumulate as the result of additional ovulations during delay until their combined progestin secretion is sufficient to induce implantation. In fact, the corpora of delay are all characterized by varying degrees of vacuolation in the cytoplasm of the lutea cells and even by fairly advanced cellular degeneration. The evidence from badgers kept isolated in captivity[2,4] proves that a period of delay of eight months is quite possible (there are even records of females giving birth after being kept isolated for thirteen and fifteen months), and suggests that the mating stimulus is not necessary to precipitate implantation. No vaginal smears were prepared from these animals and thus the possibility of spontaneous ovulations or even of the existence of a definite ovarian cycle during delay cannot be ruled out Lactation does not appear much to influence the events; it lasts about four months and has virtually ceased by the end of June. Increase in the length of day has been suggested[5,6] as a factor inducing implantation in the mink, but it is difficult to consider this a factor in the badger. The animal lives mainly in a deep burrow during the day, emerges in the dusk and is virtually nocturnal in its habits ; further, our evidence suggests that implantation in many animals must occur before the days start to lengthen. The age of the animal does not influence much the reproductive pattern, since both young and old females display delay ; there is slight evidence from two older females that there had been an increase in the number of times follicles had ruptured during delay.

It is felt that insufficient attention has been directed to the part that may be played during delay by the adrenal and by the interstitial tissue of the ovary. In the badger, the latter tissue is well developed, particularly in the cortical region, and is curiously invaded by numerous communicating epithelial tubes. These intra-cortical tubes sometimes extend from openings on the surface of the ovary to the hilum, where they may anastomose with the rete ovarii. They are reminiscent of the sub-surface crypts of the covering epithelium described by Harrison and Matthews[7] in a wide variety of mammals, but are developed to a degree much greater even than that observed in Pinnipedia. The cortical interstitial tissue passes through a distinct series of cytological changes during delay, and histochemical techniques strongly suggest it to be active during this time ; it reacts to a variety of techniques more strongly than any other component of the ovary.

A detailed account of all the aspects of reproduction elicited from the observations on behaviour and examination of the fixed material will be presented shortly.

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ORGANIC PEROXIDES AND MUTAGENIC EFFECTS IN *DROSOPHILA*

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Mutagenicity of Dihydroxydimethyl Peroxide and the Mutagenic Effects of Formaldehyde

It has been suggested[1] that the mutagenic action of formaldehyde may be related to that of organic peroxides. The fact that a mixture of formaldehyde and hydrogen peroxide is a much stronger mutagen for *Neurospora* conidia than either substance alone has been attributed to the formation of an organic peroxide, dihydroxydimethyl peroxide, HO—CH_2—O—O—CH_2—OH [2]. According to Jensen *et al.*, even pure formaldehyde solutions exercise their mutagenic effect on *Neurospora* by way of peroxide formation.

In *Drosophila* a mixture of formaldehyde and hydrogen peroxide did not produce more mutations than formaldehyde alone[3]. This may be due to the high catalase content of the body fluids of the fly. Catalase inhibition has been used to test the idea that peroxide formation plays a part in the production of mutations by formaldehyde injections into *Drosophila*. The result supported this assumption ; for a given dose of formaldehyde produced twice as many mutations in males which had been pretreated with sublethal doses of cyanide vapour than in flies not so treated[4].

Mutations in *Drosophila* have been produced by direct application of organic peroxides by Altenburg[5], using tert.-butylhydroperoxide, and by Sobels[6], using dihydroxydimethyl peroxide. The latter substance is of particular interest because of its probable implication in mutagenesis by a formaldehyde – hydrogen peroxide mixture, and it has therefore been studied in more detail.

The compound was synthesized by Mr. M. J. D. van Dam, of the Department of Organic Chemistry, University of Utrecht, by the reaction of formaldehyde and hydrogen peroxide in ether[7]. All solutions contained 0·7 per cent sodium chloride in distilled water and were buffered at *p*H 6·6. 0·28 mm.^{3} of such solutions was injected into the abdominal cavity of wild-type Oregon-*K* males characterized by a spontaneous mutation-rate of 0·2–0·3 per cent. The treated males were afterwards tested for the incidence of sex-linked lethals by means of the Muller-5 method. Preliminary observations were made on the pattern of sensitivity in the gonads of the treated males by mating them individually to three fresh virgin Muller-5 females at specific intervals. The successive broods arising in this way then represent successively younger stages of spermatogenesis at the time of treatment.

Four different concentrations of dihydroxydimethyl peroxide were used. Those with the higher doses showed that it is a fairly potent mutagen for mature spermatozoa. A 0·04 *M* solution, which is highly toxic, produced 1·7 per cent lethals in 662 chromosomes from sperm used during the first three days after treatment. A 0·02 *M* solution produced 3·6 per cent lethals in 471 chromosomes from sperm utilized on the first day after treatment. In the latter experiment, spermatozoa which had been utilized from the second to the fourth day were also tested for lethals ; they carried only five lethals in 662 chromosomes (0·8 per cent). Still later broods were not examined.

The lowest concentrations of dihydroxydimethyl peroxide were, on the contrary, ineffective on mature spermatozoa, but resulted in an increased mutation-rate in the third brood produced from the seventh to the tenth day after treatment. After treatment with 0·0138 *M* dihydroxydimethyl peroxide, this brood contained 1·3 per cent lethals in 933 chromosomes, and after treatment with a 0·015 *M* solution it contained 1·8 per cent lethals in 439 chromosomes. It thus appears that at some stage during spermatogenesis, sensitivity to the mutagenic action of dihydroxydimethyl peroxide is even higher than in mature spermatozoa.

The present finding that dihydroxydimethyl peroxide, like formaldehyde, induces mutations in mature sperm supports the hypothesis[4] that formaldehyde exerts at least part of its mutagenic effects via the formation of an organic peroxide. In addition to their action on mature sperm, both dihydroxydimethyl peroxide and formaldehyde[3] produce mutations in earlier stages of spermatogenesis. This further similarity suggests that the formation of a peroxide may also be involved in the mutagenic effects of formaldehyde on earlier stages of sperm development. It cannot yet be decided whether the same is also true for the mutagenic action of formaldehyde, if fed to the larvæ, in which case mutations were obtained only in the auxocyte stage preceding meiosis[8].

In view of the enhancing effects of a cyanide pretreatment on formaldehyde mutagenicity, the effects of cyanide on peroxide-induced mutation-rates were studied. Such pretreatments did not enhance the mutagenic effects of strong doses of dihydroxydimethyl peroxide; a slight effect in the first brood after injection of the low doses is not excluded, however. This result can perhaps be interpreted by assuming that after administration of dihydroxydimethyl peroxide the fly is provided with the ready-made product, whereas in the case of formaldehyde, catalase-inhibition favours accumulation of the peroxide.

Finally, it may be mentioned that one daughter of a male treated with dihydroxydimethyl peroxide carried a mutation to an allele of white in part of her gonads. This observation of delayed action brings dihydroxydimethyl peroxide into line with other chemical mutagens[9].

I am much obliged to Mr. M. J. D. van Dam for his co-operation in synthesizing the dihydroxydimethyl peroxide preparation.

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Effect of Pretreatment with Dihydroxydimethyl Peroxide on the Rate of Mutations induced by X-rays

Previous observations showed an enhancement of the rates of mutation induced by X-rays after pretreatment with cyanide and azide[1]. This finding suggested that increased production of hydrogen peroxide, due to inhibition of the cytochrome and catalase enzyme systems, made the genetic material more sensitive to the effects of radiation. The fact that pretreatment with formaldehyde likewise enhanced the genetical effects of X-rays (unpublished work) supports this assumption, because formaldehyde also inhibits catalase and in addition produces mutations, presumably through the formation of an organic peroxide (see above).

For a further test of the idea that the presence of increased amounts of a peroxide enhances the effects of irradiation, flies were pretreated with an organic peroxide, dihydroxydimethyl peroxide.

Oregon-*K* males one to two days old were injected with low concentrations of dihydroxydimethyl peroxide and placed under the X-ray apparatus immediately afterwards, the average time between injection and irradiation being 13 ± 10 min. X-radiation was by a General Electric, Maximar 100 model of the dermatology clinic of the University of Utrecht at 100 kVp., 5 m.amp., 1 mm. aluminium (half-value thickness: 1·3 mm. aluminium) and 240 r. per minute. Simultaneous exposure of pretreated and X-ray control flies to the irradiation was possible by the use of different indian ink marks on their thorax. The preparation of the dihydroxydimethyl peroxide solutions and the genetic methods employed were essentially similar to those described before (see above).

Table 1 (upper half) presents the results of two experiments in which males were mated one day after treatment and afterwards changed to three fresh Muller-5 females per male every three days. It will be seen that, as in previous experiments, dihydroxydimethyl peroxide by itself in low concentrations had only a negligible effect on frequency of mutation in the first two broods, but exercised a definite mutagenic action on some earlier stage of spermatogenesis, which in these experiments furnished spermatozoa for the third brood. In the two

Table 1. Frequency of Sex-linked Lethals in Successive Broods from Males which had been Injected with Solutions of Dihydroxydimethyl Peroxide prior to X-radiation, as compared with that from Males which were Irradiated with X-rays or Injected only

Experiment	Concentration of dihydroxydimethyl peroxide or radiation dose	Sex-linked lethals (days after treatment)					
		1–4		4–7		7–10	
		n chrom.	% leth.	*n* chrom.	% leth.	*n* chrom.	% leth.
P 1–2	0·015 *M*	515	0·6	536	0·2	439	1·8
R_1	1,700 r.	479	4·8	452	4·4	534	7·3
P–R_1	0·015 *M* + 1,700 r.	462	5·8	408	15·9	339	4·7
				*$\chi^2 = 11·96$; $P < 0·001$			
R_2	1,700 r.	485	5·6	516	5·8	474	5·5
P–R_2	0·015 *M* + 1,700 r.	484	4·5	518	11·6	561	5·3
				$\chi^2 = 6·32$; $P < 0·02$			

Experiment	Concentration	1–4		4–5		6		7–10	
		n chrom.	% leth.	*n* chrom.	% leth.	*n* chrom.	% leth.	*n* chrom.	% leth.
P_3	0·0138 *M*	524	—	495	—	495	0·4	512	1·4
R_3	1,511 r.	497	4·6	513	4·9	261	7·3	329	2·4
P–R_3	0·0138 *M* + 1,511 r.	506	4·7	458	9·8	70	20·0	387	2·6
				$\chi^2 = 5·77$;	$P < 0·02$	$\chi^2 = 8·06$;	$P < 0·01$		

* χ^2 is based on a comparison between P–R_1(4–7) and R_1(7–10). For all χ^2 calculations corrections have been made allowing for mutation rates induced by dihydroxydimethyl peroxide in the last brood (7–10).

experiments in which it was combined with irradiation, an effect of the pretreatment was apparent only in the second brood, where it was statistically highly significant. It remained significant after correction for the possibility that the mutagenic effect of dihydroxydimethyl peroxide by itself, which in the controls occurred in the third brood, was in these experiments shifted to the second.

With the mating scheme used, the second brood in X-ray experiments is usually drawn from the most sensitive stage in spermatogenesis and yields the highest frequency of mutation after irradiation[1,2]. It s this stage which responds most clearly to the potentiating action of cyanide and azide on X-ray mutagenesis (Fig. 1). The present results, therefore, seem to bring pretreatment with dihydroxydimethyl peroxide in line with those earlier experiments. Unfortunately, however, sperm utilization in the present experiments was not as had been expected, and had resulted in unusual brood patterns of mutation-rate. In R_1 the peak occurred in the third brood, in R_2 there was no clear peak at all. In R_1 at east it seemed possible that the high mutation-rate in the second brood of the pretreated series was due not so much to an effect of dihydroxydimethyl peroxide on X-ray mutagenesis as to a change in the rate of sperm utilization, as a result of which the stage most sensitive to the peroxide alone furnished sperm for the second brood. Even on this assumption, there remains a real excess of mutations in the pretreated series. Thus the enhancing action of dihydroxydimethyl peroxide on X-ray mutagenesis seems well established by these experiments; but the question whether this action is exercised at the same stage as those of cyanide and azide could not be decided from them.

A third experiment was therefore carried out with a mating scheme which, it was hoped, would result in a clearer separation of the stages of spermatogenesis. Four broods were raised, covering successively three, two, one and three days. A smaller X-ray dose and a lower concentration of peroxide were chosen than in the previous experiments, the former to guard against sterility and saturation at the most sensitive stage, the latter in order to minimize the mutagenic action of the peroxide by itself. The results are set out in Table 1 and in Fig. 2. Under these conditions, mutation frequency after irradiation without pretreatment rose slightly from the first to the second brood and reached a decisive peak in the third. The potentiating effect of dihydroxydimethyl peroxide started in the second brood and was most pronounced in the third; χ^2 was significant for both broods. Dihydroxydimethyl peroxide by itself, on the other hand, produced a slight mutagenic effect only in the fourth brood, when mutation frequencies in the two irradiated series had already dropped below the initial level. These results lead to the conclusion that dihydroxydimethyl peroxide, like potassium cyanide and sodium azide, enhances the mutagenic effect of X-rays mainly or perhaps exclusively during the sensitive stage, while its own mutagenic effect is exercised on some earlier stage.

The marked similarity between the enhancing effects of dihydroxydimethyl peroxide and those of potassium cyanide and sodium azide supports my earlier hypothesis that, after pretreatment with the latter substances, increased amounts of peroxide were responsible for the greater mutagenic action of the radiation. In this connexion the results of Stone *et al.*[3] on carbon monoxide poisoning before and after irradiation of *Drosophila virilis* are of great interest. They found that, due to inhibition of the cytochromes, an increase in the X-ray-induced translocation-rates in this species is most pronounced

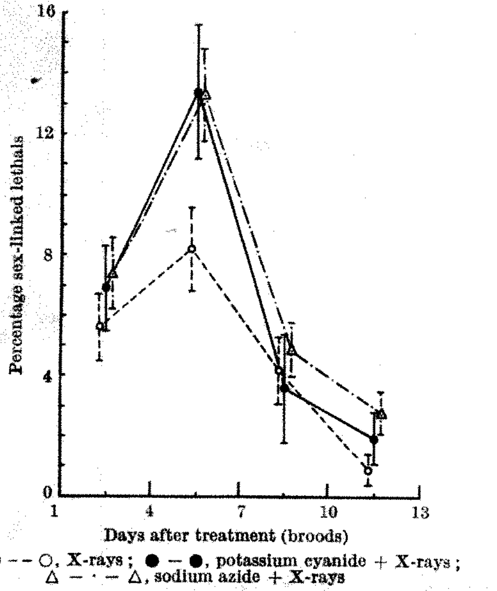

Fig. 1. Frequency of sex-linked lethals in successive broods from males which had been injected with solutions of cyanide (0·008 *M*) or azide (0·003 *M*) prior to X-irradiation with 1,700 r., as compared with that from males receiving X-rays only

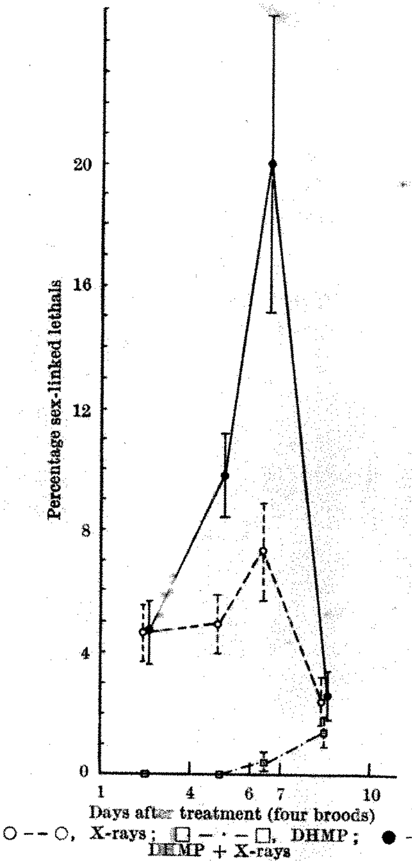

Fig. 2. Frequency of sex-linked lethals in successive broods from males which had been injected with 0·0138 *M* dihydroxydimethyl peroxide prior to X-irradiation with 1,511 r., as compared with that from males which were irradiated or injected only

at a stage corresponding to stages of peak sensitivity to the mutagenic effects of irradiation in *D. melanogaster*.

The present observation that one particular stage of spermatogenesis, characterized by peak sensitivity to the mutagenic action of X-radiation, also shows a preferential response to pretreatment with an organic peroxide and other compounds which are thought to act via peroxide formation, suggests that the two phenomena may be related. They support the view put forward by Auerbach[4] for the mutagenic action of mustard gas, that at the sensitive stage some new mechanism for mutagenesis is added to that which acts on mature spermatozoa, this new mechanism presumably being connected with biochemical conditions prevailing in immature germ cells, but no longer in ripe ones. Altogether, then, it seems a reasonable assumption that the formation of peroxides accounts for at least part of the mutagenic action of X-rays on the genetic material of *Drosophila*.

Prof. J. J. Zoon, who made the X-ray apparatus of his department available, and the technical assistance of Miss V. van den Hul and Mrs. J. Lanzing are gratefully acknowledged. I also wish to thank Dr. Charlotte Auerbach for reading both these manuscripts. The investigation was subsidized by the Radiobiological Group of the Health Research Council T.N.O. [Feb. 22

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TESTS OF PURITY OF DIPHTHERIA TOXINS BY ELECTROPHORESIS IN STARCH GEL

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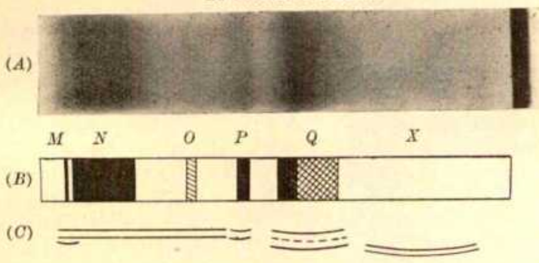
I HAVE previously reported on the purification of diphtheria toxoid by filter-paper electrophoresis and continuous electrophoresis methods[1,2]. Three components were obtained, two of them possessing no biological activity as demonstrated by the immunoelectrophoretic method introduced by me in 1952[1]. Recently I have separated highly concentrated and purified diphtheria toxins and toxoids as well as tetanus toxoids into several components by electrophoresis in starch gel[3].

Since the actual concentrations of the materials are low, photography of these gels is very difficult in spite of the fact that the components are clearly visible by viewing them in reflected or transmitted light. The results from only a few of the materials tested will be presented here. Fig. 1 shows the photograph (*A*) of a starch gel in which the diphtheria toxoid from the Connaught Laboratories was separated. Five components (*M*, *N*, *O*, *P*, *Q*) stained with amido black 10*B* can be seen. Under the photograph is a diagram (*B*) of the same pattern. All other results described in this communication are represented by similar drawings. The biological activity of the components obtained was demonstrated by flocculation in agar gel using the technique of immunoelectrophoresis already mentioned[1]. The result is represented graphically by a series of flocculation lines (Fig. 1,*C*); each of the components shows at least two. Component *X* gave two flocculation lines in spite of the fact that it could not be demonstrated by staining methods. In the same figure the protein pattern obtained with toxin purified by Lepow and Pillemer[4] is shown with the corresponding lines of flocculation. This material is fraction *E*-2-2 containing 6,850 Lf./ml.; 2,350 Lf./ mgm. nitrogen; 2·80 mgm. nitrogen/ml. (Lepow, I. H., communication to Dr. D. T. Fraser). Seven clearly visible components were obtained and also three additional components perceptible by transmitted light (Fig. 1,*D*). The corresponding flocculations are drawn below (Fig. 1,*E*). The number of the stained components and the number of the flocculation lines correspond to the number of flocculation lines found by carrying out the flocculations in agar[5]. It is felt, therefore, that most of the components

Di-toxoid-II-Toronto



Di-toxin: Lepow–Pillemer

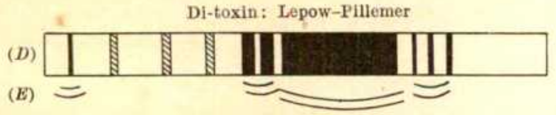
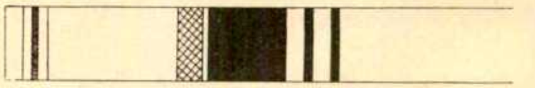
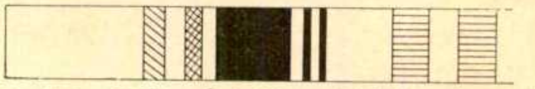


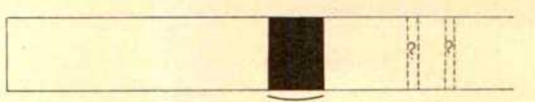
Fig. 1. Full black shading: heavy stain. Cross-hatching: plainly visible. Diagonal hatching: barely visible. Horizontal hatching: visible in transmitted light



TD – 8/51 – 1,800 Lf./mgm. total nitrogen



TD–3/51 – 162 Lf./mgm. 0·084 mgm. total nitrogen/mgm.



Toxin-Pope *MS*–605/7 – 2,610 Lf./mgm. total nitrogen

Fig. 2. Shading same as in Fig. 1; vertical dotted lines: probably present

proposed by Dr. S. G. Pope *et al.*[5] are demonstrated by the present technique.

Fig. 2 shows graphically results obtained with toxins *TD*-3/51 and *TD*-8/51 obtained from the Statens Serum Institut of Denmark through the courtesy of Dr. Inge Scheibel and with a toxin obtained from the Wellcome Laboratories through the courtesy of Dr. Pope. The latter material, designated *MS*-605/7, contained 1,540 Lf./ml.; 2,900 Lf./mgm. protein nitrogen; 2,610 Lf./mgm. total nitrogen. After at least three further crystallizations, this material would give a single flocculation line in agar gel (communication to Dr. D. T. Fraser[6]).

Since the number of components differs in toxins from different laboratories, an attempt was made to determine the purity of Pope's toxin by interaction with serum. During studies (unpublished) of the binding capacity of diphtheria toxin by polyvinylpyrrolidone, albumin and serum, it was observed that the filter-paper electrophoresis pattern of normal serum (Fig. 3,*D*) is disturbed when mixed with toxin (Figs. 3*A*, *B*). The space between albumin and alpha-1 is widened, the 'alpha-1 globulin' fraction is increased in amount and the 'alpha-2 globulin' fraction is decreased. By flocculation in agar gel the toxin was localized in the alpha-1 globulin position[1]. It can be seen that both toxins *TD*-8/51 (Fig. 3,*A*) and *TD*-3/51 (Fig. 3,*B*) influence the pattern in the same way. The percentage distribution of the components was measured by an electronic computer[7] and the results are given on the left-hand side of each serum pattern. The toxin of Lepow and Pillemer was also found to have similar properties. The changes were induced even when the toxin was diluted 1 : 500 (1·9 Lf./ml. of serum in the case of *TD*-8/51). Pope's toxin, when mixed with the serum, was also localized in the region of alpha-1 globulin (Fig. 3,*C*) but did not change the pattern. A striking example of this interaction of toxin with the serum proteins was obtained by mixing the toxins with a nephrotic serum (Fig. 3,*H*) in which the alpha-2 globulin was markedly increased. The photograph shows that a significant portion of the alpha-2 globulin was removed (Fig. 3*E*, *F*) by the toxins and shifted to the beta-globulin region, thus producing a heavy band. The distance between alpha-1 globulin and albumin was again increased. Here also the toxins were localized by flocculation in the alpha-1 globulin region.

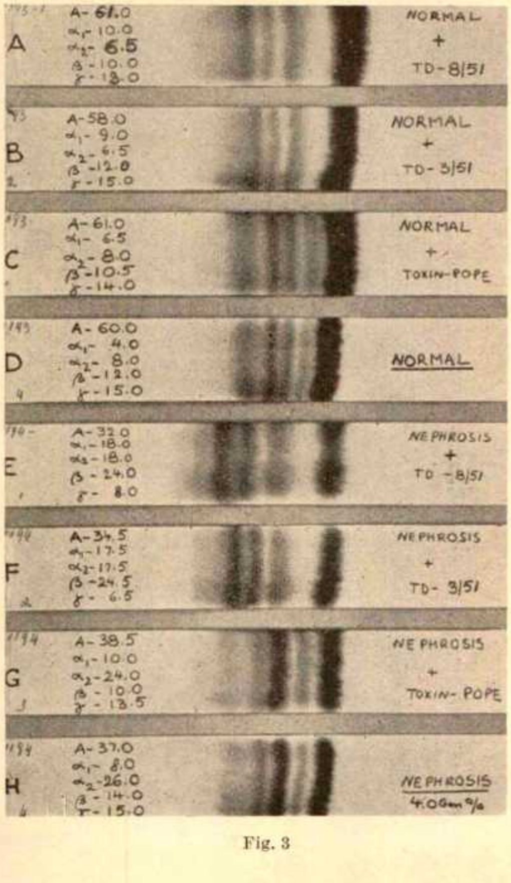


Fig. 3

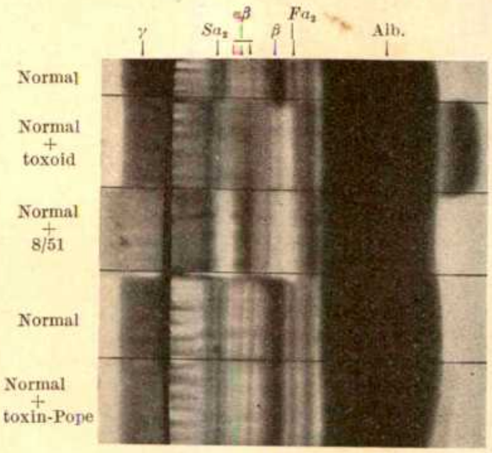


Fig. 4

The failure of Pope's toxin to induce the change in serum protein pattern described for the other toxins is apparent by comparing pattern *C* with pattern *D* and *G* with *H* in Fig. 3. It is therefore concluded that substances missing in the preparations *MS*-605/7 and present in the other toxins are responsible for this change. The sole component of *MS*-605/7 in starch gel gave two flocculation lines by the immunoelectrophoretic technique, and this toxin must be regarded as much more purified than the others.

More detailed information about the fractions involved in these changes was obtained by subjecting the mixtures to electrophoresis in starch gel[3]. A mixture of serum with toxoid was also included, in order to illustrate its effect on the serum protein pattern.

Fig. 4 shows a photograph of a large gel in which the mixtures were applied side by side and subjected simultaneously to the same electrophoretic conditions. Disregarding the photographic blemishes, it is evident that Pope's toxin induces no change in the main protein pattern. On the other hand, toxin *TD*-8/51 involves not only the subfractions of alpha-2 and beta-globulins, but also gamma-globulin. A detailed discussion of these various interactions will be given at a later date.

This work was supported by a Federal Public Health Grant. I am indebted to Dr. O. Smithies for the comparative experiment in the large gel and to Mr. C. Smith for the photographs. [Feb. 22

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Metal Whiskers

'Whiskers' are small crystals which grow from the surface of several metals. It is believed that their structure is to an unusual degree free from imperfections[1]. Whisker growth from the free edges of tin plate is affected by stress in the tin, both growth-rate and whisker population being increased[2]. Hasiguti[3] has suggested that whisker growth is a means of reducing stress when general extrusion is inhibited. In the present work evidence has been obtained that extrusion must be obstructed if whiskers are to form. Thus on compressing a 3-mm. slab of an alloy containing small particles of tin dispersed in aluminium, profuse growth of whiskers occurred over the whole exposed tin surface (Fig. 1).

Growth of a whisker ceases abruptly at a length independent of pressure[2]. It has now been observed that after a crop of whiskers has been wiped from the tin plate a further set will grow. After twelve cycles of growth and removal a few sources remained active, and some sources produced a total whisker length of about 1 cm. although individual whiskers were rarely as long as 1 mm. There was sometimes an 'incubation period' of a few days before growth recommenced on a source.

When the sources in a surface had been exhausted, grinding away 20μ from this surface made fresh growth possible.

Near the melting point of tin, growth is more rapid and whiskers are longer (up to 5 mm.).

Electron micrographs of carbon replicas of tin whiskers showed star-shaped cross-sections to occur in those of smaller diameters (Fig. 2). Thicker whiskers appear as bundles of thinner ones: using the optical microscope, striations along the length of some of these were seen and occasionally they branched toward their tip.

It appears difficult to account for such properties as the abrupt termination of growth, a constant growth-rate and the reactivation of sources by a dislocation mechanism involving climb only. It is now proposed that whiskers are generated mainly by a glide mechanism; but that the frequency with which the whisker generating dislocations operates depends on diffusion: this will still give the linear relationship between growth-rate and pressure[3]. This model will be discussed in detail elsewhere.

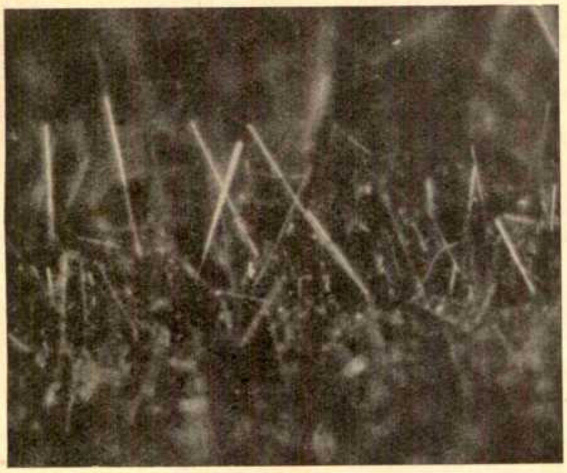

Fig. 1. Tin whiskers growing from tin finely dispersed in aluminium (approximately equal weights of each metal). Oblique view. (× 60)

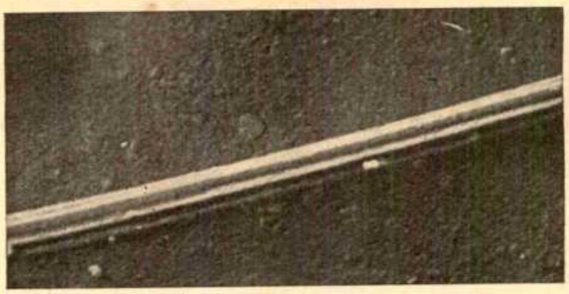

Fig. 2. Electron micrograph of tin whisker. (× 20,000)

I wish to thank Dr. G. A. Geach for suggesting this work and Dr. T. E. Allibone for permission to publish this communication.

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Aldermaston, Berkshire. April 23.

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Microwave Detection of Metallic Ions and Organic Radicals in Plant Materials

In numerous plant substances we have detected strong electron-magnetic resonances from manganese ions (see Fig. 1, for example). The manganese resonance can be immediately recognized by its six-line hyperfine structure resulting from the manganese nuclear interaction (spin 5/2). In all plant materials in which it was found, the multiple spacing was exactly that for manganese ions in aqueous solution (component separations of 95 gauss). Since the manganese multiplet spacing in crystals has been found to depend upon crystalline fields, we conclude that the manganese ions which we have found in plants may be dissolved in their water content.

Note the single sharp line with $g = 2{\cdot}00$ superimposed on the manganese hyperfine structure for pine cone and pine needle in Fig. 1. In pine needles picked up from the ground, this single resonance appeared much stronger relative to the manganese resonance. Possibly its greater strength relative to the manganese structure came about because the fallen needles had lost some of their water content. We have observed similar resonances in fallen oak leaves, naturally dried ivy stems, and other apparently dead plant materials.

The sharp single resonance observed in these experiments, which is apparently like that observed by Commoner, Townsend and Pake[1] in many lyophilized substances, may in some instances arise from bound or semi-bound oxygen. We have identified a similar resonance[2] of bound oxygen in irradiated 'Teflon'; but for plants which generate oxygen, a controlled experiment to test this hypothesis is more difficult.

A third type of resonance we have observed in several plant materials is illustrated by Fig. 2. This

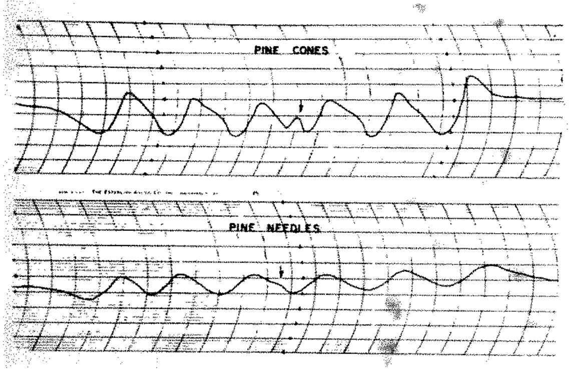

Fig. 1. Paramagnetic resonance of various plant materials at room temperature. The six equal components occurring for all have a total spread of 475 gauss (component-spacing 95 gauss). This sextet arises from manganese ions of the plant. The source of the additional resonance indicated by arrows is uncertain. It may arise from organic free radicals or from trapped oxygen. The curves were obtained with an Esterline-Angus recorder. Low-amplitude magnetic modulation of the absorption line was employed, synchronized with a phase-lock-in detector and amplifier. The curves do not represent the true line shape but approximately the first derivatives of the actual absorption curves. That for pine needles was obtained at 9 kMc./s., the other at 23 kMc./s. The centre of the patterns (points indicated by the arrows) represents the position of the free electron spin resonance

s a broad resonance with a g factor of 2·06. In the stems of oak leaves we found the manganese resonance superimposed on the broader resonance. In cotton eaves no manganese resonance is evident. We are not yet certain of the origin of the broad resonance; but we tentatively attribute it to cupric ions. The g factor of 2·06 is exactly that found by Ingram and Bennett[3] for the copper derivative of chlorophyll. We have found an identical resonance in a commercial sample of chlorophyll. We suggest that this resonance in the commercial sample, as well as the similar ones in Fig. 2, indicates an occasional substitution by certain plants of copper for magnesium in their chlorophyll. Such substitution may depend on many factors, such as the condition of soil and season.

Our preliminary observations reported here were made at room temperature on materials simply taken from the plant, or the ground below, and placed directly in the absorption cell. Certainly at lower temperatures and perhaps at room temperature resonances of other metallic ions should be observable. The method should become a convenient tool for plant physiologists or agriculturists.

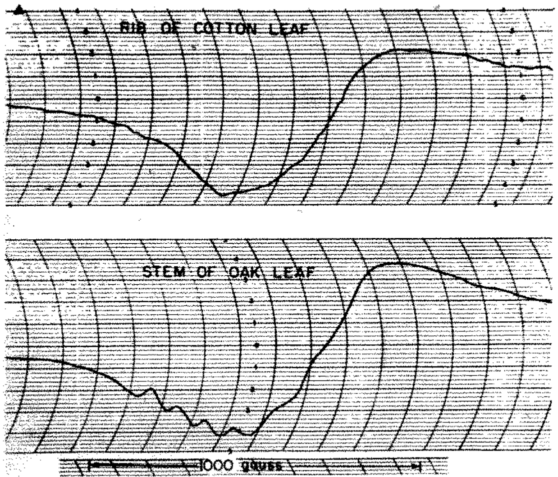

Fig. 2. Paramagnetic resonance at 23 kMc./s. in certain plant materials. The curves were obtained as described for Fig. 1, except that the amplitude of modulation was increased, and the scale condensed to favour detection of a broader resonance. The broad resonances here are believed to result from cupric ions in the plant. The g factor is 2·06. The structure superimposed upon the broad resonance for oak leaves arises from manganese ions

This investigation is supported by the Office of Ordnance Research, Department of the Army, and by the Office of Scientific Research of the Air Research and Development Command, U.S. Air Force.

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Structure of 3 : 4-Benzpyrene

3 : 4-BENZPYRENE is one of the most potent carcinogenic compounds. It is the active cancer-producing agent in coal-tar and in the tars produced during the combustion of many organic materials. It crystallizes in two forms (*a*) monoclinic and (*b*) orthorhombic. The unit cells and space groups of both forms have already been determined[1]. (In this earlier work the compound was called 1 : 2-benzpyrene; but the nomenclature was afterwards changed.) The monoclinic form has now been investigated in more detail.

The structure was solved by a combination of the trial-and-error method with that of Fourier transforms. Two-dimensional Fourier syntheses were calculated on the following zones, ($0kl$), ($hk0$), ($h0l$) and (hkh). In addition, a bounded projection on (010) of $\frac{1}{4}$ of the unit cell was calculated. The atomic co-ordinates were refined by successive F_0 syntheses followed by $(F_0 - F_c)$ syntheses on the ($0kl$) and (hkh) zones. It is interesting to note that in the ($0kl$) zone where every atom is well resolved, the co-ordinates obtained by repeated $(F_0 - F_c)$ synthesis refinement agreed very closely with those obtained by applying to the F_0 Fourier map the corrections given by the method used by Burns and Iball[2] for chrysene. In this latter method each electron-density peak position obtained from an F_0 synthesis is corrected for the effect of neighbouring peaks in the projection.

The observed structure factors were obtained from equi-inclination Weissenberg photographs by eye-estimation of the intensities. The calculated structure factors were obtained by using the scattering curves of McWeeny[3] for carbon and hydrogen, with temperature factors (B) of 3·42 and 4·75 for carbon and hydrogen respectively.

The crystal data are as follows: $a = 4{\cdot}535$ A., $b = 20{\cdot}40$ A., $c = 13{\cdot}49$ A., $\beta = 97{\cdot}0°$; space group $P2_1/c$; 4 mol. ($C_{20}H_{12}$) per unit cell, density observed = 1·351 gm./c.c., calculated = 1·352 gm./c.c.

Fig. 1 shows the Fourier projection on the plane perpendicular to the a-axis. Only a few atoms are resolved in each of the other projections calculated.

The following reliability indices $\left(R = \frac{\Sigma|F_0 - F_c|}{\Sigma|F_0|}\right)$ indicate the agreement between the observed and

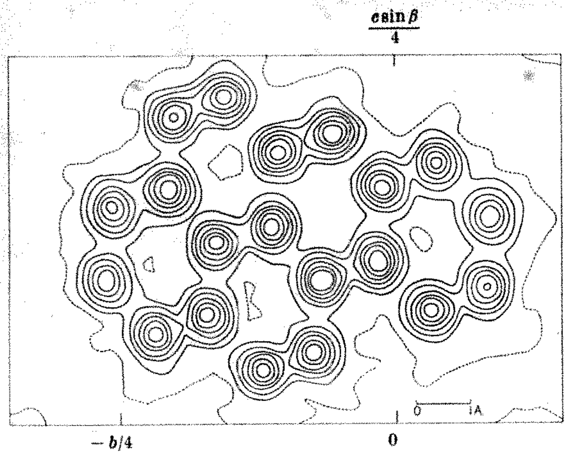

Fig. 1. Electron-density map of projection on plane perpendicular to a-axis. Contours at intervals of one electron per A.^{2}; the one-electron contour is dotted

calculated structure factors, $R(0kl) = 0{\cdot}12$, $R(hk0) = 0{\cdot}17$, $R(hkh) = 0{\cdot}17$.

The position of the molecule in the unit cell can be given by stating the co-ordinates of atom S (Fig. 2), which are $x/a = 0{\cdot}200$, $y/b = -0{\cdot}112$, $z/c = 0{\cdot}268$.

The equation of the mean plane of the molecule is

$$0{\cdot}770\,x' - 0{\cdot}602\,y - 0{\cdot}222\,z' - 0{\cdot}891 = 0$$

where x' is parallel to a, y is parallel to b and z' is perpendicular to the plane (001).

This molecule is not as planar as the molecules of some of the other condensed-ring hydrocarbons. The mean deviation of the carbon atoms from the above plane is 0·037 A. and the deviations of four atoms are rather larger than was expected. They are: $M = 0{\cdot}087$ A., $R = -0{\cdot}067$ A., $Q = -0{\cdot}067$ A. and $E = 0{\cdot}101$ A.

The bond-lengths calculated from the latest co-ordinates are given in Fig. 2. There are two abnormally short bonds IJ and AR, and one very long one, RQ. It seems probable that the co-ordinates of atom R are in error and that this is the explanation of the abnormal bond-lengths AR and RQ. However, if the co-ordinates of atom R are changed, the agreement between calculated and observed structure factors is adversely affected.

The investigation is being continued in an effort to determine the atomic co-ordinates more precisely. It is hoped to carry out three-dimensional calculations, and in addition more accurate methods of measuring the intensities are to be used. Full details of the crystallographic analysis will be published later.

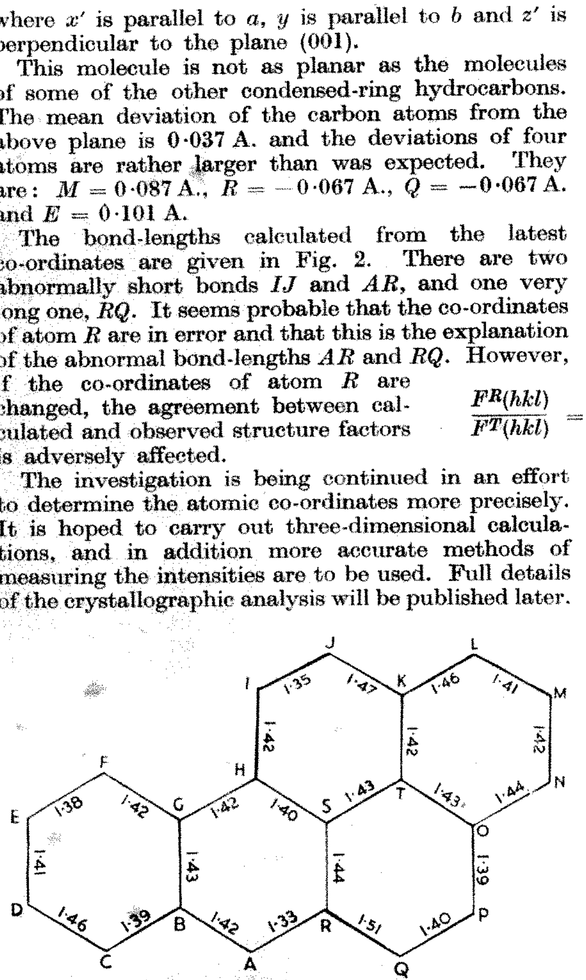

Fig. 2. Bond-lengths (A.) in 3 : 4-benzpyrene ($C_{20}H_{12}$)

This work has been assisted by grants from the Royal Society and the British Empire Cancer Campaign.

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March 15.

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Anisotropic Temperature Factors in Cubic Crystals

IN recent structure analyses of crystals it has been found impossible to obtain reliable atomic co-ordinates unless allowance is made for anisotropic thermal vibration of the individual atoms[1]. It has, of course, long been known that different atoms have different amplitudes of vibration even in cubic structures[2]. Weiss, DeMarco, Weremchuk, Corliss and Hastings[3] have recently reported that the Debye factors for the 222 and 400 reflexions from α-brass are different, and they have asked how this can be, since they interpret Ott's theory[4] as implying that the Debye factor for reflexions from a cubic crystal should be independent of crystallographic direction.

This is only true, however, if all atoms have similar thermal motions. It is not true in general: (1) if the amplitudes of vibration of different atoms are different; (2) if the amplitudes are anisotropic and the ellipsoids of thermal movement are differently orientated for crystallographically different types of atom.

Since $B^T = (\lambda^2/\sin^2\theta)\ln|F^R/F^T|$ (R = rest, T = given temperature), we may take $|F^R/F^T|$ as a measure of the Debye temperature factor. We shall assume that the mean parameters of the atoms are the same for the structure at rest or in therma motion, and then,

$$\frac{F^R(hkl)}{F^T(hkl)} = \frac{\Sigma f_r(hkl)\,.\,\exp 2\pi i(hx_r + ky_r + lz_r)}{\Sigma f_r(hkl)\,.\,\exp\{-B_r^{hkl}\sin^2\theta/\lambda^2 + 2\pi i\,(hx_r + ky_r + lz_r)\}}$$

Unless B_r^{hkl} is identical for all atoms, then in general this ratio will vary from one hkl to another. There will be different ratios even for different orders of reflexion from the same (hkl) and the ratio may sometimes be less than 1; that is, the structure factor may be greater at a high temperature than at a low one, and may change sign. There seems no reason, however, apart from extinction, dispersion and absorption effects, why the ratio $F^T(222)/F^T(400$ should vary with wave-length.

It is easy to demonstrate this variation of temperature factor by numerical examples. Suppose there are six atoms A at $\pm\,|\,x00,\ 0x0,\ 00x\,|$ and eight atoms B at $\pm\,|\,yyy,\ y\bar{y}\bar{y},\ \bar{y}y\bar{y},\ \bar{y}\bar{y}y\,|$ and that $f_A = f_B$ for all values of $\sin\theta/\lambda$.

(1) Let $[\sqrt{\overline{u_x^2}} = \sqrt{\overline{u_y^2}} = \sqrt{\overline{u_z^2}}]_A = \dfrac{a}{10}$ and $[\sqrt{\overline{u_x^2}} = \sqrt{\overline{u_y^2}} = \sqrt{\overline{u_z^2}}]_B = \dfrac{a}{20}$, where a is the lattice parameter. $(\sin\theta/\lambda) = 1/2a$ for 100, $1/a$ for 200, $\sqrt{3}/2a$ for 111. Suppose we take $x = 1/3$, $y = 1/6$

$$\frac{F^R(100)}{F^T(100)} = \frac{2(2 + \cos 2\pi x) + 8 \cos 2\pi y}{2(2 + \cos 2\pi x) . \exp(-2\pi^2/100) + 8 \cos 2\pi y . \exp(-2\pi^2/400)} = 1{\cdot}12$$

$$\frac{F^R(200)}{F^T(200)} = \frac{2(2 + \cos 4\pi x) + 8 \cos 4\pi y}{2(2 + \cos 4\pi x) . \exp(-8\pi^2/100) + 8 \cos 4\pi y . \exp(-8\pi^2/400)} = 0{\cdot}52$$

$$\frac{F^R(111)}{F^T(111)} = \frac{6 \cos 2\pi x + 8 \cos^3 2\pi y}{6 \cos 2\pi x . \exp(-6\pi^2/100) + 8 \cos^3 2\pi y . \exp(-6\pi^2/400)} = 2{\cdot}51$$

(2) Let atom A at $x00$ vibrate linearly along [100] with $\sqrt{\overline{u_x^2}} = a/10$, $\sqrt{\overline{u_y^2}} = \sqrt{\overline{u_z^2}} = 0$, and atom B at yyy vibrate linearly along [111] with $\sqrt{\overline{u^2}} = a/10$ (atom B at $y\bar{y}\bar{y}$ along $[1\bar{1}\bar{1}]$, etc.). Then if $x = 1/3$, $y = 1/6$:

$$\frac{F^R(100)}{F^T(100)} = \frac{2(2 + \cos 2\pi x) + 8 \cos 2\pi y}{2\{2 + \exp(-2\pi^2/100) . (\cos 2\pi x)\} + 8 \cos 2\pi y . \exp(-2\pi^2/300)} = 1{\cdot}01$$

$$\frac{F^R(200)}{F^T(200)} = \frac{2(2 + \cos 4\pi x) + 8 \cos 4\pi y}{2\{2 + \exp(-8\pi^2/100) (\cos 4\pi x)\} + 8 \cos 4\pi y . \exp(-8\pi^2/300)} = 2{\cdot}13$$

$$\frac{F^R(111)}{F^T(111)} = \frac{6 \cos 2\pi x + 8 \cos^3 2\pi y}{6 \cos 2\pi x . \exp(-2\pi^2/100) + 2 \cos 6\pi y . \exp(-6\pi^2/100) + 6 \cos 2\pi y . \exp(-2\pi^2/300)} = 2{\cdot}63$$

Mr. R. E. Gilbert, in this laboratory, has made ntensity measurements at different temperatures on hexamethylene tetramine, which are now being extended by Mrs. M. Canut, and these show the expected variation of Debye factor with direction. Measurements on urea also show a wide variation, even in the $\{hk0\}$ zone. An analysis of the latter results is now in course of publication in *Acta Crystallographica*.

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Adsorption of Carbon Dioxide at −79° C. on High-Silica Sands

THE presence of an adsorptive layer on the surface of the grains of high-silica sands, postulated as a esult of determinations of the amount of methylene blue adsorbed from aqueous solution[1], has been confirmed by measurements of the adsorption of carbon dioxide at its vaporization temperature under atmospheric pressure. S-shaped isotherms were obtained, and the extent of the surface available to arbon dioxide molecules was calculated from the Brunauer–Emmett–Teller relationship[2]. These values were compared with the superficial surface areas determined by an air permeability method[3] or, for he finely powdered samples, by a light-extinction method[4]. The two sets of figures are given in Table 1 or three samples of silica and for four high-silica ands from the Lower Greensand exposure.

After washing away the intergranular clayey material, all the sands were found to be coated to a greater or lesser extent with compounds of iron or aluminium or both, and the presence of a crust of highly ferruginous matter accounted for the large surface area found by carbon dioxide adsorption on the red sand from Redhill However, after extraction with concentrated hydrochloric acid, the surface available to carbon dioxide molecules was still large compared with the superficial surface, and this was also true of the other sand samples after similar treatment, an observation which can only be explained by assuming that the silica surfaces were themselves considerably involuted. The ratio of the surface available to carbon dioxide to superficial surface was considerably less for the silica samples which had been subjected to crushing and grinding. It was further observed that these samples did not give rise to hysteresis effects in the gas adsorption experiments. (A sample of commercial silica gel gave a large hysteresis loop.)

The action of hydrochloric acid on three of the sand samples referred to in Table 1 appeared to result in the removal of basic impurities from narrow capillaries in the silica surfaces. Thus two of the samples showed hysteresis only after acid extraction, and two showed a significant increase in surface available to carbon dioxide. All the sands except that from the King's Lynn area took up less methylene blue from solution after acid extraction than previously. The Lynn sand showed no significant change in adsorptive capacity.

These observations seem to support the conclusion arrived at in a previous communication[1] that the silica surface uncovered by acid extraction is, in

Table 1

	Surface area (sq. cm./gm.) Superficial surface	By carbon dioxide adsorption
Quartz crystals	105	300
Milled sand	2,700*	4,800
Crushed flint	4,100*	17,000
Red sand ex Redhill, Surrey	121	4,100 (*H*)
do. extracted with conc. HCl	121	1,700
White sand ex Redhill	118	700
do. acid extracted	118	1,500 (*H*)
Yellow sand ex King's Lynn	134	3,400
do. acid extracted	137	3,200 (*H*)
Yellow sand ex Leighton Buzzard	61	4,100 (*H*)
do. acid extracted	61	4,900 (*H*)

* Measured by light extinction method. (*H*), isotherm showed hysteresis.

many sands, contained within narrow fissures and capillaries and is not, for example, accessible to molecules as large as those of methylene blue. At the same time, certain parts of the external silica surface are removed in the process of dissolution of neighbouring basic compounds, leading to a 'smoothing out'. This latter assumption was supported by the discovery that the strongly acid extracts from the sands contained silica in solution in significant quantities.

It is hoped that this work, which forms part of a general investigation of the surface properties of sands of industrial importance, will be more fully reported elsewhere.

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Enrichment of Heavy Water by a Biological Method

In all methods for the enrichment of heavy water, the first stage is always very expensive, and a slightly enriched feed water could mean a lot in the price of the final product. Some biochemical processes, such as the photosynthesis of *Chlorella*[1], have been shown to give a small separation between light and heavy water. We have tried to investigate some further possibilities and measured the heavy-water content of water from some industrial biological and microbiological processes.

The greatest difficulty encountered in this type of problem is that industrial biological processes, for example, the growth of *Penicillum chrysogenum* in the production of penicillin, give a rather small volume reduction of the used water and can thus give only small enrichment factors. The most promising line of investigation seemed to us to be the first water percolation of barley in malt production, where the water uptake in the barley is a considerable fraction of the total water amount.

To ascertain the possibilities of the method, we have percolated barley with water in nine successive stages to get very great volume reductions. After every third percolation, the water was distilled to purify it from organic substances originating from the barley. Experiments were carried out with different proportions of barley and water, but otherwise under constant conditions as regards other relevant factors such as temperature, time of percolation, etc. The results are shown in Fig. 1 where enrichment factor α is shown as a function of the volume reduction ratio V_0/V. The diagram shows that there is a great difference in the enrichment proceeding in the various cases.

Lewis[2] has given the following relation for the separation factor s in the electrolysis of water:

$$\frac{dN_H}{N_H} = s \cdot \frac{dN_D}{N_D} \qquad (1$$

where N is the total number of isotopic nuclei taking part in the separation process. By introducing the initial volume V_0 and the end volume V in equation (1 we get, after some approximations:

$$s = \frac{\ln V_0/V}{\ln \frac{V_0}{V} - \ln \alpha}$$

The enrichment factor α is here defined as the rati between the molar concentrations of heavy wate in the volumes V and V_0 respectively. The straigh line that can be drawn in Fig. 1 for each series o successive percolations indicates that this formul can be applied also in our case. Stockholm tap wate has been assumed to have a heavy-water content o 0·015 per cent w/w. The following values for s hav been obtained:

Barley weight / Water weight	s
0·30	3·0
0·67	1·54
1·33	1·15

The isotope determinations have been made by means of infra-red spectrophotometry of the HDO absorption band[3] at 3·83μ. These measurements can be carried out with an accuracy of ± 0·003 per cen on the absolute D_2O percentage scale[4]. The observations of s were also confirmed by repeating a short series of three percolations with a wate containing 0·5 per cent heavy water and analysing for isotopic contents by means of precision pyknometry.

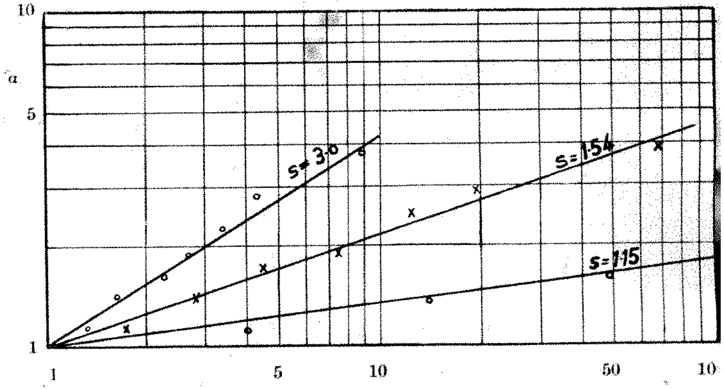

Fig. 1

The separation factors determined in this way seem surprisingly high for a biological method, and w cannot account for the variations in s with the barley–water ratio. One contributing factor may be the influence of the water contents in the barley.

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Thermal Conductivity of Soil

THE flow of heat away from buried electric cables, team pipes, etc., is directly proportional to the onductivity of the surrounding soil. It follows that knowledge of soil conductivities is necessary to the ngineer. Unfortunately, there are almost as many alues of soil conductivity as there have been experimenters in this field. Austin[1] suggests that the lack f consistency has been inevitable due to the lack f standardization of apparatus and probably even nore so to the loose specification of the soil sample. The composition of soil varies enormously, and so lso does the water content and the tightness of the acking, yet these quantities must have an immediate earing upon the value of the conductivity.

Gemant[2] has made a very interesting calculation o find the thermal resistivity of soil. The oil is assumed to consist of uniformly acked spheres each of which touches six eighbouring spheres. The statement is made : If the spheres were to touch at a geometric oint only the resistivity of dry soil would e close to that of air . . ." I am unable o accept this statement, which amounts to saying hat the conductivity of a cube of air is not greatly nfluenced by the insertion into the cube of a spherical onductor.

However, the cube will now contain two phases, amely, the solid soil phase and the surrounding air hase. The conductances of these two phases must e added to yield the total conductance, and it will e shown that the conductivity is quite different om that of air.

Let O be the centre of a hemisphere of solid of adius a. At a height z above the XOY plane, that , at the section PQ, the radius of the solid phase is ven by $\sqrt{a^2 - z^2}$.

It follows that the area of the solid phase section $\pi(a^2 - z^2)$ and that the area of the air phase section $4a^2 - \pi(a^2 - z^2)$.

Consider now the thermal resistance of each phase turn, taking each time a 'slice' of thickness Δz :

$$\text{Thermal resistance of solid slice} = \frac{\Delta z}{k_s\,\pi(a^2 - z^2)}$$

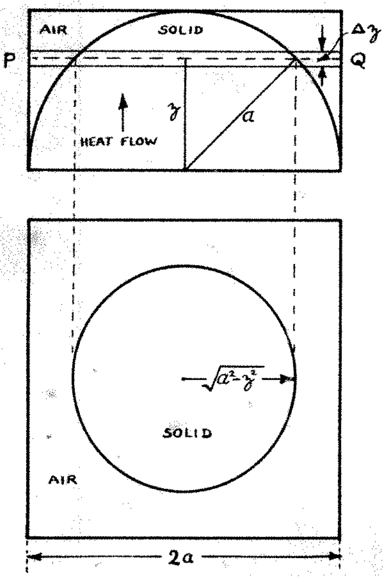

Fig. 1

$$\text{Thermal resistance of air slice} = \frac{\Delta z}{k_a\,\{4a^2 - \pi(a^2 - z^2)\}}$$

The thermal resistance of the two parallel phases is obtained by adding together the reciprocals of these two expressions and then taking the inverse of this sum. The resulting expression when integrated between the limits $z = 0$ and $z = a$ will yield the total resistance to heat flow of the half cube. Thus,

$$\text{thermal resistance is} \int_{z=0}^{z=a} \frac{\Delta z}{4k_a a^2 + \pi(a^2 - z^2)\,(k_s - k_a)}$$

The thermal resistivity is now obtained by equating the radius of the spherical particle to unity and by multiplying the integral by 4, the area of the base of the half cube.

Hence, thermal resistivity of the composite is :

$$\frac{4}{2\pi(k_s - k_a)\sqrt{1 + \dfrac{4k_a}{\pi(k_s - k_a)}}} \log \frac{\sqrt{1 + \dfrac{4k_a}{\pi(k_s - k_a)}} + 1}{\sqrt{1 + \dfrac{4k_a}{\pi(k_s - k_a)}} - 1}$$

in which $k_s > k_a$. Taking $k_s = 0{\cdot}010$ cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ (suggested by Gemant) and $k_a = 0{\cdot}00006$ cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ (Kaye and Laby give k for air at 0° C. $= 0{\cdot}577 \times 10^{-4}$) this formula gives a value for the resistivity of the air – solid composite equal to 400 cm.-deg. C./calorie.

The conductivity of dry soil is therefore 0·0025 cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$.

The observed conductivity of dry soil is, however, only one-third of this value (Jakob quotes a value of 0·0008) ; this wide discrepancy must be due to the initial assumption made both by Gemant and me, namely, that the particles are ideally packed spheres. I am aware that the heat flow is facilitated by convection and radiation in the air phase and that this will also have some influence on the thermal 'conductivity' of soil.

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Flash Photolysis of Rhodopsin in the Retina

IT has long been suspected that the ability of rhodopsin to sensitize vertebrate retinal rods to visible light depends in some way upon the rapid and conspicuous fading which the purple photopigment undergoes when it is illuminated[1]. If so, some part of the bleaching process that is undergone by photochemically excited rhodopsin molecules must be very rapid, for vertebrate eyes respond very quickly to flashes of light. Indirect evidence for the existence of fast reactions in the bleaching of rhodopsin has been provided by Wald, Durell and St. George[2], who found that two successive unstable intermediates, lumi- and meta-rhodopsin, were formed when dry gelatin films or frozen solutions containing extracted rhodopsin were illuminated and examined spectrophotometrically. These authors suggested a scheme for the photochemical decomposition of rhodopsin

$$\text{Rhodopsin} \underset{(1)}{\overset{+h\nu}{\rightleftharpoons}} \textit{lumi}\text{-rhodopsin} \underset{(2)}{\overset{\text{(Thermal)}}{\rightleftharpoons}} \textit{meta}\text{-rhodopsin} \underset{(3)}{\overset{\text{(Thermal)}}{\rightleftharpoons}} \text{retinene-protein}$$

Fig. 1. Scheme proposed by Wald, Durell and St. George for the early stages in the photolysis of rhodopsin

shown in Fig. 1, in which they believed that all reactions except (3) would be fast enough *in vivo* to be able to play some part in the excitation of living rods.

A search for the reactions of Fig. 1 and measurement of their rates under conditions in which the eye usually functions seemed desirable, and this communication reports a study of the decay of a substance resembling meta-rhodopsin, produced by flash photolysis in intact visual rods.

Dark-adapted eyes were excised from freshly killed albino rabbits and quickly mounted in an air-saturated bath of neutral Locke's solution. A weak beam of steady monochromatic light was passed through the pupil to illuminate a small area of fundus. Light scattered back from the sclera through the rhodopsin-filled retina and the pupil was collected by an ophthalmoscopic arrangement and directed upon the cathode of a photomultiplier, the output of which was displayed oscillographically. At chosen intervals, bright 20-μsec. flashes from a xenon-filled discharge tube were focused upon the exterior surface of the translucent sclera overlying the area of retina being studied. The photochemical effects of the flashes upon the light-absorbing materials in the retina were determined by calculating the 'retinal density' D_r of the fundus from the oscillographic measurements of fundal reflectivity r by the formula $D_r = -\log_{10} r/r_0$, where r_0 is the reflectivity of a fully bleached fundus. Thus D_r increases with rising optical extinction of the light-absorbing layers of the retina.

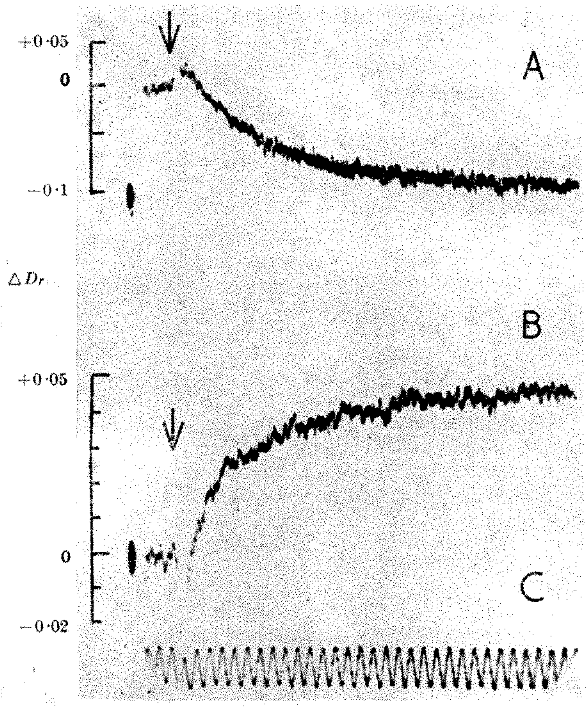

Fig. 2. (*A*) Reflectivity of a fundus at 486 mμ; flash at arrow. (*B*) Reflectivity of a fundus at 400 mμ; flash at arrow. Ordinates: Change in reflexion density ($\log_{10} r/r_0$). Abscissa: time. (*C*) Time calibration, 200/sec.

Curve *A* of Fig. 2 shows the effec of a flash upon the 'reflexion density of a dark-adapted fundus at 12° C measured in light of wave-length 486 mμ The oscillograph sweep began at th level corresponding to unbleached rhodopsin. At the arrow, a flash was delivered, with the result that the retinal density rose suddenly by a small amount and then fell exponentially to a lower level with a half-time of about 20 m.se Curve *B* shows an identical experiment except tha the measuring light is of wave-length 400 mμ. Her the flash produced no obvious immediate change except for a large electrical artefact ; but the retina density afterwards rose, again exponentially with half-time of 20 m.sec.

At higher temperatures, the rate of the exponentia reaction increases rapidly until at 26° C. it is hal complete in 1 m.sec. and becomes difficult to measur accurately. The rate-constant follows Arrhenius law with an apparent heat of activation of 27 kcal mole, so that at 37° C. it should have a half-time o about 120 μsec.

The identity of the substance which fades exponentially is not certain ; but its absorption spectrum has been estimated by measuring the immediat changes in retinal density produced by flashes in series of experiments using measuring lights o several wave-lengths. The results of such measurements are compatible with its being either lumi- o meta-rhodopsin. However, the exponential fadin reaction with the production of material whic absorbs strongly at 400 mμ is strongly suggestive o the conversion of meta-rhodopsin to retinene-protein

The earliest known response of the rabbit's eye t a flash of light is the electroretinogram, which has latency (in my measurements) of about 35 m.sec. a 26° C. and 20 m.sec. at 37° C. It seems clear, therefore, that the fast phases of the breakdown of excite rhodopsin molecules to retinene-protein are complet long before any electrical responses of the retina t a flash can be detected. Thus it is possible that an of the reactions of Fig. 1 may participate in th processes of visual excitation, though, of course, non of them need necessarily do so.

A detailed account of these experiments is preparation. The financial support of the U.S National Science Foundation and the Fulbrigh Commission is gratefully acknowledged.

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Relationship between Air Concentration of Radioactive Fission Products and Fallout

Perhaps the simplest and most widely use methods for the evaluation of the long-range hazar due to atmospheric radioactivity and fallout are th air-filter and gummed-paper techniques, respectivel Since effects associated with meteorological factor especially rain, make it difficult to predict the pe formance of one method relative to the other, w believe that an experimental comparison which w made at the time of the 'Teapot' tests may be o interest.

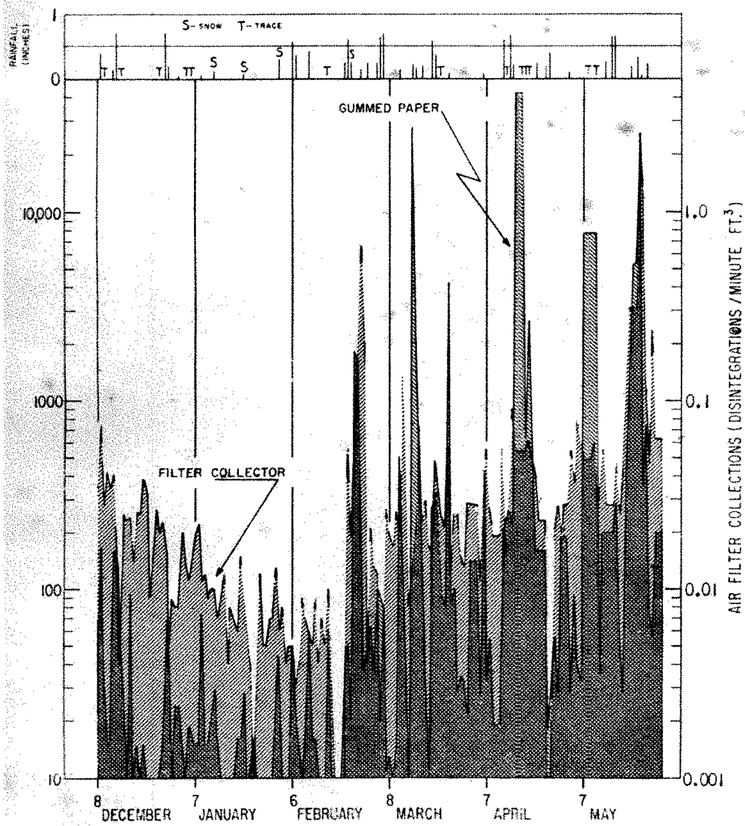

Fig. 1. Comparison of daily concentrations of fission products collected by gummed paper and air filter

The daily atmospheric concentration and fallout radioactivity due to fission products was measured Washington, D.C., during December 1954–May 55. Daily values of the fission product concentra-on per unit volume of air were obtained from filter llections (Blifford, I. H., Friedman, H., Lockhart, B., and Baus, R. A., to be published), using the parent rate of decay to distinguish between natural orium *B* and fission products. Simultaneous easurements of fallout were made using the standard mmed-paper methods developed by the Weather ureau and the Atomic Energy Commission[1]. The posited radioactivity per unit area was found from e counting-rate of the ignited residue of the gummed pers. In addition, weekly filter collections were sayed by allowing the short-lived natural products decay and then counting the ashed residue.

Results are shown in Fig. 1, where the right-hand dinate shows atmospheric concentration in dis-tegrations per min. per cu. ft. and the left-hand dinate shows daily deposited activity in dis-tegrations per min. per sq. ft. Rainfall is shown the top of the figure. The figure shows that the posited activity usually increases with rain or ow. This seems to be true for recent material from e 'Teapot' tests as well as for old fission products llected between December 1954 and February 22, 55.

The ratio of the fallout activity per unit area per y to the activity per unit volume has the dimen-ns of velocity. The expression 'rate of fallout' used in this discussion as a convenient means for mparing these quantities. As may be seen in Table 1, the observed rates of fallout varied from 0·7 to 400 × 10³ ft. per day. The average for these one-week collections over a five-month period was 43 × 10³ ft. per day. The fallout rates obtained from tabulation of the daily readings are shown in Table 2 for each month for the period December 1954–May 1955. In this case the average rate of fall was 2·7 × 10³ ft. per day for days without rain, and for rainy days, 30 × 10³ ft. per day. Non-homogeneity in the atmospheric concentration resulted in extremely high rates of fallout in some instances, when radioactivity apparently was rained out of high-level clouds from recent atomic tests. In other cases, rain caused a proportionately larger increase in the air concentration than in the fallout. It will be observed that fallout in a single week amounted to 65 per cent of the total for the whole period of the measurements.

There appears to be little basis for the correlation of individual daily measurements of the air concentration of atomic bomb debris and fallout of this material on the ground. The extent to which the average rates of fallout can be used to determine the long-term deposition is not clear. Undoubtedly, the distance from the tests at which measurements are made, particle size, the frequency of rainfall, efficiency of rainfall in washing the atmosphere, and height of rainfall are important factors. Although

Table 1. COMPARISON OF COLLECTION OF RADIOACTIVITY BY GUMMED PAPER AND FILTRATION TECHNIQUES

Date of collection	Filter (disinteg./min. ft.³)	Gummed paper (disinteg./min. ft.² day)	Rate of fall (ft./day)	Rain (in.)
21/2–28/2/55	28 $\times 10^{-3}$	49	$1 \cdot 8 \times 10^3$	1·22
28/2–7/3	8·3	29	3·5	1·78
7/3–14/3	18	13	0·7	0·13
14/3–21/3	19	730	38	1·13
21/3–28/3	24	290	12	0·43
28/3– 4/4	22	24	1·1	0
4/4–11/4	27	46	1·7	0·07
11/4–18/4	47	19,000	400	1·50
18/4–25/4	30	330	11	0·47
25/4– 2/5	18	100	5·5	0·40
2/5– 9/5	50	4,400	88	0·01
9/5–16/5	31	790	25	1·62
16/5–23/5	210	1,400	6·7	0·50
23/5–31/5	200	1,600	8·0	1·11
		Average	43×10^3	

Table 2. EFFECT OF RAIN ON APPARENT RATES OF FALLOUT

Month	No. of tests	No. of rains	Rate of fallout without rain (ft./day)	Rate of fallout with rain (ft./day)
Dec. 1954	0	8	$1 \cdot 0 \times 10^3$	$1 \cdot 4 \times 10^3$
Jan. 1955	0	7	0·7	1·2
Feb. (before tests)	0	9	1·1	3·7
(after tests)	2	1	9·2	5·2
March	7	12	2·4	50
April	3	15	3·9	133
May	3	18	0·7	12
		Average	2·7	30

it does not have the usual physical significance as applied to falling particles in air, the concept of rate of fallout may be useful in correlating the concentration of activity in the air with the deposition.

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Determination of the Rate of Initiation in Vinyl Polymerization

We have recently studied the polymerization of a number of vinyl monomers in essentially non-aqueous media in the presence of ferric chloride. There appear to be no data in the literature on the behaviour of such systems, and since the work provides important information about some aspects of the polymerization, we wish to report the main results here. In particular, they enable the rate of initiation to be determined simply and accurately.

When acrylonitrile in NN-dimethylformamide solution is polymerized with azobis*iso*butyronitrile as catalyst in the presence of hydrated ferric chloride, a ferrous salt is formed which may be estimated accurately by titration with ceric sulphate. It is found that for given monomer and catalyst concentrations the rate of formation of ferrous ion is practically independent of the initial ferric ion concentration over a wide range of values of the latter. This is shown by the results in Table 1, which refer to initial catalyst and monomer concentrations of $9 \cdot 63 \times 10^{-3}$ mole l.$^{-1}$ and $3 \cdot 76$ mole l.$^{-1}$ respectively at 60° C. In the absence of catalyst no ferrous ion can be detected, and no polymerization occurs. Further, ferrous salts have no effect on the polymerization. These results would follow if each chain started by the catalyst were terminated by reaction with ferric chloride, with formation of a ferrous salt. In this case it is easily shown that the rate of reaction is given by

$$-\frac{\mathrm{d}[M]}{\mathrm{d}t} = \frac{k_2}{k_5}\,\frac{I[M]}{[\mathrm{FeCl_3}]} \qquad (1)$$

where $[M]$ is the monomer concentration, I the rate of initiation and k_2, k_5 the velocity coefficients for chain growth and termination by ferric chloride respectively. By analogy with its behaviour in other organic solvents, ferric chloride is considered to exist in NN-dimethylformamide solution as $FeCl_3$ molecules. Fig. 1 shows that the results are in fact consistent with equation (1), a linear plot being obtained when the rate is plotted against $[M]/[FeCl_3]$ for constant concentration of catalyst. The degrees of polymerization obtained in these experiments were very much lower than those corresponding to bimolecular termination, indicating the virtual absence of the latter. In further accord with the proposed mechanism, we find that the rate of polymerizati at constant initial concentrations of monomer a ferric chloride shows first-order dependence on t catalyst concentration.

Table 1

$10^3[FeCl_3]$, initial (mole l.$^{-1}$)	$10^7\,\frac{\mathrm{d}[Fe^{++}]}{\mathrm{d}t}$ (mole l.$^{-1}$ sec.$^{-1}$)	$10^5 k_i$ (sec.$^{-1}$)
0·435	1·70	0·92
0·870	1·70	0·92
1·31	1·68	0·91
2·18	1·68	0·91
4·35	1·68	0·91

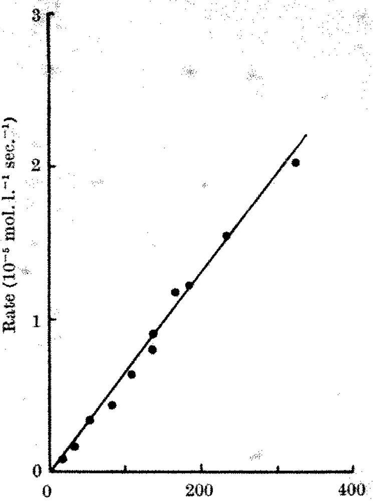
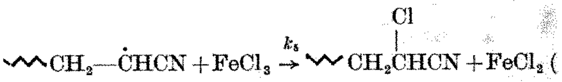


Fig. 1. Dependence of the rate of polymerization on concentratio of ferric chloride. Acrylonitrile 2·51 mole l.$^{-1}$ in NN-dimethylformamide, azobis*iso*butyronitrile $1 \cdot 14 \times 10^{-2}$ mole l.$^{-1}$; 60° C

These results show that the reactions occurring m be summarized by the simple equation (2):



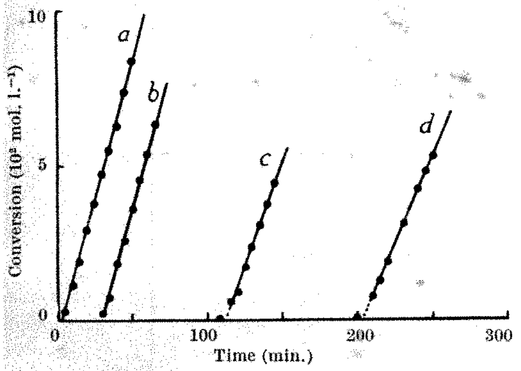
$$\sim\!\sim CH_2-\dot{C}HCN + FeCl_3 \xrightarrow{k_5} \sim\!\sim CH_2\overset{\overset{Cl}{|}}{C}HCN + FeCl_2\ ($$

Since the state of the ferric ion in these systems uncertain, the mechanism of this reaction is n clear; we believe, however, that an electron transf between the acrylonitrile radicals and ferric ion involved. It is interesting to compare these resul with those reported for aqueous systems. They a in the opposite sense to the observations on acryl nitrile mentioned by Dainton[1], but appear to resemb those on acrylamide and ferric salts[2]. Results recent described by Haines and Waters[3] for non-polyme radicals with structure analogous to that of pol acrylonitrile radicals are in qualitative agreeme with our experiments.

On the basis of this reaction scheme, the value $\mathrm{d}[Fe^{++}]/\mathrm{d}t$ gives at once the rate of initiation, a from this the rate constant k_i for the decompositi of the catalyst into useful radicals may be derive since $k_i = \frac{1}{2\bar{C}}\,\frac{\mathrm{d}[Fe^{++}]}{\mathrm{d}t}$, $\bar{C}$ being the mean conce tration of catalyst, which in the experiments Table 1 is only about 4 per cent different from t initial value. Values of k_i are given in Table 1.

The slope of the line in Fig. 1 is $6 \cdot 5 \times 10^{-8}$ mole l sec.$^{-1}$, and since $I\ (= 2k_i\bar{C})$ is known, we find th $k_2/k_5 = 0 \cdot 31$, and if $k_2 = 100$ mole^{-1} l. sec.$^{-1}$ $k_5 = 323$ mole^{-1} l. sec.$^{-1}$. It follows that if the molecular termination coefficient for acrylonitr radicals is 10^6 mole^{-1} l. sec.$^{-1}$, this type of terminati will be unimportant for concentrations of radicals l than about $1 \cdot 2 \times 10^{-7}$ mole l.$^{-1}$ for a concentrati of ferric chloride of 4×10^{-3} mole l.$^{-1}$. This is appr imately equal to the maximum concentration radicals in our experiments.

It might be expected that the rate of reaction would depend on the electron-donating properties the polymeric radicals. Acrylonitrile radicals a



'ig. 2. Induction periods in the polymerization of styrene 2·49 mole l.$^{-1}$) in methyl ethyl ketone at 60° C. Azobis*iso*butyro- ıtrile 6·92 × 10^{-3} mole l.$^{-1}$. Ferric chloride concentrations mole l.$^{-1}$): (*a*) 0, (*b*) 2·65 × 10^{-3}, (*c*) 7·95 × 10^{-3}, (*d*) 13·25 × 10^{-3}

ıong the least effective and styrene radicals among ɘ most effective in this respect. In agreement th this we find that while ferric salts are, as shown ove, retarders of the polymerization of acrylonitrile, ey are strong inhibitors of the catalysed poly- rization of styrene in solution in methyl ethyl tone or NN-dimethylformamide, and give rise to ll-defined induction periods. Some typical results given in Fig. 2. The length of the induction period directly proportional to the initial value of [Fe^{+++}] d inversely proportional to the concentration of talyst, and from it the rate of chain-starting may calculated. The values of k_i obtained are 74 × 10^{-5} sec.$^{-1}$ (methyl ethyl ketone) and 0·67 × $^{-5}$ sec.$^{-1}$ (NN-dimethylformamide).

If the rate constant for the decomposition of the talyst at 60° is taken as 1·2 × 10^{-5} sec.$^{-1}$, the iciency of initiation is 0·62 and 0·56 respectively the two solvents. This is in excellent agreement th results for styrene in benzene obtained by vington[5] using a tracer technique.

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Nucleic Acid Content and Distribution of Chromosome Number in Original and Sublines of Two Mouse Ascites Tumours

Koprowski[1] has described the adaptation of the 3HED lymphosarcoma[2], an ascites tumour hal to *C3H* mice and to F_1 hybrids between the ginal strain and *A* or *DBA* mice, to a strain of iss mice. Two sublines, designated *C3H*+ and F_1, re obtained by injecting embryos of the *ICR* stitute for Cancer Research, Philadelphia, Pa.) iss mice *in utero* with blood of either *C3H* mice (*C3H* × *DBA*) F_1 hybrids, followed six to eight eks after birth by the intraperitoneal implantation with cells of the *6C3HED* ascites tumour. A third subline, No. 123, was established by injecting *ICR* mice in the embryonic stage directly with tumour cells followed by the intraperitoneal implantation into adult *ICR* mice of suspensions of the palpable tumours which developed in the subcutaneous tissue of the neck of mice that had been inoculated *in utero*.

More recently, Koprowski (unpublished results) has established—again employing the technique of implantation of tumour cells in embryos—a Swiss mouse (*ICR* strain)-adapted subline derived from the strain-specific *DBA* lymphoma ascites tumour.

As part of a programme to investigate biochemical differences resulting from this breaking of the strain barrier, the nucleic acids of the original *6C3HED* and *DBA* ascites tumours have been compared with those of the Swiss mouse-adapted sublines. *C3H* or F_1 mice bearing the original *6C3HED* ascites tumour, *DBA* mice bearing the original *DBA* lymphoma ascites tumour, and *ICR* mice bearing the derivative *6C3HED* or *DBA* sublines of ascites tumours, were killed on the seventh to tenth day after tumour implantation, and the ascitic fluids aspirated. Tumour cells were sedimented by centrifugation, washed several times in isotonic saline and finally suspended in isotonic saline and enumerated. Mixed nucleic acids were separated by the method of Schneider[3]. Aliquots of the cell suspensions were extracted with the following reagents in the order listed: cold 10 per cent trichloroacetic acid, cold ethanol, boiling 3 : 1 ethanol–ether, and hot 5 per cent trichloroacetic acid. Ribo- and deoxyribonucleic acids were estimated in aliquots of the hot 5 per cent trichloroacetic acid extracts by the orcinol and diphenylamine reactions respectively (see Table 1).

That marked changes occur in the quantity of cellular nucleic acids as a result of the adaptation of the strain-specific ascites tumours to the Swiss mouse is evident. Cells of the three derivative sublines of *6C3HED* showed an increase of 30–40 per cent in cellular deoxyribonucleic acid, and an increase of approximately 100 per cent in cellular ribonucleic acid over the original tumour line. Cells of the Swiss mouse-adapted subline of the *DBA* lymphoma ascites exhibited increases of approximately 100 and 300 per cent in the quantities of cellular deoxyribo- and ribo-nucleic acids respectively over the original line.

The results of a study of the distribution of chromosome number for the *6C3HED* ascites tumour (grown in *C3H* mice), the *DBA* lymphoma ascites tumour (grown in *DBA* mice), and for their Swiss mouse-adapted sublines are summarized in Table 1. The original *6C3HED* tumour exhibited a hypodiploid mode in chromosome number, whereas the original *DBA* ascites tumour was characterized by a diploid mode. Levan and Hauschka[4] have reported that both these tumours possess modal values at or near diploid. Of the three Swiss mouse-adapted sublines of the *6C3HED* ascites tumour, two (sublines F_1 and No. 123) revealed hyperdiploid modal values, whereas the third (subline *C3H*+) is characterized by a diploid mode in chromosome number. A tetraploid mode prevails in the *ICR* subline of the *DBA* lymphoma ascites tumour.

Leuchtenberger *et al.*[5] have shown that, for the Ehrlich ascites and *DBA* lymphoma ascites tumours, the estimation of nucleic acids in isolated nuclei by ultra-violet microspectrophotometry or by chemical analysis is in good agreement with the chromosome counts of Levan and Hauschka[4,6]. In general, the results presented here provide further evidence of a relationship between chromosome number and cellular deoxyribonucleic acid. Within each of the two groups studied (the *6C3HED* tumour with its three sublines and the *DBA* ascites tumour with its Swiss mouse-adapted subline), a striking correlation between chromosome number and cellular deoxyribonucleic acid is seen. The original *6C3HED* and *DBA* tumours, which contain essentially identical quantities of deoxyribonucleic acid, possess slightly different modal values.

Table 1. NUCLEIC ACIDS, CHROMOSOMES AND CELL VOLUMES OF THE *6C3HED* LYMPHOSARCOMA AND *DBA* LYMPHOMA ASCITES TUMOURS
THEIR SWISS MOUSE-ADAPTED SUBLINES

Tumour	γ DNA-P/Cell ($\times 10^{-6}$)	γ RNA-P/Cell ($\times 10^{-6}$)	RNA/DNA	Chromatogram (per cent cells) Mode	Below mode	At mode	Above mode	Cell volume (cubic microns
6C3HED—Original	0·811 ± 0·061*	0·809 ± 0·089	0·995 ± 0·052	30	25	31	44	462
6C3HED—Subline F_1	1·112 ± 0·149	1·638 ± 0·162	1·487 ± 0·139	45	42	39	19	610
6C3HED—Subline No. 123	1·119 ± 0·155	1·665 ± 0·191	1·497 ± 0·106	45	22	40	38	651
6C3HED—Subline *C3H* +	1·068 ± 0·120	1·583 ± 0·135	1·492 ± 0·094	40	19	41	40	492
DBA—Original	0·805 ± 0·057	0·680 ± 0·044	0·847 ± 0·014	40	21	39	40	272
DBA—*ICR* line	1·777 ± 0·180	2·924 ± 0·150	1·666 ± 0·130	80	31	23	46	1,215

* Standard error of the mean, calculated from $\sigma = \sqrt{\Sigma(x^2)/N}$, where x is the deviation from the mean, and N the number of estimati
performed.

Cell volumes have been estimated and the values are listed in Table 1. Although adaptation of each of the two strain-specific tumours to the Swiss mouse is accompanied by an increase in the size of the tumour cells, there appears to be no strict relationship between cell volume and the quantity of either of the cellular nucleic acids. In the case of the *6C3HED* sublines F_1 and No. 123, the increase in cell volume (32 and 41 per cent respectively) corresponds closely to the increase of 37 per cent in cellular deoxyribonucleic acid. However, the relationship does not hold for subline *C3H* +. In the second (*DBA*) group of tumours, a close correlation exists between the increase in cell volume (347 per cent) and the increase in ribonucleic acid (330 per cent) which followed adaptation to the *ICR* strain of Swiss mice.

The striking differences in susceptibility to virus infection between the main line *6C3HED* and its derivative tumours have been described[1]. It is tempting to speculate that the susceptibility of the *ICR*-adapted sublines to the oncolytic action of Mengo and Bunyamwera viruses is related to the marked alterations in cellular nucleic acids described. In any event, the system would appear to be an excellent one for studies of the requirements for virus reproduction, and for investigations into the relationships between cellular nucleic acids and the metabolic activities of the cells.

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Immunological Studies with Protein Fractions isolated from Ehrlich Ascites Carcinoma Cells

THE oncolytic action of Bunyamwera virus on
cells of the Ehrlich ascites carcinoma has b
described by Koprowska and Koprowski[1], and
cytological and morphological changes induced
virus infection have been reported by Love, Kopro
ski and Cox[2]. During the past three years we ha
studied the effects of infection with Bunyamw
virus on many of the biochemical characteristics a
metabolic activities of Ehrlich ascites cells. Resu
will be reported elsewhere.

Attempts to demonstrate the immunologi
capacity of certain of the tumour cell proteins a
possible changes resulting from virus infection
the cells will be described here. Protein fractio
isolated both from uninfected and Bunyamwe
virus-infected Ehrlich ascites tumour cells, w
injected intravenously into rabbits, with the ho
that one antiserum or more would be produc
capable of interfering with the growth of the tumo
in mice. It is pertinent to mention here the wo
of Werder and co-workers[3] on the inactivation
mouse leukæmic cells by rabbit leukæmic tiss
antiserum, and of Nungester and Fisher[4], w
demonstrated the inhibition of lymphosarco
6C3HED by antibodies produced in the rabb
against a fraction isolated from the tumour.

Cells were obtained from Ehrlich ascites tumou
grown in Swiss mice. Ascitic fluids were collect
by aspiration from the peritoneal cavity on the nin
or tenth day of tumour growth; and virus infecti
of cells was accomplished by the intraperitone
injection, 72 hr. before harvest, of Bunyamwer
infected mouse brain. Cells were freed of erythr
cytes by washing in isotonic sodium chloride soluti
as described by McKee[5], after which they were tran
ferred to a mortar set in an alcohol – 'dry ice' ba
and ground to a fine, homogeneous powder.

Nuclei were separated from a suspension of t
ground cells in isotonic sodium chloride–0·001
sodium citrate solution of *p*H 7·0 by low-spe
centrifugation, washed several times in saline-citrat
and deoxyribonucleoprotein isolated therefrom by
technique derived from the methods of Stern *et a*
and Gajdusek[7]. In brief, this consisted of extracti
of the protein by prolonged shaking of the nucl
with distilled water, followed by its precipitati
from the extract at isotonic sodium chloride co
centration. Further purification was effected
subjecting the protein to several additional cycl
of dissolution in distilled water and precipitation
0·14 *M* sodium chloride concentration.

Ribonucleoprotein was isolated from the cyt
plasmic extract remaining after the separation of t

iclei according to the method of Mirsky and llister[8]. A third fraction, consisting of cytoplasmic otein and designated here 'soluble protein', was tained by the dialysis and lyophilization of the toplasmic extract after the removal of the nucleo-otein.

Antisera were prepared by the intravenous in-ction into rabbits of solutions of each of the follow-g: deoxyribonucleic acid, ribonucleic acid and luble protein isolated from uninfected Ehrlich lls, and the same fractions derived from virus-fected cells. Each rabbit received 2 ml. containing mgm. protein/ml. twice weekly for a total of ght injections. One week after the final injection, e rabbits were anæsthetized and bled by cardiac ncture. The sera were separated, sterilized by tration, and stored at – 30° C.

The antisera were tested for their ability to inhibit e growth of the Ehrlich ascites tumour in mice in e following manner. The cell concentration in a ol of ascitic fluid was adjusted to 80 million per ml. the addition of saline; 1-ml. aliquots of this ol were mixed with 3-ml. volumes of the various tisera or, as controls, with saline or normal rabbit rum. Ten mice were injected intraperitoneally with 25 ml. (5 million cells) of each of the resulting cell spensions. At intervals of 48 hr. thereafter, for a tal of three injections, each mouse received intra-ritoneally 0·25 ml. of the corresponding antiserum. The results from three separate experiments are mmarized in Table 1. In general, antisera against e nucleoprotein fractions exerted a strong inhibitory ect on the development of ascites in mice, while tiserum against the soluble-protein fraction was thout pronounced effect. The results also indicate at antisera against those nucleoproteins isolated m virus-infected cells are more effective in inhibit-g tumour growth than are those from uninfected lls. In the case of the deoxyribonucleoprotein, this servation was consistent in all three experiments. owever, with the ribonucleoprotein, there was an parent difference only in the first experiment per-rmed, in which seven mice died of solid tumours at developed at the site of injection, presumably a result of subcutaneous implantation of tumour lls.

Although an appreciable number of deaths occurred the groups of mice which received antisera against e nucleoproteins of uninfected Ehrlich cells, the ean survival times of the animals which died were nificantly increased; namely, 30–40 days as com-red to 12–13 days for control groups.

When the administration of antisera was withheld r periods of 24, 48 or 72 hr. following tumour implantation into mice, the development of ascites was not inhibited, and a marked increase in mean survival time was noted only in the case of a 24-hr. delay. However, if fewer than 5 million cells had been implanted, and more than 1·0 ml. (4 × 0·25 ml.) of antiserum afterwards injected, inhibition of tumour growth might well have been seen.

ble 1. INHIBITION OF THE EHRLICH CARCINOMA ASCITES TUMOUR MICE BY ANTISERA PRODUCED IN THE RABBIT AGAINST EHRLICH CELL PROTEIN FRACTIONS

plant: 5,000,000 cells, intraperitoneally. Controls: saline and normal rabbit serum; 100 per cent mortality with ascites

Protein ntigen	No. of mice	Deaths			Survivors	Per cent survival
		With ascites	With ascites + solid tumour	With solid tumour		
DNA	30	11	2	7	10	30
NA	30	1	–	7	22	73·3
oluble	30	27	1	1	1	3·3
DNA*	30	1	1	1	27	90
NA*	30	1	–	–	29	96·7
oluble*	30	23	1	3	3	10

* Isolated from Ehrlich cells 72 hr. after infection with Bunyamwera us.

These preliminary observations clearly point the way to further investigations. It would be of interest to know the effects, if any, of antisera against the Ehrlich cell nucleoproteins on the growth of other ascites tumours in mice. The effects on the growth of various ascites tumours of mice of antisera against nucleoproteins isolated from a normal mouse tissue might also be studied. Finally, and perhaps most important, would be investigations designed to elucidate the mechanism whereby these antisera inhibit the growth of the Ehrlich ascites tumour. Work along these lines is in progress in our laboratory.

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Tumour Growth-inhibitory Alkyl Sulphonates

IN the course of the preparation of various chloroethylamines which are potential tumour growth-inhibitors we have examined 2-chloroethyl methane-sulphonate (I, $X = Cl$; *CB* 1506) as a reagent for the direct conversion of an amino-group into a chloroethylamino-group under mild conditions. It occurred to us that amino-groups in biological systems might be chloroethylated *in vivo* by this compound. For this reason the methanesulphonate (I, $X = Cl$) was tested against a number of transplanted animal tumours.

(I) $CH_3SO_2OCH_2CH_2X$

2-Chloroethyl methanesulphonate is an effective inhibitor of the transplanted Walker rat carcinoma both in its solid and ascites form, either given as a single intraperitoneal injection of a solution in arachis oil (20 mgm./200 gm. rat) or by daily feeding of an aqueous solution (10 mgm./rat/day) for the duration of the experiment (thirteen days). A preliminary investigation of this substance by Dr. L. A. Elson indicates no significant depression of the bone marrow, as indicated by blood counts, at these effective doses (private communication). Dr. O. G. Fahmy and Mrs. M. J. Fahmy have examined the mutagenic action of 2-chloroethyl methane-sulphonate on *Drosophila melanogaster* and report that, while it is an effective agent, its mode of action appears to differ from that of the well-known biological alkylating agents such as the sulphur and nitrogen mustards, diepoxides, dimethanesulphonates, and polyethyleneimines (see following communication).

Cytotoxic activity is also shown by the fluorine analogue (I, X = F) when given by injection at the same dose level as (I, X = Cl) and by ethyl methanesulphonate (I, X = H). A striking feature is the greater efficiency of the latter compound (I, X = H) when administered orally in aqueous solution (20 mgm./rat/day) than by daily injection of the same solution.

2-Chloroethyl methanesulphonate was obtained as a colourless oil, b.p. 134–135°/14 mm., n_D^{17} 1·4571 (found C, 23·1; H, 4·6; S, 20·3; Cl, 22·0 per cent. $C_3H_7O_3SCl$ requires C, 22·7; H, 4·5; S, 20·3; Cl, 22·4 per cent) by the interaction of ethylene chlorohydrin and methanesulphonyl chloride in pyridine solution at 0°. 2-Fluoroethyl methanesulphonate, b.p. 130°/18 mm., n_D^{21} 1·4150 (found: C, 25·1; H, 4·8; S, 22·7 per cent. $C_3H_7O_3SF$ requires: C, 25·3; H, 4·9; S, 22·5 per cent), was similarly prepared.

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Mutagenicity of 2-Chloroethyl Methanesulphonate in *Drosophila melanogaster*

Tumour-inhibitors belonging to the so-called alkylating agents (nitrogen mustards, diepoxides, dimethanesulphonates and polyethyleneimines) have been shown to be strong mutagens[1] when injected intra-abdominally into adult *Drosophila* males. This indicates that with these agents, the overall cell damage accompanying inhibition is, in part at least, due to action on the genetic material. The analysis of the nature of this genetic damage revealed some intricate differences in the mode of action of compounds belonging to different chemical series. These differences were most pronounced in relation to: (*a*) the cell stage predominantly affected, and (*b*) the proportion of the various mutations induced, particularly the ratio of sex-linked recessive visibles to lethals. In both these respects chloroethyl methanesulphonate (*CB* 1506) differs from all other potential alkylating agents so far investigated.

Chloroethyl methanesulphonate was administere by intra-abdominal injection in solution either arachis oil or in isotonic (0·4 per cent) saline. It w found that, for the same concentration of the co pound, the mutagenic activity is much higher (near ten-fold) in aqueous than in oil solutions, and accor ingly only aqueous solutions were used for the detaile genetic analysis. The optimal concentration range f mutagenesis work is 0·3 – 1·5 × 10^{-2} M and t average volume of solution injected per male 0·25 μl., thus making the dose-range 0·8–3·8 × 10 mole per male. The mutations scored were the se linked recessive lethals and visibles detected by t Müller-5 technique.

The cell stages of the male germ line showin maximal mutagenic response to chloroethyl methan sulphonate have been determined by the standar brood technique previously described[2]. Young mal (30 ± 5 hr. old) injected with moderate doses chemical mutagens (*L.D.* 50 or less), and whose pr geny was fractionated by repeated matings to fres virgin females every three days, were found t ejaculate sperm derived from post-meiotic germ cel within four broods (that is, twelve days after trea ment) and from meiotic and pre-meiotic stages i later broods. The results with the above techniqu for chloroethyl methanesulphonate are summarized i Table 1. It can be seen that the compound is pra tically ineffective on the mature sperm utilized i brood I, and very active on the early germ cel (mainly spermatogonia) utilized in the fifth–sevent broods. The data given for these later broods hav been corrected for clustering, on the basis of th frequency of identical visibles in each brood. Th selective mutagenic action of chloroethyl methan sulphonate on the pre-meiotic germ cells stands i sharp contrast to all other potential alkylating com pounds, which induce their maximal mutageni activity on post-meiotic germ cells, particularl spermatids undergoing nuclear condensation[2].

The most striking feature of the mutagenicity c chloroethyl methanesulphonate, however, is the ver high frequency of visible mutations it induces. Th ratio of visibles to lethals produced in the same sampl of treated X-chromosomes is roughly of the order c one visible to ten lethals for most of the other potentia alkylating compounds, except for the nitroge mustard derivatives of amino-acids where it is thre visibles to ten lethals[3]. The data presented in Table show that the overall ratio of visibles to lethals fo chloroethyl methanesulphonate is even higher, bein of the order of four visibles to ten lethals. For th germ cells most sensitive to the action of the com

Table 1. The Relationship of Cell Stage to the Rate of Mutation induced by 2-Chloroethyl Methanesulphonate

Concentration injected	1·05 × 10^{-2} M					1·4 × 10^{-2} M				
Brood	Chromosomes tested	Visibles* No.	Visibles* %	Lethals No.	Lethals %	Chromosomes tested	Visibles* No.	Visibles* %	Lethals No.	Lethals %
I	1,376	2	0·1	7	0·5	771	2	0·3	7	0·9
II	1,255	7	0·6	17	1·4	684	10	1·5	27	3·9
III	687	7	1·0	22	3·2	164	3	1·8	8	4·9
IV	527	2	0·4	12	2·3	173	—	—	2	1·2
V	482	16	3·3	50	10·4	201	13	6·5	22	10·9
VI	356	18	5·1	52	14·6	224	10	4·5	19	8·5
VII	244	19	7·8	21	8·6	83	3	3·6	3	3·6
Total	4,927	71	1·4	181	3·7	2,300	41	1·8	88	3·8
Ratio: Visibles/Lethals	0·39					0·47				

* Each cluster of identical visibles is entered as a single mutation.

und this ratio is as high as five visibles to ten hals, and approaches unity in the youngest germ lls tested (brood VII). This extraordinary efficiency chloroethyl methanesulphonate in mutating orphogenesis loci is unprecedented among all known utagens.

O. G. Fahmy
Myrtle J. Fahmy

ester Beatty Research Institute,
Institute of Cancer Research:
Royal Cancer Hospital,
London, S.W.3.
April 17.

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ird, M. J., and Fahmy, O. G., *Proc. Roy. Soc.*, B, **140**, 556 (1953).
ahmy, O. G., and Fahmy, M. J., *J. Genet.*, **53**, 563 (1955).
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reparation of Cell Suspensions from Rat Livers

Dulbecco and Vogt[1] have prepared suspensions of t liver cells by tryptic digestion in order to produce sue cultures from single cells. We thought that ch suspensions might be suitable for studies of llular respiration, but found that they contained o few intact cells and many mitochondria. The spiration of mitochondria was found to be unaffected en by concentrations of trypsin strong enough to se intact cells. An accidental observation suggested at a technique of mild acid digestion without added zyme might be effective. A solution similar to lbecco and Vogt's phosphate buffer saline[1] was ed. The phosphates were replaced by the equivalent ount of phosphoric acid and the solution brought the selected pH value with potassium hydroxide. e most acid solution used was at pH 2·3. This oduced the greatest yield of separated cells; but ey barely respired. More alkaline solutions yielded wer cells, but with increasing alkalinity the respiration-rate rose until with extraction at pH 4 a susnsion could be obtained with a respiration-rate of e value given by Krebs[2] for liver slices. In practice thought it best to use a medium of pH 5, which en mixed with the chopped tissue gives a pH value nearly 6.

The method finally employed is as follows. The er from a freshly killed six-week old rat is cut into mm. cubes with a battery of razor blades fixed gether, washed with phosphate buffer saline, pH 3, to remove most of the blood, and incubated th phosphate buffer saline, pH 5·0, for 10 min. at ° C. The medium is then poured off and 25 ml. of sh medium at the same pH value added. The sue is disrupted by being drawn into and out of inverted pipette about fifty times. Large particles e removed by filtration through glass wool. The lls are spun down at 1,800*g* for thirty seconds, and suspended in phosphate buffer saline, pH 7·3. The spension at this stage is contaminated with red lls, but these can be reduced in number by spinning 50*g* for 2 min. Repetition of this procedure will entually eliminate the contaminants.

Examination of wet films stained with 1 per cent utral red shows that most preparations contain dividual cells with only a few clumps containing to four cells. If the pipetting is not sufficiently gorous, the preparation shows large clumps and discarded. Permanent stained preparations can be ade on gelatine-coated slides and stained with hæmatoxylin and eosin (Fig. 1). In such preparations some of the cells tend to adhere to one another.

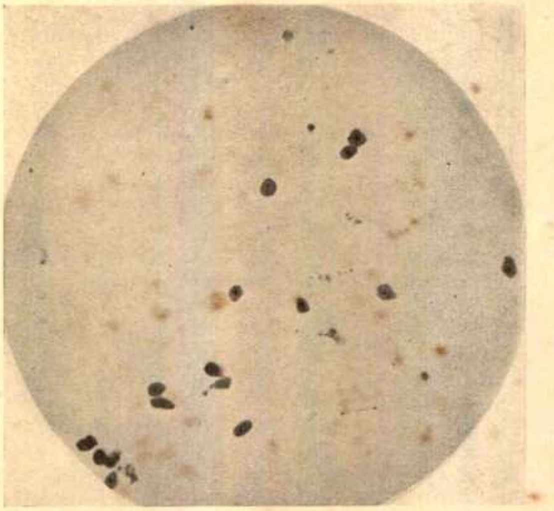

Fig. 1. Rat liver cells prepared as described, stained with hæmatoxylin and eosin. × 60

The Q_{O_2} in the presence of succinate is about -18 and is thus comparable to the values found by Krebs[2].

It is unlikely that such a weakly acid solution hydrolyses the cellular adhesive as does Hornsey's method[3]; it is more probable that some charge effect is involved.

We are indebted to Prof. A. Haddow, of the Chester Beatty Research Institute, for the supply of rat livers.

I. S. Longmuir
Wendy ap Rees

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Jan. 6.

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[1] Dulbecco, R., and Vogt, M., *J. Exp. Med.*, **99**, 167 (1954).

[2] Krebs, H. A., *Biochim. Biophys. Acta*, **4**, 249 (1950).

[3] Hornsey, S., *Nature*, **176**, 7[illegible]4 (1955).

"The Metaphysics of Science"

In his essay on my Riddell Lectures in *Nature* of February 25, p. 369, Dr. C. K. Grant has quoted fairly and amply from what I have said; but some of his own contributions are, I am afraid, more likely to obscure than to clarify the problem. There are two basic questions.

The first concerns the nature of the laws of physics. Is everything that is logically possible also physically possible, or are the laws like those of statute books such as to exclude certain logical possibilities? To quote Russell's remark that "there is no logical absurdity in the idea that the Universe was created five minutes ago, complete with memories" does not help. The remark is obviously false. Had Russell said "complete with the illusion of memories" he would have avoided one error, but only one. "Logically possible" means, in scientific methodology, logically consistent with the complete body of scientific knowledge. In this sense, to give a striking recent example, Dirac found that a state of negative kinetic energy was logically possible. Answering the question posed above in the affirmative, he concluded that it was also physically possible, that is, not precluded by any law of the statute book kind. On this assumption he predicted that a state of negative kinetic energy would be observable in the form of the positive electron. This startling discovery justified the assumption made by Dirac that the laws of physics are not of the statute book kind. The important question is whether the same assumption can always be made.

The illustration taken from Dirac's work shows that the question belongs more to the methodology than to the metaphysics of science. The implication in Dr. Grant's quotation from Russell that it is easy to suggest what is logically possible leads one away from the question, while I want it to be faced. In fact, it is extremely difficult to know what is logically possible in the sense of logically consistent with the whole body of scientific knowledge. Mathematics is wholly concerned with discovering one part of just that. The important question is whether the same applies to physics, or whether some of the laws in physics preclude classes of events that would nevertheless be consistent with the whole body of knowledge. Had Dirac assumed that the laws of physics are of that restrictive kind, he might not have predicted the positive electron.

The second very basic question is about the laws of biology. If the laws of physics do not preclude any events that are logically possible, those of biology seem nevertheless to do so. For there is evidence that the laws of biology lead to specified order whereas the laws of physics do not. The label given by Dr. Grant to both kinds of law, namely, descriptive law, does not provide a means of testing this evidence for its validity. By giving one name to two things one cannot prove that they are the same thing. To dismiss the apparent differences between the laws of physics and those of biology as lightly as that is to do poor service to the methodology of science.

Reginald O. Kapp

"Gardole",
Stanhope Road,
Croydon.

Prof. Kapp's remarks have brought out one important respect in which we are at cross-purposes—and also in agreement. This concerns the notion of 'logical possibility'. Prof. Kapp contends that I have misunderstood his views on this matter; this may well be so, for it is now clear that he attaches to the phrase 'logical possibility' a somewhat unusual meaning, quite different from that which I have assigned to it. He asserts that " 'Logically possible' means, in scientific methodology, logically consistent with the complete body of scientific knowledge". Now Prof. Kapp, like anyone else, is entitled to attach any meaning he likes to any word or combination of words, and no one can gainsay him—except to point out that certain forms of words are misleading. I would like to persuade Prof. Kapp that his terminology is liable to lead to confusion.

I agree with Prof. Kapp, if I understand him rightly, that 'logically possible' is an expression that occurs not in accounts of scientific investigations or theories, but in what he calls the 'methodology of science' for which I should prefer the name 'philosophy of science'. This is a branch of logic, in a wide sense of that term. It therefore seems both relevant and important to make clear the generally accepted philosophical meaning of the phrase 'logically possibl This notion is applicable in two different ways.

(i) Application to an individual proposition, '*p* is logically necessary' means 'not-*p* is a se contradiction'. It is logically necessary that bachelo are unmarried because the denial of this propositic is self-contradictory—and this is what is meant l a logically impossible proposition. This is qui different from a false proposition; we do not fir out that no bachelors are married by conducting survey of bachelors; we can assert *a priori* that r bachelor can be married in virtue of the meanin or rules for the use of, 'bachelor'. It is clear from th that to say that a proposition is 'logically possibl is to say only that it is internally consistent; m quotation from Russell was designed to illustra this, although I quite agree with Prof. Kapp th Russell should have talked of 'the illusions memories'.

(ii) The notion of 'logical possibility' may als refer to the relation between one proposition or se of propositions and another set of propositions; he we are concerned with compatibility—or 'con possibility', to use Leibniz's phrase. Here again th issue is one that must be settled *a priori*, althoug as Prof. Kapp points out, it may be very difficu to do so. Prof. Kapp's account of the problem the relation between a certain hypothesis and th rest of the system is put in the form of the questic of whether physical laws "preclude classes events that would nevertheless be consistent wit the whole body of knowledge". This is to confus the vital distinction between an *a priori* and a empirical problem. If *p* and *q* are logically incon patible, we can assert *a priori* that both cannot l true; but which of them is true, if either, is a empirical issue. In Prof. Kapp's usage, if *p* is i compatible with the rest of the system, it is "logicall impossible"; this implies that it is unnecessary t investigate its empirical truth. But, of course, th question of its truth has not been touched an remains a problem. For Prof. Kapp to use th expression 'logically possible' in such a way that proposition can be logically impossible and yet tru is, to quote him, "likely to obscure . . . the problem' Although not explicitly stated, this conclusion entailed by the conception of 'logically possible' a meaning 'consistent with the rest of science'. Di coveries of fact (for example, the duck-billed platypu and of theory (for example, the heliocentric theory are often logically impossible in this sense, that i incompatible with the body of scientific knowledg

Prof. Kapp's use of the word 'preclude' shows tha he does not recognize the essential difference betwee descriptive and prescriptive laws; only the latte can be properly said to preclude anything.

In calling biological, as well as physical, law 'descriptive', I merely wished to direct attention t the fact that they possess an indicative or descripti character, as distinct from the laws of the land whic are imperative or coercive in form, and which may l properly said to 'make for order'. In applying th label to the laws of both biology and physics I di not, of course, try to prove that they are 'the sam thing', any more than one who says that both appl and peaches are fruit is trying to deny the differences.

C. K. Grant

Philosophy Department,
University,
Nottingham.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 28

Royal Society of Arts (at John Adam Street, Adelphi, London, C.2), at 6 p.m.—Dr. Roger F. Tredgold: "Changes in Social sponsibilities". (Last of three Cantor Lectures on "Recent Studies Sociology".)

Tuesday, May 29

Vright–Fleming Institute of Microbiology (at St. Mary's spital Medical School, London, W.2), at 5 p.m.—Dr. R. E. O. liams: "The Numbers and Significance of Bacteria in Air"* mroth Wright Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at) p.m.—Sir Harold Spencer Jones, F.R.S.: "How We Get Our ie". (Lecture for Fourth Form Pupils.) (Further Lecture on 30.)

ociety of Instrument Technology (at Manson House, 26 Portd Place, London, W.1), at 6 p.m.—Annual General Meeting. Mr. G. Stanley and Mr. J. F. Brown: "Process Analytical Instruatation".

Tuesday, May 29—Friday, June 1

nstitution of Gas Engineers (in the Royal Festival Hall, South ik, London, S.E.1)—93rd Annual General Meeting.

Wednesday, May 30—Friday, June 1

nstitute of Petroleum, Hydrocarbon Research Group (at Institution of Electrical Engineers, Savoy Place, London, W.C.2) ymposium on "Vapour-Phase Chromatography".

Thursday, May 31

hysical Society, Low Temperature Group (in the Lecture atre of the Royal School of Mines, Prince Consort Road, London, .7), at 4 p.m.—Mr. N. R. Barber and Dr. G. G. Haselden: "The uefaction of Naturally Occurring Methane".

oyal Society (at Burlington House, Piccadilly, London, W.1), 4.30 p.m.—Sir Frederic Bartlett, F.R.S.: "Some Experiments ut Thinking" (Croonian Lecture).

niversity of London (at St. Thomas's Hospital Medical School, don, S.E.1), at 5 p.m.—Prof. E. Rothlin (Basle): "The Pharmlogical Basis of the Action of Lysergic Acid Diethylamide on in and Mind".*

Friday, June 1

Royal Institution (at 21 Albemarle Street, London, W.1), at .m.—Dr. A. Comfort: "The Biology of Old Age".

APPOINTMENTS VACANT

pplications are invited for the following appointments on or re the dates mentioned:

ssistant Lecturer in General and Physical Chemistry— Dean, Guy's Hospital Medical School, London Bridge, London, .1 (May 31).

ecturers (2) (with a good honours degree in electrical engineering, preferably completed a graduate apprenticeship, or with good istrial experience), one in Light and one in Heavy Electrical ineering—Head of the Department of Electrical Engineering, erial College, London, S.W.7 (May 31).

fficial Fellow and Lecturer in Physics—The Rector, Exeter lege, Oxford (May 31).

cientific Officer (with a good honours degree in botany or cultural botany) in the Seed Multiplication Section, Welsh nt Breeding Station—The Registrar, University College of Wales, rystwyth (May 31).

echnician in the new Department of Zoology, to take charge he laboratories, from August 1—The Registrar, University College wansea, Singleton Park, Swansea (May 31).

esearch Assistant (B.Sc. in chemistry or equivalent qualifica-), for investigations involving the application of isotope tracer hods to organic reactions—Prof. E A. Braude, Organic Chemistry oratories, Imperial College, London, S.W.7 (June 1).

ssistant (Grade B) in the Science Department, Croydon nical College, to teach chemistry—Chief Education Officer, ication Office, Katharine Street, Croydon (June 2).

iochemist Chemist, Senior grade (with a first- or second-class ours degree) in the Pathological Department—The Secretary, erpool Radium Institute, 1 Myrtle Street, Liverpool 7 (June 2).

ssistant Lecturer or Lecturer in Mechanical Engineering he Registrar, University College, Singleton Park, Swansea (June 5).

hair of Chemistry—The Registrar, University College, Singleton k, Swansea (June 5).

cientific Officer, Grade 1 (with a degree of high standard in nce or engineering with metallurgy as a major subject) in the ence Standards Laboratories, Department of Supply, Alexria, New South Wales, for research and investigational work in ical metallurgy—Senior Representative (A.P.57), Department of ply, Australia House, Strand, London, W.C.2 (June 7).

ssistant Lecturer (with a good degree in physics and preferably hing experience) in Physics—The Principal, Leeds College of nology, Cookridge Street, Leeds 2 (June 8)

Assistant in Genetics—Secretary of University Court, The University, Glasgow (June 9).

Assistant Lecturer in Philosophy—The Secretary, The University, Exeter (June 9).

Biochemist (suitably qualified graduate) in the Department of Hop Research for research work on the organic chemistry of the hop plant—The Registrar, Wye College, near Ashford, Kent (June 9).

Physicist, Experimental Officer grade (with at least H.S.C. (science) or equivalent), at a Ministry of Supply Experimental Establishment in Carmarthenshire to investigate problems arising in observation of behaviour of models under test, and introduce instruments (including optical and electronic) suitable for use under unusual conditions associated with these tests—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.166/6A (June 9).

Lecturer in Inorganic Chemistry—Prof. G. Wilkinson, Department of Chemistry, Imperial College, London, S.W.7 (June 10).

Lecturer and Assistant Lecturer (with special qualifications in organic chemistry) in Chemistry—The Registrar, The University, Manchester 13 (June 11)

Research Assistant (with a good honours degree in chemistry, biochemistry or physiology) in the Department of Surgery—The Registrar, The University, Manchester (June 14).

Senior Scientist (with high qualifications in physics or chemistry, research experience, and preferably a knowledge of coal science), at the National Coal Board's London Headquarters, to direct and co-ordinate investigational work on the physical and chemical properties of coal carried out by Coal Survey Laboratories, and to assist in the general direction of coal survey—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting Ref. SS/280 (June 15).

Lecturer (with a special interest in the field of physical metallurgy, and preferably experience in the application of X-ray diffraction techniques to metallurgy) in Metallurgy—The Registrar, The University, Sheffield (June 16)

Soil Chemist (with an honours degree in science with inorganic or physical chemistry as a major subject) in the Division of Soils, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T., Australia, to conduct investigations, as part of a research team, into the iron and aluminium phosphates in soil—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (June 23).

Assistant Lecturer (with a degree in science or in dairying) in Dairying—The Registrar, (Room 9, O.R.B.), The University, Reading (June 30).

Chair of Animal Husbandry and Preventive Veterinary Medicine—The Secretary of University Court, The University, Glasgow (June 30).

Research Fellow (with a Ph.D. degree and research experience in organic chemistry and ultra-violet spectroscopy), for work in connexion with the development of organic dye filters which will in the first place be used for astronomical purposes—The Registrar, College of Technology, Manchester 1 (June 30).

Fellow (preferably with practical experience in station seismology and geophysical prospecting) in the Department of Geophysics; and a Fellow in the Department of Nuclear Physics, Research School of Physical Sciences, Australian National University, to work with the 600 KeV. or 1·25 MeV. Cockcroft–Walton machine or with the 33 MeV. Electron Synchrotron—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 2).

Director of the Otago Museum, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (London and New Zealand, July 15).

Senior Lecturer or Lecturer (with a good honours degree in botany and specialist knowledge and research experience of plant pathology) in Plant Pathology at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (August 1).

Biochemist, Basic grade (graduate), for research work in relation to steroids—Group Pathologist, Mental Hospitals' Group Laboratory, West Park Hospital, Epsom, Surrey.

Chemist or Physicist (with a first- or second-class honours degree or equivalent qualification, and preferably a knowledge of modern laboratory instrumentation techniques and experience in handling explosives), at a Ministry of Supply Research and Development Establishment, near Sevenoaks, Kent, for research on initiation of explosive systems and in application to Service stores—The Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.307/6A.

Demonstrator or Assistant Lecturer in Botany in the Department of Biological Sciences—The Registrar, Wye College, near Ashford, Kent.

Physicist (with a first- or second-class honours degree in physics, an interest in electronics and a liking for experimental work, and willing to development interests in classical and biological physics) with the Air Ministry at Farnborough, Hants, for research on problems connected with applications of physics to aviation medicine—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.190/6A.

Principal Scientific Officer and Senior Experimental Officer at the Ministry of Fuel and Power, London, for work in connexion with the development of windmills, hydraulic transport of coal, atmospheric pollution, industrial drying processes, oil burning, heat pumps, and the development of low grade fuels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.180/6A.

Principal Scientific Officers, Senior Scientific Officers or Scientific Officers (with a first- or second-class honours degree and preferably research experience), for research on controlled thermonuclear reactions—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 2253/532/34.

Research Assistant (with, or candidate for, the B.Sc. (special chemistry) degree of the University of London) in Chemistry—The Registrar, Brighton Technical College, Brighton.

SCIENTIFIC OFFICER (with an honours degree in zoology, and preferably some knowledge or training in statistics) in the Edinburgh Laboratory of the Scottish Marine Biological Association, to join a team of biologists studying plankton ecology in relation to fisheries—The Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 6.

SOIL SCIENTIST, Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree in agriculture or soil chemistry and two years postgraduate experience (three to appointment to the senior grade), preferably on plant nutrition problems), in the Research Branch of H.M. Oversea Civil Service, British Guiana, to study the nutriment supply to padi from soils under anaerobic conditions to determine how the yield may be maintained and increased economically by the use of fertilizers—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/30/01.

TECHNICAL OFFICER (with scientific training to at least higher school certificate standard, and preferably experience in meteorology) IN THE EAST AFRICA HIGH COMMISSION METEOROLOGICAL DEPARTMENT—The Crown Agents, 4 Millbank, London, S.W.1, quoting Ref: M3B/43104/NF.

TECHNICIAN (with experience in handling farm and/or laboratory animals) IN THE DEPARTMENT OF AGRICULTURE—The Secretary, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Macaulay Institute for Soil Research Annual Report, 1954–1955. Pp. 75+2 plates. (Craigiebuckler, Aberdeen: Macaulay Institute for Soil Research, 1956.) [93

Air Ministry: Meteorological Office. Professional Notes. No. 118: Rainfall of Depressions Which Pass Eastward Over or Near the British Isles. By J. S. Sawyer. Pp. 13. (M.O. 524r.) (London: H.M. Stationery Office, 1956.) 9*d*. net. [93

British Museum (Natural History). A Short Guide to the Exhibition Galleries of the Natural History Museum Fourth edition. Pp. vii+28. (London: British Museum (Natural History), 1956.) 1*s*. 6*d*. [93

Carnegie United Kingdom Trust. Forty-Second Annual Report, 1955. Pp. viii+92 (9 plates). (Dunfermline: Carnegie United Kingdom Trust, 1956.) [93

British Electrical and Allied Industries Research Association. Technical Report L/T307: On the Theory of Dielectric Breakdown in Non-Ionic Crystals. By B. V. Paranjape. Pp. 7. 9*s*. Technical Report U/T133: Metal Transfer between Palladium and Silver Contacts at Low Inductances. By J. Riddlestone. Pp. 10+12 figures. 12*s*. 6*d*. (Leatherhead: British Electrical and Allied Industries Research Association, 1954 and 1955.) [93

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 954, Vol. 248 (1 March 1956): The Transition to Superconductivity. By P. R. Doidge. Pp. 553–573. 7*s*. No. 955, Vol. 248 (1 March 1956): The Generation of Waves in an Infinite Elastic Solid by Variable Body Forces. By G. Eason, J. Fulton, and I. N Sneddon. Pp. 575–607. 10*s*. 6*d*. No. 956, Vol. 248 (1 March 1956): The Distribution of Electrons in the Undisturbed F_2 Layer of the Ionosphere. By E. R. Schmerling and J. O. Thomas. The Rates of Production and Loss of Electrons in the F Region of the Ionosphere. By J. A. Ratcliffe, E. R. Schmerling, C. S. G. K. Setty and J. O. Thomas. Pp. 609–642. 11*s*. (London: Royal Society, 1956.) [93

Scottish Home Department. Marine Research Series. No. 1 (1956): The Effect of Electric Fields on Marine Fishes. By Lt. Cdr.(Sp.) B. McK. Bary, R.N.Z.N. Pp. 32+1 plate. 7*s*. net. Freshwater and Salmon Fisheries Research Series No. 12: Seventh Annual Report of the Supervisory Committee for Brown Trout Research, 1954–1955. Pp. 12. 2*s*. 6*d*. (Edinburgh: H.M. Stationery Office, 1956) [93

Observations Made at the Royal Observatory, Greenwich, in the year 1942 in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. vii+244. 70*s*. net. Observations made at the Royal Observatory, Greenwich, in the year 1943 in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. viii+240. 70*s*. net. Observations made at the Royal Observatory, Greenwich, in the year 1946 in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. vii+342. 90*s*. net. (London: H.M. Stationery Office, 1955.) [93

Planning, Vol. 22, No. 393: What's in the Papers? Pp. 21–36. (London: Political and Economic Planning, 1956.) 2*s* 6*d*. [93

Experiments Relating to Increases in Crop Yield by Radionic Stimulation. By Geo. de la Warr. Pp. 10. (Oxford: Delawarr Laboratories, 1955.) 3*s*. [203

Planning. Vol. 22, No. 394: Business Forecasting. Pp 37–52. (London Political and Economic Planning, 1956.) 2*s*. 6*d*. [203

Aluminium Development Association Information Bulletin No. 2: The Properties of Aluminium and Its Alloys. Fourth edition. Pp. 204. 7*s*. 6*d*. Revised British Standard for Aluminium Alloy Ingots and Castings for General Engineering Purposes. Pp. 4. Revision of British Standards for Aluminium-Magnesium-Silicon Heat-Treatable Wrought Alloys. Pp. 4. (London: Aluminium Development Association, 1955 and 1956.) [203

Other Countries

Mauritius Sugar Industry Research Institute. Bulletin No. 5: Observations on Sugar Cane Diseases in Australia and Fiji. By Robert Antoine. Pp. i+61. (Réduit, Mauritius: Mauritius Sugar Industry Research Institute, 1955.) [93

Food and Agriculture Organization of the United Nations. Yearbook of Forest Products Statistics, 1955. Pp. vi+161. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1955.) 12*s*. 6*d*.; 2.50 dollars. [93

Indian Council of Medical Research. The Nutritional Resea Laboratories, Coonoor (South India). Annual Report for 1954 Pp. ii+36. A Review of Activities, 1949–53. By V. N. Patward Pp. i+18. Indian Research Fund Association, Coonoor, S. In A History of Its Origin, Development and Activities. By V. N. wardhan. Pp. 23+7 plates. (Coonoor: Nutrition Research Lab tories, Indian Council of Medical Research, 1950, 1954 and 1955.)

Kenya Forest Department. Pamphlet No. 13: The Pruning Early Thinning of Exotic Softwoods in Kenya. By H. H. C. Pud Pp. 15. (Nairobi: Kenya Forest Department, 1955.)

Indian Council of Medical Research, New Delhi. Medical Rese in the Second Five Year Plan. Pp. iii+114. (New Delhi: In Council of Medical Research, 1955.)

Tanganyika: Geological Survey Department. Bulletin No. The Geology of the Songwe-Kiwira Coalfield, Rungwe District. D. A. Harkin. Pp. vii+33+9 plates. (Dar-es-Salaam: Governm Printer, 1955.) Shs. 7/50.

East Africa High Commission. East African Agriculture Forestry Research Organization. Annual Report, 1955. Record Research for the period 1st January 1954 to 30th June 1955. x+114. (Kikuyu: East African Forestry Research Organizat 1956.) Shs. 3/50.

Commonwealth Scientific and Industrial Research Organizat Australia. Bulletin No. 278: A Survey of the Beef-cattle Indu of Australia. By W. A. Beattie. Pp. 135. (Melbourne: Comm wealth Scientific and Industrial Research Organization, 1956.)

United States Department of Agriculture. Circular No. 977: In ticides and Repellents for the Control of Insects of Medical Importa to the Armed Forces. Prepared by the Orlando, Fla. Laboratory the Entomology Research Branch, Agricultural Research Serv Pp. ii+91. (Washington, D.C.: Government Printing Office, 19 35 cents

Meddelanden från Statens Skogsforskningsinstitut. Band 45: 1955. (Reports of the Forest Research Institute of Sweden.) iii+580. (Stockholm: Statens Skogsforskningsinstitut, 19 17 kronor.

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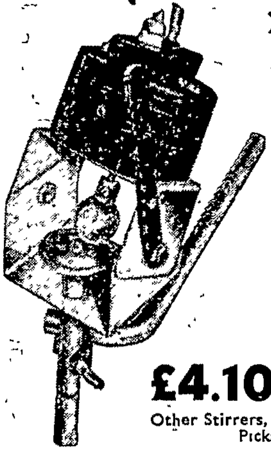

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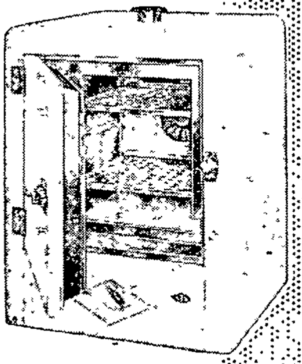

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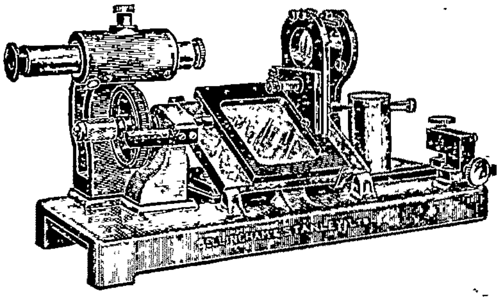

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HUMAN PROBLEMS OF INDUSTRIAL LEADERSHIP

THE brochure "New Developments in Industrial Leadership in Great Britain, the United States, rmany and France", which F. A. Heller has edited the Polytechnic Management Association*, is ed on four lectures and one discussion forum for ectors and senior executives, organized by the partment of Management Studies of the Poly- hnic, Regent Street, London. Even between the ding of the lectures in November 1954 and the blication of the brochure in December 1955, the portance of industrial leadership has been in- asingly recognized and, in particular, its bearing the introduction of new ideas into industry and causes of resistance to change and the most ective ways of overcoming that resistance. This ter problem was discussed more specifically by . J. F. Scott in his review of new aspects of manage- nt in the United States, although some of its olications were well indicated by Dr. J. A. C. own in surveying the British scene.

As Sir Geoffrey Vickers and Sir Walter Puckey nt out in their introduction, Dr. Brown's lecture s designed to introduce the series and to set the ole problem of industrial leadership in its broad ial as well as industrial context. None the less, challenges he threw out were taken up by the sequent lecturers, though Mr. F. A. Heller's survey ecent changes in industrial democracy in Germany minates especially the issues involved in joint nagement, and M. H. Hauck's review of modern nagement in private and nationalized industry in nce touches on the role of the trade unions and works committees. Both these lectures stress structural and legal aspects of leadership, as inst the psychological problems emphasized by Brown and Mr. Scott. In France and Germany, wever, there is the same realization as in Britain l the United States that much of the psychology l sociology of the nineteenth century must be arded, and that work will not be successful nomically unless it is also a satisfactory social ivity.

These last two papers describe some experiments ich have been made in the reorganization of great ustries in France and in Germany with the object changing the situation to which the people con- ned have to respond, and thus to encourage new itudes to change. Apart from Mr. Scott's paper, re is little reference to training or education in brochure; although the value of these activities stressed by Sir Geoffrey Vickers and Sir Walter key. The brochure is of value indeed chiefly for clear indication of the primary issues rather than setting forth precise action to be taken to over- e resistance to change or promote the spread of v ideas; and its importance has been accentu- d with the coming of automation to the fore as an urgent and leading issue. Moreover, Dr. Brown's contribution is of no less relevance to the issues of nationalization, which he shows, as it is practised in Britain, has created problems of human relations which are yet unsolved.

Dr. Brown begins by directing attention to the main implications for industrial leadership of the Hawthorne researches of the late Prof. Elton Mayo. The most important factor in industrial productivity is the feeling of the individual worker that his work has meaning and that he has a useful and essential part to play in society. In ordinary circumstances, money is one of the least effectual of incentives. People should and usually do, in fact, like their work, and changes in the physical conditions of work which involve no basic change in the common assumptions of management can lead to no fundamental improvement. Workers judge managers by what they do and by their assumed intentions. Management has to develop the social skills which lead to its acceptance by working groups, and, in particular, to the coincidence of the natural discipline of the working group and the formal discipline of management.

Accordingly, even if money were as effective an incentive as some people suppose, the study of human relations is essential in the Welfare State, where income tax largely removes the stimulus of increased wages and unemployment is no longer a real threat, and also because in modern mass production group co-ordination is of the first importance and the factory manager is concerned less with technical skills than with the co-ordination of human activities. To-day, authority can only come from mutual agreement between management and worker, as in fact the recent dispute over the reorganization and re-tooling of tractor production at the Standard Motor Company's works at Coventry seems to show. It is true, as Dr. Brown points out, that the study of human attitudes and relations can be carried to excess and the ultimate purpose of labour—the satisfaction of the consumer's demands and needs—overlooked; but the British industrial tradition is, on the whole, to resist change, and there is also a widespread suspicion of the idea that one can establish and put into practice a technique of human relations. With some exceptions, Dr. Brown suggests that British managements have paid lip service to Mayo's researches while fearing to put their implications into effect, or doing so only half-heartedly.

The fundamental issue, as Dr. Brown sees it, is the establishment of greater trust between the two sides of industry. Unless mutual trust exists, works councils, for example, are a waste of time; and this question of trust is the more important in view of the suspicion of technology which characterizes British scientific tradition—especially when concerned with human beings—and of the way in which our respect for the individual discourages any suggestion that he can be further understood by investigation or changed by new circumstances. As it is, Dr. Brown points out, while in Britain the workers are at present much better-off than anywhere else in Europe, there is more mutual suspicion between management and workers. Britain, in consequence, is more haunted by the past than many less progressive countries, and this is no less true of the nationalized industries than of private industry. In fact, Dr. Brown considers that whereas nationalization may have succeeded economically, in the human sense it has failed because it has not observed that ordinary individuals can only think in terms of people: the Trades Union Congress or the National Coal Board is without personal significance of any sort. It is probably true to say that the large privately-run concerns in Britain have shown a much greater tendency than nationalized industry to appreciate the dangers of over-centralization with its attendant bureaucracy, and have attempted to delegate authority to the local units.

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* New Developments in Industrial Leadership in Great Britain, United States, Germany and France. Edited by Frank A. Heller. 75. (New Development Series, No. 1.) (London: Polytechnic agement Association, 1955.) 5s.

The two criteria by which we must judge the industrial working group, namely, its productivity, and the social and psychological satisfactions which it gives its members, are not in contradiction but rather go together. Dr. Brown argues that the only possible solution of our problem to-day is that of treating people as human beings, giving them responsibility and trusting them to respond. Status and function within the society to which a man belongs are the most important things to him. Mr. Scott's review of the way this solution is being worked out in the United States, and particularly the emergence in the past fifteen years of a new national attitude towards the study of management and the selection of managers, indicate the possibility of altering the pattern of human relationships and thus overcoming the traditional barrier which custom offers to technical change. No society, he remarks, can survive that cannot find ways of evolving managers who are at once technically suitable to new needs and at the same time acceptable to those whom they must lead.

Mr. Scott emphasizes two points that seem to be of particular importance in regard to industrial leadership in Britain to-day, and especially where, as in the issues raised by automation, technical aspects are interwoven with and dependent on human relations. First, Mr. Scott notes that the concept of productivity should be applied to management in its human aspects, so that we give due weight to preventing human problems arising and are not occupied solely in trying to solve them as they arise. Then, as a consequence of the greater interest in the study of management in the United States, more and more of the managers of to-morrow are being consciously selected and trained, and more and more of them are accepted. That is most important both from the point of view of recruiting leaders from all ranks of society on the basis only of ability, and in order to reduce the time-lag between technical discovery and production. Secondly, he emphasizes the importance of understanding. The details are important, but it is the spread of understanding that really counts and enables technical change to proceed smoothly and at an increasing rate. If we in Brita could learn to make greater use of social science a apply it in a less materialistic and mechanical w than has sometimes been done in the United Stat the difficulties in the introduction of automa methods might be much less formidable.

These four papers should stimulate that furth thought about industrial leadership and its functio which is needed as much on the trade union side on that of management. It is not always realiz how large are the demands for leadership made the trade unions themselves, though the implicatio have been brought out by Mr. John A. Mack in article contributed to the recent special issue of *T Political Quarterly* dealing with trade union problem In a wider context, however, the implications automation and of nuclear energy are well indicat by Dr. Alexander King in an article entitled "Scien and the Changing Face of Industry—the Soci Phase" in *Impact* of March 1956. Dr. King does n believe that the automatic factory is likely to becon common within the next decade, but considers th automatic working will extend sufficiently to cau considerable industrial strain and to necessitate t tackling of many difficult social and manageri problems.

Although Dr. King covers a much wider field tha automation, his article is an important contribution the discussion of the problems which this latest e tension of mechanization brings in its train, in that sets those problems in the context of technical chan generally and facilitates a clearer understanding what is involved in the changing pattern of indust under the influence of science. Technical innovati can no longer be considered apart from the hum factor, not merely from the point of view of technic education and the training of men and women in t skills required to operate new processes and to han new materials: regard must equally be had to t effects on society as well as on the pattern a location of industry itself. Dr. King gives inde clear warning that automation and nuclear power a not the only developments in which scientific di covery is changing the pattern of industry and human institutions. It may well be that on revolutionary developments in, for example, phot synthesis may enable the problem of population a food supply, particularly in the under-develop areas, to be solved.

The outstanding challenge to-day is, in fact, create the social and political institutions that w enable us to utilize the discoveries and techniqu which science and technology have put at our di posal. Such developments cannot be considered fro the point of view of a single scientific discipline even of a single technology or industry. Just as t first need was for co-operation between the vario natural sciences and engineering, so now the need increasingly for co-operation between different indu tries, between all sides of industry, and between t social as well as the physical scientists. Econom and social factors may determine the rate of progre much more than the technological factors; and whi at present the social sciences can, as Dr. Ki serves, do little more than delineate the problems, this third—the social—phase of industrial evolu- on, they may well play a more important part than e natural sciences or technology.

While the demands which nuclear power and tomation will make on management for wise adership are thus unmistakable, it should not be ought that that leadership is a responsibility of anagement or even of government alone. Tech- ologists will indeed, as Sir Walter Puckey remarks, ed to be more concerned with the effects of their ork on the men and women concerned, and managers give much more attention to human problems and the problems of organization involved in using achines more intensively. Neither, however, can their work effectively unless there is a wider preciation on all sides of what is involved—the nderstanding stressed by Mr. Scott.

Accordingly, it is the more welcome to find Mr. obert Edwards, member of Parliament for Bilston, eaking as a trade union general secretary at the ommittee stage of the Restrictive Trade Practices ll on May 3, and urging that we should not be raid of short-term redundancy with the develop- ent of increased production; but that on both des of industry, and on both sides of the House of ommons, we should face the social consequences of dundancy in the interest of the general standard of ving of the people and in the interests of an economy oving towards abundance. Further evidence of adiness to consider the needs of the community as whole rather than sectional needs in a particular dustry was forthcoming when the Minister of abour made his statement on automation on May 8. eplying to questions, Mr. Iain Macleod said that tomation is the latest and most novel form of chnological change, and is welcomed by the Govern- ent and responsible opinion on both sides of dustry as essential to the future efficiency of ritain. The problems of re-deployment of labour d of the introduction of new skills involved can be tisfactorily solved, he said, if the Government and th sides of industry work in close co-operation. It essential that firms contemplating the introduction automation should in their planning consider the fect on their workers from the beginning and bring em into early discussion. For its part, the Govern- ent accepts a continuing responsibility for main- ining the general level of demand and, besides the ovision for the extension of technical education ready announced, it would provide opportunities r training and would assist through its employment rvices workers who had to change their employ- ent. In the light of the imminent report from the epartment of Scientific and Industrial Research, he id he proposes to discuss the whole question with presentatives of the employers, trade unions and tionalized industries on the national joint advisory uncils, and, as appropriate, with other advisory dies. The Government is confident that if all con- rned play their part in this way, these new changes ll prove of immeasurable benefit to the nation.

These observations were welcomed by the Opposi- on in the House of Commons; and it was clear from the remarks both on May 8 and later, on May 10, when the Prime Minister was asked for a statement of policy, that both Government and Opposition welcome the development of this new technique but are both concerned as to its social and economic effects. Sir Anthony Eden, affirming the Government's complete support of a policy of full employment, said he is doubtful as to the expediency of consultation on the floor of the shop or factory rather than through the trade unions. He reiterated that a continual and steady improvement in our industrial techniques is necessary to preserve the competitive position of Britain in the world, to maintain full employment and to ensure a continuous rise in the standard of living. The Government hopes that industry will invest in the new types of machinery to the fullest possible extent, but simultaneously there must be joint consultations with industry at an early date so that the introduction of new methods may proceed without friction.

There is thus reason to hope that in spite of the dispute at Coventry, which has brought automation and its attendant problems to the notice of the general public, plans will be concerted in advance to reduce the difficulties and fears which many people understandably entertain about the consequences of technological change. Meanwhile, however, the Government's proposals for the expansion of technical education, and indeed the educational programme as a whole, should be scrutinized the more carefully with a view to their adequacy in providing not merely workers with the technical skill needed, but also citizens with the adaptability which an age of technological change demands of them as citizens as well as workers. Both technological and university education should likewise be examined for their ability to provide the leaders required not merely in industry but also in government and in trade unions. Nor must either management or trade unions delay in examining the appropriateness to modern conditions of their own practices, and the effectiveness of their present systems of recruiting and training leaders, and adapting policies or practices to new demands.

GUIDED MISSILES

Guidance

By Arthur S. Locke and collaborators. (Principles of Guided Missile Design Series. Edited by Grayson Merrill.) Pp. xvii+729. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 12.50 dollars; 90*s*. net.

DEVELOPMENTS in the theory, design and testing of guided missiles include some of the major contributions to military technology during recent years, and they are of considerable scientific interest. The nature of these developments, however, is such that security regulations have permitted only a limited amount of information to be published; and the proposed series of five books on the basic principles of the subject, of which this is the first volume, will constitute the first major published work.

The design of guided missiles involves many specialized fields. For example, the guidance of a missile introduces advanced problems in servomechanism theory, aerodynamics, radar, navigation and communications, and the application of analogue and digital computers. The present book covers the relevant principles of these subjects, albeit in an elementary, and occasionally disjointed, manner; this latter is to be expected since the work has been written by several authors, and the task of co-ordinating a subject with such a broad basis must have been extremely difficult.

The volume appears to have been written essentially for technical officers in the Armed Services, and civilian scientific personnel in defence and industrial laboratories engaged in the development of missiles. It will also provide a basic text-book for the more comprehensive postgraduate courses in guided missile technology which have been introduced at several Service colleges; and the specialist in any one of the topics mentioned above will find the book useful in providing a general introduction to the subject as a whole. On the other hand, it cannot be regarded as an authoritative text-book but rather as a reference work which will supplement the classified literature. The most important chapters are those dealing with terrestrial and celestial references; measurements of missile motion; detection and information gathering; missile guidance systems; and missile guidance bandwidth studies; because this material includes specialized topics which have not hitherto been described in the literature. In addition, the chapters on transmission of radio waves and servo-system theory have been well planned and presented, and they will give a newcomer excellent background material in these important subjects. Notwithstanding the brevity of the chapter on the missile airframe, the authors have included the derivation of the airframe transfer functions and their approximate representation in the form of Bode diagrams; this is a desirable step because it effectively bridges the gap between the essentially servo and the essentially aerodynamic aspects of the design problem. The historical introduction, outlining the development of anti-aircraft instruments and weapons and navigational systems, and the short chapters introducing tactical and economic considerations, will be of considerable interest to the military technologist.

In the attempt to cover so extensive a field in a single volume, several topics have been treated rather summarily, and in some cases the desirability of introducing them is questionable. The brief notes on mathematical methods, especially curve-fitting, probability theory, and correlation functions are inadequate and of little value, and various sections of the chapters on transmission of radio waves and on radar will be incomprehensible to readers having no previous knowledge of these subjects. Again, in the penultimate chapter, the brief notes on digital computers will tend to confuse rather than to clarify—it is not possible to describe a high-speed digital computer and to introduce the programming of the machine in four pages. But these are not major criticisms because, for the most part, the book is well written and gives a lucid account of the basic principles of missile guidance.

A noteworthy feature is the large number of well-conceived and excellently executed diagrams, which enhance and clarify a text that will be welcomed by all technologists interested in defence problems.

A. Porter

JUBILEE OF THE JOSIAH MACY, JR. FOUNDATION

The Josiah Macy, Jr., Foundation, 1930–1955

A Review of Activities. Pp. xii+174. (New York Josiah Macy, Jr., Foundation, 1955.)

TO medical research workers in Great Britain th Josiah Macy, Jr., Foundation is best known fc its admirably planned conferences and conferenc groups of investigators in different disciplines bu with common interests; the published reports c these meetings extend their value far beyond th small number of experts (usually twenty-five including "at least one from abroad") who are abl to attend them. The Foundation's policy of bringin together specialists in a variety of subjects and skill which may bear upon the topic chosen for discussio represents an enlightened interpretation of th founder's wishes that the trustees should pay specia attention to "integrating functions in medical science and medical education for which there seems to b particular need in our age of specialization and technical complexities". The "Transactions" of th successive meetings dealing with topics as various a administrative medicine, the adrenal cortex, live injury, neuropharmacology, problems of infancy an childhood, problems of ageing (appropriately th subject of longest study) and cybernetics, to nam only a selection, represent important if inevitabl rather diffuse contributions to the literature of thes subjects. It is interesting to note that the idea c arranging such serial meetings developed from th Foundation's initiative in organizing conferences o medical subjects of urgent military significanc during the Second World War, and from the desir then expressed by the groups of investigators attending the meetings concerned with rapidly developin research problems, such as wound healing and shock to renew their consultations at intervals over a perio of years.

The present book surveys the surprisingly wid range of activities of the Foundation during th quarter-century since it was established in 1930. I addition to the conference programme, these activitie have included support for certain marginal an somewhat speculative investigations which migh otherwise have languished, as well as for man subjects of more orthodox appeal. The review o these different activities is a little optimistic in it assessment of the studies aided (it is surprising, t say the least, for example, to find the whole story o the role of acetylcholine in the transmission of nerv impulses apparently attributed to one worker in th United States who has been assisted by the Foundation); but the Board of the Foundation is certainl to be congratulated upon the presentation of a ver creditable account of its stewardship.

The present value of the Foundation's endowmen exceeds 28 million dollars. In twenty-five years th Foundation has distributed more than 4,268,00 dollars as grants-in-aid (842 projects), and has spen more than 1,350,000 dollars on its conference programme and other operational activities. Naturally the greater part of its resources is expended withi the United States; but the report refers also to grant that have been made from time to time to investigators in Belgium, Canada, Denmark, France Germany and Great Britain, as well as to variou overseas conferences which have been subsidized An investigation within Britain currently bein assisted by the Foundation is the study by Dr. John Bowlby and others at the Child Guidance Department of the Tavistock Clinic, London, of the ffects upon personality development of the separation of young children from their mothers.

The guiding principle of the Foundation, in accordance with the expressed desire of Mrs. Walter Graeme Ladd, the founder, is to be interested in “the architecture of ideas”. This is a lofty aim, and here is no cause for wonder if some of the ideas thus assisted prove ephemeral. Taken as a whole, however, the Foundation's solid achievement in stimulating and co-ordinating good research work onstitutes an impressive memorial to Mrs. Ladd's father, after whom the benefaction is named.

F. H. K. Green

BRITISH UNIVERSITIES THROUGH AMERICAN EYES

Higher Learning in Britain

By Prof. George F. Kneller. Pp. xii+301. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 45*s.* net.

“IT is obvious from what has been revealed in this volume”, writes Prof. G. F. Kneller, “that the author sees a crisis, or better a critical situation, in the very intellectual substance of the writing which has appeared in the last few decades on university education *per se*.” This writing, which is a native diagnosis of the British university system, Prof. Kneller does not commend. After an intensive xamination of the literature on the “crisis”, he finds it “impoverished and rapid”, with “thinly-sown ideas”, “worn-out and threadbare documentation” and based on “trite and nugatory educational fundamentals”.

It is obvious that Prof. Kneller has little time for the rearguard skirmishers or the pessimists, for he regards their observations as “bickering”. As an optimist who sees that “values in abundance prevail everywhere”, he is obviously stimulated by the panorama of human interests and experiences in Britain that spring from the expansion of social, political and religious interests of the modern world. He sees in their interplay the very strength of the system. His sources of inspiration are basically cientific. A. N. Whitehead and (with reservations) J. D. Bernal are the stilts on which he lifts himself above despondency. His severest strictures are reserved for the purely ‘arts’ critic of our academic ociety. To him Sir Richard Livingstone is “uniformly vulnerable”; Dr. F. R. Leavis “verbally prolix”, reflecting the “constricted modes of the nineteenth entury”; Prof. M. V. C. Jeffreys “is not only unrealistic . . . but totally impractical” and Bruce Truscot “contradicts himself”. As for Sir Walter Moberly, Prof. Kneller writes, “It is rudely evident, o say the least, that Moberly did not succeed in defining the crisis in the university, but rather described one situation which might be said to involve a crisis”. For the bouts of academic fisticuffs that flared up around Sir Walter Moberly, Prof. Kneller provides a ringside commentary, recording ach blow with painstaking accuracy. He has, by so doing, made his point clear that the real crisis in the university is “in the very intellectual substance of the writing which has appeared in the last few decades on university education *per se*”.

Yet, though his sympathies are avowedly with the scientists and their claims, Prof. Kneller's ample bibliography and critical apparatus is singularly deficient on the scientific side. The *Economist* and *The Times Educational Supplement* are cited, but not *Nature*. Nor has he probed the influence of (among other bodies) the Advisory Committee on Scientific Policy, though he seems aware of its existence. Even when he does choose a scientist to adorn his story, he has to make him do the work of two. True, the present High Master of Manchester Grammar School probably can do this, but that seems no reason for giving him two separate identities in the index as “James, E. J. F., 232, 269 n. 12, 283” and “James, Eric, 92–3, 221, 257 n. 48, 261 n. 35, 283; quoted 93”. This is running against the Ockhamite canon: *essentia non sunt multiplicanda praeter necessitatem.* Evidently the necessity was too great.

W. H. G. Armytage

MEYRICK'S MICROLEPIDOPTERA

Catalogue of the Type Specimens of Microlepidoptera

In the British Museum (Natural History) described by Edward Meyrick. By J. F. Gates Clarke.

Vol. 1. Pp. vii+332+4 plates. 60*s.*

Vol. 2: Stenomidae, Xyloryctidae, Copromorphidae. Pp. iv+531 (263 plates). 120*s.*

(London: British Museum (Natural History), 1955.)

THE first of these volumes introduces the reader to the peculiar problems arising from the vast number of species of Microlepidoptera described by Edward Meyrick (1854–1938). It gives an alphabetical list of the 14,199 names he gave them, and indicates the location of the type specimens. The second volume consists mainly of illustrations of the types (or newly designated lectotypes) belonging to three families, and it supplements Meyrick's original verbal descriptions with photographs of the left wings, photomicrographs of skilfully mounted preparations of the genitalia, and sometimes photographs or drawings of other structural details.

The author expects that four more volumes will be needed to cover the Meyrick types in London; he will then have laid the foundations on which detailed revisions of the classification can begin. It is indeed a herculean task which Meyrick left unfinished. For over half a century he dominated the study of these small moths. Collections from many parts of the world were submitted to him for naming and description. He described new species very methodically, but had an almost fanatical objection to the designation of types. This complete faith in verbal descriptions implied a belief that they were sufficient to distinguish new species not only from those already known, but also from those yet to be discovered. In a period when the science of entomology was rapidly advancing, his methods remained unchanged. Moths were still mounted on brass pins—now often corroded—and inadequately labelled. Wing venation was the prime character on which he based his classification, and shape, colour and markings were used in specific diagnoses. The genitalia were seldom examined, with the result that important structural differences were unobserved, and occasionally the sex of specimens was mistaken. Gates Clarke claims that Meyrick's genus *Stenoma* is "one of the largest conglomerations of unrelated species ever brought under one name in the Lepidoptera". The illustrations of this genus in Vol. 2 show an astonishing diversity in the structures portrayed and will greatly help revisers of the group.

This pair of volumes is a landmark. It is a joint project of the United States Department of Agriculture, the Smithsonian Institution, and the British Museum (Natural History). The last-named authority is to be congratulated for the far-sighted decision to permit the dissection of so much type material. Would that comparable illustrated guides to the Linnaean and other great collections were available. The extension of this sort of work is vital to the understanding of the old descriptions of animals and plants, on which the stability of nomenclature depends.

Considering the quality of the production and the large number of excellent half-tone illustrations, the volumes are not expensive. Vol. 2 would have been more useful with an index and a table of contents, particularly since some species listed in Vol. 1 only under their original generic names are transferred to different genera in Vol. 2.

G. C. VARLEY

GENERAL THERMODYNAMICS

Thermodynamics from the Classic and Generalized Standpoints

By Dr. Joseph Louis Finck. Pp. xv+224. (New York: Bookman Associates, 1955.) 7.50 dollars.

THIS book presents ideas which the author has developed over a number of years in papers published principally in the *Journal of the Franklin Institute*. These ideas relate to a study of thermodynamics from what the author calls a generalized point of view, which concerns itself with the thermodynamics of metastable states and irreversible processes as well as with the stable states and reversible processes of classical thermodynamics.

The author admits that the transition from classical to his generalized thermodynamics involves concepts which his readers may be reluctant to accept and, in order to facilitate this transition, he gives in the first half of the book a presentation of the subject-matter of classical thermodynamics, in which emphasis is placed on the limitations of the classical approach. This section of the book suffers from a confused presentation of the concept of heat itself, illustrated by the frequent appearance of statements such as "in an actual case when a force is applied to a body, heat is involved". This is the more unfortunate in a book in which the main theme requires a clear appreciation of the difference between the definition of heat in classical thermodynamics, and the layman's concept of heat, which usually includes vague ideas arising from phenomena associated with friction and other dissipative effects. It is, indeed, with these energy dissipative effects that the remainder of the book is principally concerned.

In the second half of the book the author introduces his own concept of a 'complete' system, in which the total number of independent variables required to describe the state of the system completely includes those which are beyond the control of, and the existence and variations of which may be unknown to, the observer. By this means the author claims to show how 'incomplete' systems acquire dissipative properties such as viscosity and electrical resistance, and why in some cases these properties vanish at very low temperature. The phenomenon of catalysis i among the other subjects studied.

Although the reader is certain to find cause fo disagreement with the author in not a few places and although he is unlikely to conclude that the author's presentation of 'generalized thermodynamics' has answered his own questions to the degree of satisfaction which the author claims for himself the book is thought-provoking, and the autho invites comments from his readers.

R. W. HAYWOOD

NORTH AFRICAN PREHISTORY

Préhistoire de l'Afrique

Par Prof. Raymond Vaufrey. Tome 1: Le Maghreb (Publications de l'Institut des Hautes Études de Tunis, Vol. 4.) Pp. 458+60 plates. (Paris: Masson et Cie., 1955.) n.p.

PROF. RAYMOND VAUFREY has written a magnificent monograph, profusely illustrated on the prehistory of Algeria, Tunisia and Morocco the "Isle of Maghreb". So rich is it in documentation that one can confidently assert that it is neve likely to be entirely replaced. Prof. Vaufrey is a professor in the Institute of Human Palæontology Paris, and he has visited and worked in North Africa repeatedly. He has also absorbed the very considerable literature on the prehistory of the area which has not infrequently seen the light in obscure journal not easily obtainable.

After an introductory chapter and another on the history of research in the region, the Lower and Middle Palæolithic periods are considered. Account of the geological conditions and deposits are given and excellent half-tone and line diagrams illustrate the chapter. Next the main Capsian culture is deal with. Here Prof. Vaufrey seems to have accepted the conclusion that, in spite of the presence of some pigmy flints in the levels, a connexion with the Perigordian must be postulated. Incidentally, a regards the pigmies, it has been suggested that i these more southern latitudes softwood trees occurred in much greater numbers than in France during the Perigordian period. Microlithic industries are indicative of composite tools, and the best material fo hafts would surely be softwood. Pigmy flints, then in the main Capsian levels may merely mean that i these regions softwood was of commoner occurrence than it was farther north. A chapter on the late Capsian and another on the early Neolithic follow and the palæontology of the region is then considered. A chapter of general conclusions brings the book to an end.

As already remarked, the volume as a whole is a magnificent piece of work which will long remain the classic account of the prehistory of the "Isle o Maghreb". The drawings alone, some thousands o them from the pen of that acknowledged expert, the Abbé Bouyssonie, provide a corpus of information indispensable to the student. Prof. Vaufrey is to be congratulated on the production of such a magnificen contribution to the prehistory of Africa.

M. C. BURKITT

Antimetabolites and Cancer

Edited by Cornelius P. Rhoads. (A Symposium presented on December 28–29, 1953, at the Boston meeting of the American Association for the Advancement of Science.) Pp. vi+312. (Washington, D.C.: American Association for the Advancement of Science, 1955.) 5.75 dollars.

THE fact that the collection of papers given at this symposium in December 1953 provides a review of the field which is still, on the whole, up to date indicates the general high quality of the contributions.

Stimulating and informative papers by Hitchings, Burchenal, Mandel, Lansford and Shive, Parks and G. B. Brown review a great deal of the work which they and others have done on purine, pyrimidine and folic acid analogues as anti-metabolites, and describe what is known of their relation to the treatment of experimental and clinical malignant disease. Particularly significant in this connexion are papers by Skipper, and by Nichol and Welch, on the development of drug resistance following the administration of amethopterin and 8-azaguanine. Woolley ascribes the inhibition of growth of a spontaneous mouse tumour by analogues of 1 : 2-diamino-4 : 5-dimethylbenzene (a vitamin B_{12} precursor) to interference with the synthesis of B_{12} by the tumour. However, this hypothesis appears to be inconsistent with statements, made elsewhere in his paper, that transplanted tumours do not synthesize B_{12} but that, on the other hand, one of these tumours is better inhibited than the spontaneous tumour by the antimetabolites.

Informative papers on perhaps less well-known topics in the field are given by Nickell on plant tumours, by Totter on the effect of aminopterin on bone marrow, by Visser on the use of nucleoside and nucleotide analogues as anti-metabolites, by Nelson on fœtal abnormalities following the administration of anti-metabolites and by Weinhouse on the carbohydrate metabolism of tumour cells.

This book provides an excellent review by experts of the state of knowledge on the subject covered by the title.

G. M. TIMMIS

Mumps, Measles and Mosaics

A Study of Animal and Plant Viruses. By Dr. Kenneth M. Smith and Dr. Roy Markham. (New Naturalist Special Volume.) Pp. xii+160+20 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 18*s*. net.

THIS is a serious study of animal and plant viruses. In common with other books in the "New Naturalist Series", it deals with its subject authoritatively, yet in a manner which is easily comprehensible to any reader with a reasonable background of general science. Drs. K. M. Smith and R. Markham explain the results of their researches, some of which are quite dramatic, in clear language, and they write compellingly of the work of others. Thus, the book deals with the gradual discovery of the very small size of viruses, of their unique methods of propagation, of the extraordinary relationship of many viruses with insects and "above all, of their border-line status between life and not life".

It is only twenty years since man saw a virus for the first time and only sixty years since the very existence of such things was first suspected. The authors describe how the electron microscope has shown us the shape and appearance of many of the viruses. A large part of the book deals with plant viruses, with particular reference to their importance in horticulture and agriculture; but there are also chapters on virus tumours and the control of virus diseases. Of particular interest is a section on everyday virus diseases, which should prove to be valuable to students of medicine, hygiene, public health and epizootics.

There are a useful glossary and a table giving methods of testing for common plant viruses. Many practical methods, useful for the university student, are given in the later part of the book. A good bibliography of references is appended to each chapter. The book is generously illustrated with electron micrographs and diagrams. The four colour-photographs, which show the effects of plant and animal viruses, are particularly effective.

W. L. SUMNER

Statistics of Therapeutic Trials

By Dr. G. Herdan. Pp. xvi+367. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1955.) 50*s*.

DR. G. HERDAN is primarily a statistician, being lecturer in statistics in the Faculty of Medicine in the University of Bristol. His book deals with a subject which has become very important in recent years and is the first book of its kind. It is intended for the use of physicians who wish to draw statistically valid conclusions from observations of the effects of therapy.

The book opens with a statement of fundamental principles which is not easy to read, but not essential to the understanding of what comes later. Diseases are divided into acute diseases, which are best studied by comparing one group of patients with another, and chronic diseases, in which it is sometimes possible to obtain information by calculating the regression coefficient of some measurement against time and comparing the results obtained in the same patient before, during, and after treatment. The appropriate statistical methods are described, and illustrative examples are worked out.

Special sections are devoted to studies of the treatment of pneumonia, poliomyelitis, scarlet fever, diphtheria, typhoid fever, and pneumococcal meningitis, as examples of acute diseases. The chronic diseases which are used as illustrations are cancer, pulmonary tuberculosis, rheumatoid arthritis, congestive heart failure, hypertension, diabetes and nephritis. Statistical studies of the treatment of all these diseases are discussed and it is surprising what a large number of the actual data come from the German literature. The book is attractively produced and could be read with profit by many physicians.

J. H. GADDUM

The Cytology and Life-History of Bacteria

By Dr. K. A. Bisset. Second edition. Pp. xii+164. (Edinburgh and London: E. and S. Livingstone, Ltd., 1955.) 25*s*. net.

UNTIL recently, bacteriology as a science has suffered from excessive parochialism, in that bacteria have been studied primarily because of their medical, industrial or agricultural importance. Dr. K. A. Bisset pointed out in the preface to his first edition that he was concerned to present the case "for regarding bacteria as living cells with the same structure and functions as other living cells", and in the second edition he incorporates evidence on this point which has been made available by technical advances during the past six years, such as the cutting of ultra-thin sections of bacteria for examination in the electron microscope.

The general plan of the book is unaltered, with sections on techniques, surface structures, the bacterial nucleus, reproduction and sexuality, life-cycles in bacteria, macroformations, and evolutionary relationships. The final chapter, on the genetics of bacteria, is unsatisfactorily short, and the subject would surely be better considered in relation to the chapters on nuclear structure and development. The number of illustrations has been considerably increased, and almost all of them are excellent and illustrate clearly the points at issue.

This monograph contains much that is stimulating, and it brings together a great deal of evidence which shows quite clearly that, despite their small size, bacteria are cells of considerable complexity. It is a pity that the author has in places adopted a rather over-enthusiastic style which detracts somewhat from the value of the book as a whole. C. S. CUMMINS

The Sun and its Influence

An Introduction to the Study of Solar–Terrestrial Relations. By Dr. M. A. Ellison. Pp. xii+235+9 plates. (London: Routledge and Kegan Paul. Ltd., 1955.) 21*s*. net.

THE subject of solar–terrestrial relationships is one that has not always been well served by authors. It is a pleasure to welcome in this book an addition to the literature which gives the verified facts and indicates their possible significance while eschewing speculation.

Dr. M. A. Ellison uses his first three chapters in describing the Sun: its radiation, the structure of its atmosphere, and the activity therein that is associated with the terrestrial effects to be described later. Solar reactions on the ionosphere, on the Earth's magnetic field, on radio propagation and on the polar aurora are then dealt with in some detail; and the last two chapters are concerned with the Sun's radio emission and the problem of cosmic rays. It is perhaps disappointing that no mention is made of the weather—if only to dispel some of the widely held beliefs connecting its vagaries with sunspots, for which the evidence is insufficient or even non-existent.

The author's approach presupposes no more than 'school-leaving physics', and within this limitation he has achieved his object of introducing to the reader a fascinating subject that covers many widely different fields. The expert will not, of course, find his own subject treated exhaustively; but the astronomer will turn with interest to the geophysical sections and the geophysicist to the astronomical chapters, and the layman with a wide general interest in science will read the whole book with pleasure and profit. A. HUNTER

Manual of Malayan Timbers

By H. E. Desch. Volume 2. (Malayan Forest Records—No. 15.) Pp. ix+329–762+plates 70–127. (Singapore: Malaya Publishing House, Ltd., 1954.) 15 Malayan dollars.

AS is explained in the foreword, this volume is the product of more than ordinary travail. Much of the original script was lost in 1942; but, after enlisting the support of Prof. Tanakadate, who was responsible for the publication of the "Foresters' Manual of Dipterocarps", by the late C. F. Symington, the author was enabled to rewrite most of it in Japanese prison camps between 1943 and 1945.

The format of the book follows that of Vol. 1, which was published in 1941. It is divided into sections, each dealing with one family, beginning with the Melastomaceae and proceeding alphabetically to the Winteraceae, with an additional section on the Coniferae. The scope of the work, originally intended to comprise only what was generally understood by commercial species, was eventually enlarged to contain any tree of which botanically authenticated material was available for study. The book includes a description of the wood of some four hundred different species, with details, wherever available, of weight, texture, durability, macroscopic features, mechanical, working and seasoning properties. amenability to preservative treatment, defects, importance and uses. Among the appendixes there is a most valuable bibliography listing 308 references.

The publication is well produced, and there are remarkably few printing errors. Some of the plates could have been better prepared and reproduced, but this is not the fault of the author. A revision of this manual may eventually become desirable, but this monumental compilation of data will remain a standard reference for many years to all who are interested in the timbers of South-East Asia.

Proceedings of the First International Symposium on Condensation Nuclei at Dublin, April 1955.

Edited by Mario Bossolasco. (*Geofisica Pura e Applicata*, Vol. 31; 1955/II.) Pp. 202. (Milan: Istituto Geofisico Italiano, 1955.) n.p.

THIS volume contains twenty-six papers dealing with techniques for measuring the concentration and size of Aitken nuclei ($5 \times 10^{-7} < r < 2 \times 10^{-5}$ cm.), their diffusion and coagulation, with the artificial production of these nuclei, and with related physiological studies.

A number of instruments based on the Nolan–Pollak counter, which measures nucleus concentrations by allowing them to become centres of condensation and measuring photo-electrically the extinction of a parallel-light beam by the fog, are described, but a novel modification by Rich which allows of size discrimination deserves special mention. R. Fürth contributes a valuable paper on the theory of diffusion and sedimentation of nuclei in a cylindrical container; this is used to good effect by Pollak and O'Connor in their experimental investigations of aerosol decay, from which they obtain information on the concentration, size and mass of the nuclei as a function of time. Two papers will be of particular interest to cloud physicists: Vittori describes the use of microchemical methods (Liesegang reactions) for the detection of atmospheric aerosols, especially chloride particles; Day presents some measurements of nucleus concentrations made over southern England and over the sea from an aircraft.

It is, perhaps, a little surprising that the main emphasis at this conference should have been upon the small Aitken nuclei when the larger aerosol particles are currently of greater meteorological interest. It is hoped that future conferences will pay more attention to the larger end of the spectrum and to such topics as the production, constitution and origin of atmospheric aerosol. However, this first meeting has produced a valuable set of papers, in the preparation and publication of which the organizers have achieved a high standard.

B. J. MASON

THE PERKIN JUBILEE CELEBRATIONS

THE discovery of mauve by W. H. Perkin in 1856 had consequences reaching so far beyond the dye-making and dye-using industries that, while the celebration in London of the centenary was fittingly initiated by the Society of Dyers and Colourists, the celebration was appropriately sponsored also by the Royal Society, the Chemical Society, the Society of Chemical Industry, the Royal Institute of Chemistry and the Association of British Chemical Manufacturers. The proceedings opened on May 7 with a reception to the principal overseas guests at the Tallow Chandlers' Hall, and on the following morning the Perkin Exhibition at the Science Museum, South Kensington, was opened by Dr. R. P. Linstead, to whose part in establishing the structure of the phthalocyanines Sir Robert Robinson, who presided, paid a happy tribute. Dr. Linstead, before declaring the exhibition open, made two points. Emphasizing Perkin's youth and initiative, he referred to the danger of so over-organizing research that initiative and enterprise are discouraged if not suppressed. Secondly, he stressed the remarkable speed with which Perkin's discovery was brought to production, and remarked that this also has its meaning for us to-day. Besides illustrating the attendant circumstances of the discovery and the subsequent development of the industry, the exhibition included a number of interesting letters from contemporaries of Perkin.

The main feature of the celebration was a series of four lectures which dealt with different aspects of Perkin's discovery and its results. In the first of these, Prof. John Read surveyed the life and work of Perkin, presenting a vivid picture of the scientific and technical setting in which the discovery was made, and bringing out above all the human qualities of the young chemist who made it, the difficulties which he had to overcome and the magnitude of his pioneering effort, not only in manufacture but also in the application of the new colouring matter. Moreover, Prof. Read was careful to portray not merely Perkin as the discoverer and manufacturer of mauve but also his subsequent career as a research chemist, in the course of which his synthesis of coumarin was a step towards the beginning of the synthetic perfume industry, as the reaction known by his name later permitted von Baeyer's synthesis of indigo; Perkin's deep interest in religion and in music was also emphasized.

In the second lecture, on May 9, Mr. Clifford Paine, development director of Imperial Chemical Industries, Ltd., drew on his forty years experience in the dyestuffs industry to give a masterly account of the development of the dyestuffs industry since Perkin's day, in which the principal features were indicated in a way readily intelligible even to a non-technical audience. Mr. Paine noted the way in which the industry has turned full circle in that, while Perkin's mauve came from an unsuccessful attempt to prepare quinine, the discovery of paludrine at Blackley has rendered the synthesis of quinine of no pharmaceutical importance. To recapitulate the outstanding advances of successive decades would not do justice to an address which abounded in touches, as in the references to the level of research expenditure and the difficulties over laboratory glassware in the First World War, which were obviously based on Mr. Paine's personal experience. A moving moment in the celebrations was when Dr. Herbert Levinstein, who had been managing director of Levinstein, Ltd., when Mr. Paine joined the firm, and was the sole living link with the jubilee celebrations of 1906, rose to express the thanks of the audience.

Mr. Paine himself presided when, on the afternoon of May 9, Mr. J. G. Evans, technical director of the Bradford Dyers Association, read a paper on "The Tinctorial Arts To-day". Mr. Paine reminded the audience that a quarter of a century earlier Mr. Evans had assisted Prof. H. E. Armstrong in his lecture "At the Sign of the Hexagon" in the same lecture theatre of the Royal Institution, and on asking for guidance as to the order of the demonstrations had been instructed to "Use your intelligence, man". Mr. Evans began by reading Perkin's original patent and, enlarging on the dyeing materials at the disposal of the dyer in Perkin's day and the available techniques, stressed the importance of Perkin's contributions in the application of mauve and allied dyestuffs. These contributions were even more important than the discovery of mauve itself and have remained in use to-day long after mauve has been superseded. Mr. Evans indicated the way in which new dyestuffs and changing requirements for fastness have set new problems for the dyer, and referred particularly to the problems arising from the advent of new fibres and new dyestuffs. To meet the demand for increased productivity, continuous methods of dyeing are being introduced, and Mr. Evans mentioned the limits within which such methods are applicable. The vote of thanks was moved by Mr. C. M. Whittaker, who, like Mr. Evans, was originally engaged on the dyemaking side of the industry before becoming connected with the dyers, and who took the opportunity to stress the part which co-operation between the makers and users had played in the renaissance of the British dyestuffs industry.

Sir Alexander Todd's lecture on "The Development of Organic Chemistry since Perkin's Discovery", delivered on May 10, drew the smallest audience; but his fascinating survey was fully as intelligible to a non-technical audience as the three preceding lectures. Enlarging on the position of organic chemistry at the time of Perkin's discovery, only four years after Frankland's introduction of the idea of valency had given organic chemistry, or the chemistry of carbon compounds, a chance to grow, Sir Alexander gave his own view of the few simple conceptions which made the modern edifice of organic chemistry possible: Kekulé and Couper's independent introduction of the idea of the combining capacity of quadrivalent carbon atoms; Butlerow's postulate that structure determines properties; Kekulé's benzene ring structure; and the ideas of van 't Hoff and Le Bel regarding stereoisomerism, with Thiele's theory of partial valency. In the past fifty years, the major influences on the development of organic chemistry have come from physics, and in the last fifteen years dynamic aspects especially have been to the fore.

Sir Alexander emphasized the close connexion, in the latter half of the nineteenth century, of the development of organic chemistry with the rise of chemical industry, and showed how in this field science and industry have worked hand in hand. He believes that the future of industrial organic chemistry is assured, though he foresees no radical departures. While in the latter half of the nineteenth century there were few chemists working on the chemistry of living matter, in the past fifty years there has been a striking return to the original objectives of organic chemistry, and, thanks largely to new experimental techniques, academic organic chemistry may well be on the threshold of striking developments, especially in the natural products field. We now have the necessary knowledge and technique to embark on the study of such problems as the relation between chemical structure and biological action and the mechanism of biological action with reasonable hope of success. Organic chemistry, without doing the job of biology or becoming a mere handmaid to biochemistry, is likely to continue to be concerned, as was Perkin, with the natural products.

The form of the centenary celebrations thus differed considerably from that of the jubilee celebrations in 1906. The presence of Dr. Levinstein provided a living link, as already noted, and the reception at Guildhall on May 8 and the banquet on May 9 gave some measure of resemblance, and especially in the international character of the gathering. Lord Salisbury, in his tribute to Perkin, stressed appropriately the importance to Britain of being alert to make the fullest and speediest use of existing knowledge, as well as being active in research, and Mr. Paine, in proposing the toast of the guests, contrived a happy reference to the British industry's Perkin medallist, the late Mr. J. Baddiley.

Nevertheless, the celebrations, for all the excellence of the lectures, left a certain sense of disappointment or frustration, and this bears on a further feature which the jubilee and centenary celebrations have in common. In 1906 a Perkin Research Fund was established and is administered by the Chemical Society. In connexion with the centenary celebrations, it is hoped to raise £100,000 to found Perkin Centenary Scholarships designed "to promote, advance and encourage technical education in relation to all aspects of the fabrication or application of colouring matters". The proposal is timely, and Lord Salisbury's speech was well calculated to commend it. Not only was that speech, however, unnoticed in the daily Press, but also the whole opportunity which the centenary celebration offered of commending a career in technology to youth was ignored. That opportunity is not likely to recur speedily, and the excellence of the lectures testifies to what was missed. It is easy to suggest reasons for the comparative seniority of those present, though equally easy to suggest ways in which youth might have been encouraged to attend to receive inspiration. But the contrast between the treatment by the Press of the celebrations in 1906 with those of 1956 suggests some neglect of responsibility. *The Times* could find nearly three columns for the proceedings at the Royal Institution and the banquet in 1906; but in 1956 neither lectures nor the Lord President of the Council received a line. The *Manchester Guardian* published an admirable supplement on the centenary, but did not report the celebrations, and only in *The Times* was there a brief note of the exhibition at the Science Museum. Yet the fine-chemical industry is of even greater significance now than it was in 1906. Without the imaginative co-operation of the Press, it seems idle to hope that youth can be brought to realize the opportunities which technology offers, or public support and understanding secured for the expansion of technical and technological education that Britain's economic future demands.

RESEARCH ON THE HUMID TROPICS

THE UNESCO PROGRAMME

IN the humid tropical regions, as in other parts of the world, the development of the land to meet the needs of rapidly growing human populations and the ultimate attainment of a satisfactory equilibrium between man and his environment, depends on scientific research. The need for fundamental research is especially great in these regions, partly because scientific activity has been centred mainly in the temperate zones and partly because so much of the research which has been done in the tropics has been applied and short-term in its aims. To-day the need for research on the problems peculiar to the humid tropics is particularly urgent, not only because there as elsewhere populations are rapidly outgrowing their food supplies, but also because at a time when large areas of tropical Africa and Asia are passing from a Colonial to a more or less independent status, countries which formerly depended on Colonial powers for the staffing and impetus of their research programmes will in future try to depend wholly or to a large extent on their own resources. For this reason, and because a great many of the scientific problems of these regions are world-wide or at least common to more than one country, the help of United Nations specialized agencies such as the World Health Organization, the Food and Agriculture Organization and the United Nations Educational, Scientific and Cultural Organization is both timely and necessary. Unless stimulus and support are given to fundamental research in the humid tropics by powerful international bodies, research in such countries is likely, for political and economic reasons, to be even more narrowly 'applied' and *ad hoc* in the future than it has tended to be in the past.

It was considerations of this sort which prompted the proposal that Unesco should develop a programme to assist research in the humid tropical regions parallel and complementary to the programme which it initiated in 1951 for research on the arid regions. The proposal was approved at the eighth session of the General Conference of Unesco held at Montevideo in November 1954, and in accordance with the resolutions of the Conference a preparatory meeting of specialists in humid tropics research was held at Kandy in Ceylon during March 22–24 last. Since many of the most urgent problems of the humid tropics concern deforestation, erosion and land-use generally (and are therefore in the broadest sense of the word ecological), it was thought appropriate that the preparatory meeting should be preceded by a symposium on "The Study of Tropical Vegetation". This took place at Kandy and was held during March 19–21. The preparatory meeting was attended by delegates from Brazil, Ceylon, France, Holland, India, Indonesia, Pakistan, the Philippines, the United Kingdom and the United States, as well as by representatives of the specialized agencies of the United Nations (Food and Agriculture Organization, World Health Organization and World Meteorological Organization), of several international scientific unions and associations and of the Unesco secretariat. Several members of the preparatory meeting also took part in the symposium, but not all the twenty-one members who presented papers to the latter attended the meeting.

At the symposium twenty-two papers on tropical vegetation were presented, and the term 'humid tropics' was so widely interpreted that some papers dealt with regions of relatively dry climate such as Madhya Pradesh in India for which 'seasonal' might be a better description than 'humid'. Since the contributions to the symposium will be published by Unesco (it is hoped later this year), it is unnecessary to summarize them here; but it may be noted that the subjects covered ranged from vegetation mapping and the application of aerial photography to the survey of tropical plant communities to the cytogenetical analysis of the forest flora of south-eastern Asia. The papers were circulated in advance and were not read in full, the authors being asked merely to introduce them briefly and to answer questions. This excellent plan left plenty of time for discussion and was undoubtedly largely responsible for the success of the meeting. The many lively discussions were skilfully guided by the chairman, Dr. C. H. Holmes, of the Ceylon Forestry Department.

In addition to the presentation and discussion of papers, which took about half the available time, discussions were held on five general themes chosen by a steering committee. Each theme was introduced and summed up by a chosen speaker, as follows: ecological factors in the tropics with special reference to the definition of dry seasons (Prof. G. Mangenot, France), vegetation types and their subdivisions, including methods of study (Prof. F. R. Bharucha, India), vegetation mapping (Dr. F. R. Fosberg, United States), the concept of the climax as applied to tropical vegetation (Prof. P. W. Richards, United Kingdom) and regeneration as a factor in judging the status of vegetation types (Prof. C. G. G. J. van Steenis, Holland). The discussions left no doubt of the vigorous activity and lively interest in the field of tropical ecology. There was a general feeling that the methods and concepts of ecology are too largely based on experience in temperate countries, where the vegetation has been modified by human activities for a very long period of time. This point of view was expressed perhaps most forcibly by Prof. van Steenis in a paper dealing with the basic principles of plant sociology as applied to tropical rain-forest vegetation. He claimed that homogeneous samples such as current plant sociological methods require cannot be found in rain forest of the usual type, while the concept of the plant association as a unit of constant composition and definable boundaries is one which could have evolved only in temperate regions with their impoverished and specialized flora and largely anthropogenic plant communities. "If plant sociology had been developed in a tropical country," he said, "it would have another face to-day. In fact the whole of botany would have another face if it had developed in the tropical zone." It is clear that the study of tropical vegetation is likely to develop rapidly in the near future, and that the proposal of some of the Indian members of the symposium to found an international society for tropical ecology is likely to be widely welcomed.

On the afternoon of its third day the symposium adopted a series of resolutions aiming at the promotion of ecological research in the tropics. These were presented to the preparatory meeting, which endorsed them and forwarded them to the Director-General of Unesco.

The preparatory meeting of experts on humid tropics research elected Mr. D. Rhind, secretary of the Committee for Colonial Agricultural Research (Colonial Office), as its chairman. Its main purpose was to propose the formation of a permanent advisory committee of Unesco for humid tropics research and to define the scope and method of functioning of this committee. Some discussion took place on the exact meaning of the term 'humid tropics', which is difficult to define, since there are large parts of the tropics which receive a heavy rainfall unevenly distributed through the year so that the climate is only seasonally humid. It was finally decided that a rough line of division should be drawn in agreement with Unesco's Arid Zone Committee, so that there should be no overlap and no omission of intervening regions from the field of interest of either committee.

There was also discussion on the meaning of 'fundamental research'. Though the general feeling seemed to be that the main duty of the proposed committee should be to provide or initiate research on the basic underlying scientific problems of the humid tropics, some members were opposed to defining its field in such a way as to exclude all kinds of 'applied' research. Careful consideration was given to avoiding overlapping with other international organizations concerned with research such as the Food and Agriculture Organization, the World Health Organization and the Commission for Technical Co-operation in Africa South of the Sahara ('C.S.A.'). There were certain fields of research such as geology and human health and physiology under humid tropical conditions which the meeting considered were probably adequately cared for by existing organizations, but which it was unwilling to exclude formally from the field of interest of the proposed committee.

Papers on an enormous range of subjects covering such diverse fields as zoological surveys, coral atoll ecology, reclamation of swamp land in Brazil, pedology, climatology, research on medicinal plants and much else were laid before the meeting, as well as requests for financial support to various research projects, several of which were recommended to the Director-General of Unesco for favourable consideration. A remarkable feature was the number and diversity of the requests for more taxonomic work on both plants and animals (especially insects) in the tropics. Many speakers made it evident that the lack of modern Floras and other taxonomic works for many tropical countries is at present an insuperable hindrance to research in a great many fields. The remedy depends on trained man-power as well as on finance; but it is clear that the belief that the biological sciences in the tropics can progress in the absence of strong support to taxonomy is quite unrealistic.

The preparatory meeting accepted gratefully an invitation from the delegate for France that the new Humid Tropics Advisory Committee, which Unesco has been asked to set up, should hold its first meeting, if possible in 1957, at Abidjan in the Ivory Coast. At the symposium on tropical vegetation it was recommended that this meeting should be preceded by another symposium with the theme "Ecological Studies of Tropical Vegetation in Relation to Soils".

P. W. RICHARDS

GEOCHEMICAL AND GEOPHYSICAL LABORATORIES IN THE IMPERIAL COLLEGE

By PROF. DAVID WILLIAMS

ONE of the initial steps towards the goal of full expansion of the Imperial College of Science and Technology, London, has been the addition of a top story to the Royal School of Mines. This story, incorporated in the Department of Geology, provides about 11,000 sq. ft. of accommodation for the Sub-departments of Geochemistry and Applied Geophysics, which are mainly concerned with training and research in certain modern aspects of mineral exploration. The new laboratories were open to inspection on May 24.

The Geochemistry Section comprises a main laboratory for the chemical analysis of minerals, rocks and soils, two laboratories devoted to spectrochemical analysis and the study of trace elements in geological material by means of large quartz spectrographs and other modern instruments, together with sample preparation and balance rooms. X-ray equipment for mineral identification is available, and a mass spectrometer is shortly to be installed. Several research cubicles are provided for postgraduates engaged in the investigation of a wide range of problems in pure geochemistry and geochemical prospecting.

Analysis of silicate rocks by the so-called classical methods is a protracted and highly skilled technique. Fortunately, however, rapid spectrochemical methods of silicate analysis, recently devised in the United States and substantially modified as the result of research in the new Pure Geochemistry Laboratories of the College, now permit a productivity of ten complete and reliable analyses per man-week. Thanks to this increased tempo the Department has been able to make comprehensive studies of the chemical changes induced in sediments by the emplacement of granites in Donegal, and to investigate chemical variations in the serpentinized basic igneous rocks of Insch in the Scottish Highlands. The research programme in pure geochemistry also includes a comparison of different analytical procedures, using spectrographic, polarographic, chromatographic and colorimetric techniques. This study should indicate the most appropriate method to adopt for determining particular elements, and it is hoped eventually to offer interested workers in other universities and research establishments a variety of silicate rock powders of guaranteed major- and minor-element composition.

Although much is known about the partitioning of certain elements among different minerals and among varieties of particular species, little research has yet been concentrated on the geochemistry of the less common metals, including those of the rare-earth group. Timely investigations, however, are now under way in the new Department concerning the distribution in minerals of cerium, gadolinium terbium and other rare-earth elements, knowledge of which will be especially valuable in view of the increasing interest in atomic energy. Regional studies of the distribution of trace elements in specific ore minerals continue to receive attention, and the dispersal of certain elements throughout soil profiles in temperate regions is under consideration. A virgin field of attractive research in nuclear geology awaits the arrival in the Department of a mass spectrometer capable of determining the isotopic abundance of a wider range of elements than has hitherto been investigated anywhere. Among the many problems to be studied is the isotopic constitution of copper zinc and other metals within a single sulphide deposit and within a particular mineralized district, an inquiry which should not only shed light on the origin of the deposits but may also herald a novel approach to mineral exploration.

In applied geochemistry, a flourishing research school is primarily concerned with critical studies of existing methods of geochemical prospecting, with the development of new field and laboratory techniques, and with the fundamental principles involved in the formation and detection of geochemical anomalies of economic significance. Geochemical methods of prospecting rely on the presence o significant traces of metals naturally dispersed in the rocks and soils near an ore-body, in the vegetation growing on these soils, or in the waters and sediment of streams draining the mineralized area. Thus although there may be no visible manifestations o mineralization, the presence of concealed mineral deposits may be revealed by the detection o anomalous concentrations of metals in surface materials. Since the concentrations involved are usually very minute, rapid and simple trace analytical techniques have been specially devised to detec them. A Geochemical Prospecting Research Centre has been established in the Department, partly with the aid of funds from the Colonial Office and th Department of Scientific and Industrial Research and active research is being carried out in variou parts of Africa and Britain in mineralized areas containing cobalt, copper, gold, lead, zinc and othe metals. Results to date augur well for the continued success of this new method of discovering minerals.

The Applied Geophysics Department is provided with a diversity of modern prospecting instruments including vertical and horizontal magnetometers, a Worden and a North American gravity meter, seismi equipment and a variety of electrical instruments for spontaneous polarization, resistivity and electo magnetic surveys. Facilities are available for testing and calibrating these instruments and also for measuring some of the relevant physical properties of rocks and minerals. In the students' laboratory model experiments, simulating field conditions, have been developed to illustrate many of the principles employed in geophysical prospecting. A main laboratory and a number of small ones are devoted to research, and a workshop affords facilities for the construction and development of special equipment.

Current research in geophysics includes gravity-meter surveys along the margin of a gabbro mass near Insch in Scotland, and the development of an automatic method of computing the gravitational effects of various types of geological bodies. Studies of Tertiary igneous rocks in Mull and North Wales have indicated that during their extrusion or intrusion many of these rocks were magnetized in a direction opposite to that of the Earth's present field. While any theory of the Earth's magnetism must account for this adverse magnetism, possibly by invoking a reversal of the Earth's field in the geological past, the results obtained in these academic studies have an obvious bearing on the geological interpretation of magnetic surveys for mineral deposits. An attempt is now being made to use the techniques of palæomagnetism for studying the physical conditions which operated during the emplacement of granites and the injection of dykes.

On the instrumental side a flux-gate magnetometer (of the type used in aeromagnetic surveying) is being modified for use at sea, to be towed behind a ship; with this instrument it is hoped soon to make magnetic measurements in the North Atlantic. Development of a novel type of magnetometer based on nuclear magnetic resonance is expected to result in the speeding up of magnetic surveys on land, the instrument consisting essentially of a bottle of water, an electromagnet and a detector coil to measure the frequency of proton precession.

Seismic research is directed towards the production of simpler and more reproducible shocks, using an electromechanical device. Investigations, particularly of frequency attenuation and phase changes, are being continued and the new technique should prove valuable in helping to decipher shallow geological structures. Promising results have attended the evolution of an induced polarization method of locating good conducting ore-bodies enveloped by an electrolyte, and equipment is now being constructed for field-trials over known metalliferous deposits.

OBITUARIES

Prof. S. R. K. Glanville, F.B.A.

Stephen Ranulph Kingdon Glanville, Provost of King's College, Cambridge, and Herbert Thompson professor of Egyptology in the University, died, very suddenly, on the morning of April 26, his fifty-sixth birthday. The news of his death came as a great shock, not only to his professional colleagues, but also to men and women in many countries; for there were few who knew him who did not come to rely on him for friendship and sympathy.

Glanville was the eldest son of Stephen James Glanville and was born in Westminster in 1900. He was educated at Marlborough and at Lincoln College, Oxford, where he was a modern history scholar. He graduated in Literæ Humaniores in 1922. Chance largely led him to accept a post as an English teacher in the Egyptian Delta town of Mansūrah. Once there, he fell in love with the country and its people, and set himself to study them. He joined the Egypt Exploration Society's excavations at Tell-el-Amarneh in the season of 1923, the beginning of his long record of devoted service to the Society as a field-worker, and as member and chairman of committee. In 1924, he was appointed an assistant keeper in the Department of Egyptian and Assyrian Antiquities in the British Museum, where he remained until 1933. He returned, however, to Egypt to work at his beloved Tell-el-Amarneh in 1925, and at Armant in 1928, and contributed to the publications on both sites. He held the Laycock Studentship of Egyptology at Worcester College, Oxford, during 1929–35.

At the British Museum, the major outstanding task of the Department was the publication of its demotic papyri. Demotic is a cursive script in which the Egyptians wrote their documents from the seventh century B.C. until the fourth century A.D.; and in 1924 there were comparatively few aids for its study. Inspired by Sir Herbert Thompson, who became his teacher, benefactor and friend, Glanville undertook this task and did pioneer work. His "Catalogue of the Demotic Papyri in the British Museum, Vol. 1: A Theban Archive of the Reign of Ptolemy I Soter" (1939), and Thompson's "A Family Archive from Siut" (1934), set a new standard and method for the publication of demotic contracts. By painstaking compilation of family genealogies and topographical plans of streets and houses, they made the dry legal formulæ yield up a brilliant and intimate picture of the social and family life of Egyptian provincial towns in the Ptolemaic period. Vol. 2 of Glanville's "Catalogue", "The Instructions of 'Onkhsheshonqy" (1956), of which he received the first copy a few weeks before his death, broke fresh ground; in it he deciphered and translated what may well be the last great "Wisdom" book from Egypt. His deep understanding, both of Egypt and of human nature, enabled him often to interpret what might have remained dark to a more cloistered mind; while his firm critical judgment and keen historical sense controlled his imagination and ensured his accuracy.

But Glanville was by no means a one-sided scholar. During his time at the Museum, apart from editing the valuable "Studies presented to F. Ll. Griffith" (1932), he published many articles on the earlier literature and history of Egypt, and acquired a deep knowledge of Egyptian objects, for which he had always had a rare feeling. This became of the utmost importance at University College, London, where he was appointed a reader in 1933, and in 1935 Edwards professor of Egyptology; for his chief task there was the cataloguing of the Petrie Collection. Unfortunately, his work for it was undone by the Second World War. Meanwhile, he edited the "Legacy of Egypt" (Clarendon Press, 1942). During the War he served in the Royal Air Force, in which he reached the rank of wing commander, and was made M.B.E. and received Czechoslovak, Dutch and Yugoslav decorations. In 1946 he was appropriately appointed to the new chair, founded by his old master, Sir Herbert Thompson, at Cambridge, specifically for demotic and coptic studies, and was elected a professorial Fellow of King's. In the same year he was elected a Fellow of the British Academy, and recently became an honorary Fellow of his own College, Lincoln, Oxford.

At Cambridge, Glanville devoted himself not only to building up the new Department of Egyptology, its library and collections, but also served the University, his College and his Faculty in a host of functions. His courage, clear-sightedness and grasp of principle were always tempered by his warmth, his tact and his humour. Such was the trust and affection in which he was held in his College, that he became in 1954 the first Oxford man ever to be elected Provost of King's College, Cambridge. The loss of his wisdom and friendship there is as grievous as it is to his Department and students. For he was the finest type of teacher; he never spoon-fed, but worked unsparingly and sympathetically to inspire his students to make the best of their own abilities, not in their studies alone, but also in the whole of their life. His life will be an inspiration, his kindness a poignant memory, to his many friends.

H. S. SMITH

Prof. Edward Stenz

EDWARD STENZ, who died after a long illness in Stockholm on February 21 at the early age of fifty-six, had many friends among meteorologists and geophysicists all over the world.

Born in Warsaw, he went to a secondary school there (the Rey Gymnasium); even as a pupil he became an enthusiastic member of the physics section under the leadership of Ziemecki, who after the War took a chair of physics at the Maria Curie SkŁodowska University of Lublin.

Stenz studied in the University of Warsaw unde Kowalski, Pieńkowski, Gorczyński, Mazurkiewic and Sierpiński; he also spent some time at the Ja Kazimierz University of Lwów, working unde Arctowski. He took his Dr.Phil. degree at the Stefa Batory University of Wilno.

After graduating, Stenz became a lecturer in th Physics Department of the University of Warsaw and was afterwards in charge of applied physics a the Technical University of Warsaw; later he wa appointed director of the Observatory at Kasprowy Wierch in the Tatra Mountains. He spent the perio of the Second World War in Afghanistan, being i charge of the Meteorological Office and professor i the University at Kabul. After the War he wen back to Poland and was appointed professor o geophysics in the University of Warsaw. He serve as president of the Geophysical Committee of th Polish Academy of Sciences, deputy director of th Institute of Geophysics, and president of the Polish Meteorological and Hydrological Society. He wa the author of about ninety papers, covering a wid range of subjects—meteorology, terrestrial magnetism, the Sun and terrestrial radiation and gravimetric measurements; he also published severa semi-popular books. All his papers were marked by a clear and attractive style as well as by a high standard of presentation. He was one of the firs organizers of the meteorological service for the Polish Air Force.

Stenz was very sensitive, full of stimulating ideas kindly disposed to others and always ready to give a helping hand to those in trouble. In the summer o 1954 he experienced a great blow: his only daughte fell to her death, while climbing in the Tatra Mountains. His own death means a great loss to Polish science and has deprived all who knew him of one of their most valued friends.

JÓZEF MAZUR

NEWS and VIEWS

Kelvin Gold Medal

THE Kelvin Gold Medal for 1956 has been awarded to Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell. The Medal is awarded every three years to a person of any nationality "as a mark of distinction in engineering work of the kinds with which Lord Kelvin was especially identified", and the administration of the award is in the hands of a committee consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, and Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute.

Royal Meteorological Society: Awards

THE Royal Meteorological Society has made the following awards: *Buchan Prize*, founded in memory of Alexander Buchan, secretary of the Scottish Meteorological Society during 1861–1907, for the period 1951–55 has been awarded to Mr. F. H. Ludlam (Department of Meteorology, Imperial College of Science and Technology), for his outstanding contributions to the study of cloud physics; *Hugh Robert Mill Medal and Prize* for 1956, founded in memory of Hugh Robert Mill, director of the British Rainfall Organization during 1901–19, has been awarded to Mr. J. S. Sawyer (director of the Forecasting Research Division, Meteorological Office) for his outstanding contributions to the science of meteorology, with particular reference to rainfall.

Linnean Society of London

AT the anniversary meeting of the Linnean Society of London held on May 24 the Linnean Gold Medal for 1956 was awarded to Prof. W. H. Lang, emeritus Barker professor of cryptogamic botany in the University of Manchester. The following were elected officers of the Society for the session 1956–57: *President*, Dr. H. Hamshaw Thomas; *Treasurer*, Sir Frederick Stern; *Secretaries*, Dr. H. R. Hewer (zoology) and Dr. C. R. Metcalfe (botany); *New Members of Council*, Mr. D. Etherington, Dr. B. M. Hobby, Dr. Doris M. Kermack, Dr. John Smart and Dr. Errol I. White. Prof. I. W. Bailey, Dr. Anton Brunn, Prof. J. A. Efremov, Prof. Richard Harder, Prof. Bernhard Rensch, Prof. Karl von Frisch and Prof. Ø. Winge were elected foreign members of the Society.

Presidency of the Institute of Fuel: Mr. J. R. Rylands

Mr. J. R. Rylands, who has recently been elected president of the Institute of Fuel and will take office in October next, served his engineering apprenticeship with Henry Berry and Co., Ltd., of Leeds, and then, after service in the Army during the First World War, graduated from the University of Leeds. He worked at first as an electrical engineer with the Taquah and Abosso Gold Mining Co., of the Gold Coast, but later transferred to E. Green and Son, Ltd., of Wakefield, makers of fuel economizers, of which company he is now chief engineer and a director. For his work done with J. R. Jenkinson during the Second World War on fouling problems associated with economizers and air heaters, he received the John Hopkinson Premium for 1943 of the Institution of Electrical Engineers, and this work was followed by further research into the corrosion of boiler, economizer and air-heater surfaces, for which he was awarded the Thomas Lowe Gray Prize for 1948 of the Institution of Mechanical Engineers. Mr. Rylands has been active in the electrical branch of the engineering profession, having served as chairman of the North Midland Centre of the Institution of Electrical Engineers.

J. A. C. Chaptal, Comte de Chanteloup (1756–1832)

The distinguished chemist and statesman, Jean Antoine Claude Chaptal, who was born at Nogaret, Lozère, two hundred years ago on June 4, 1756, is to-day remembered chiefly for his contributions to the technical development of modern industry by the application of the science of chemistry, and for having coined the name for nitrogen. The son of an apothecary, he owed his education to a rich uncle, Dr. Claude Chaptal, and in 1777 he graduated M.D. at the University of Montpellier. After studying science in Paris, in 1781 he was appointed to a specially instituted chair of chemistry at Montpellier, where he taught the new doctrines of Lavoisier with eloquent lucidity. On the death of his uncle he inherited a large fortune, part of which he devoted to establishing chemical works for the manufacture of mineral acids, alum, white lead and soda. In 1797 he was made director of the saltpetre works at Grenelle by the Comité de Salut Public and greatly simplified the procedure of making gunpowder. Two years later he was created a Councillor of State by the First Consul, and in 1801 he succeeded Lucien Bonaparte as Minister of the Interior. In this capacity he founded a society of industries and a vaccine society, reorganized the hospitals, organized schools of pharmacy, introduced the metric system of weights and measures, and did much to promote the scientific culture of vines. Besides his many scientific honours, he was a grand officer of the Legion of Honour (1805), and received the title of Comte de Chanteloup (1811). On Napoleon's return from Elba in 1815 he became director-general of commerce and manufactures. His best-known writings are "Éléments de Chimie" (1790 and several editions), "Traité des Salpêtres et Goudrons" (1796) and "L'Art de faire les Eaux-de-Vie" (1819). He died in Paris on July 30, 1832, at the age of seventy-six.

Joseph Pitton de Tournefort (1656–1708)

Joseph Pitton de Tournefort, who was born at Aix three hundred years ago on June 5, 1656, is remembered as a pioneer botanical systematist whose classification of groups higher than genera was accepted until the time of Linnæus. Born of a noble family, he was intended for the church, but after his father's death in 1677 he devoted himself wholeheartedly to his first love, namely, botany. He studied medicine at Montpellier and also at Paris, where in 1683 he became professor of botany at the Jardin Royal des Plantes. In 1692 he was elected to the Royal Academy of Sciences, Paris, and he received the M.D. of Paris in 1698. Two years later he was sent by the king to Spain, Portugal and Asia Minor to collect botanical material. Reviving the concept of genera and species originated by Kaspar Bauhin, he provided his genera with names and characters, adding the species and varieties without special description. He refused to accept the doctrine of sexuality in the vegetable kingdom formulated by Rudolph Jacob Camerarius, of Tübingen, in 1691–94. Inclined to be dogmatic, de Tournefort regarded the morphology of the flower and fruit as the proper basis for classification, founding his system on the form of the corolla. His most important work was "Eléments de botanique ou méthode pour connaître les plantes" (1694; three volumes with 451 plates). He also compiled a materia medica, which was published in French after his death, an English translation appearing in 1708. A tremendous worker and a vivacious, gay and charming personality, de Tournefort died on November 28, 1708, at the age of fifty-two.

Nature Conservancy

The Committee of Privy Council for Nature Conservation has appointed the following as members of the Nature Conservancy: Lord de Ramsey, Colonel J. C. Wynne Finch, Sir Graham Sutton (director of the Meteorological Office) and Prof. A. R. Clapham (professor of botany in the University of Sheffield). The vacancies have arisen through the death of Sir Arthur Tansley, and the retirement of Prof. R. Alun Roberts, Prof. R. C. McLean and of Mr. C. S. Elton, who remains a member of the Scientific Policy Committee. The following members have been reappointed for a further term of service: Lord Strang, Lord Hurcomb and Dr. E. B. Ford.

Technology as an Educational Discipline

The presidential address to the Institution of Mining and Technology, given on May 17 by Prof. C. W. Dannatt, professor of metallurgy in the Imperial College of Science and Technology, London, was concerned with the study of technology as a branch of education. Discussing how education is acquired, he pointed out that the study of history and the study of science have much in common, following almost identical rules which should engender habits of high moral and intellectual worth: patient and persistent industry; an honest receptivity which accepts substantiated facts even when counter to preconceived beliefs; freedom from prejudice, and a willingness to abandon the most cherished thoughts and theories in the face of evidence; self-reliance and a readiness to challenge statements that seem open to doubt; and clarity of thought combined with constant and painstaking practice in logical inference and deduction. If these qualities become so ingrained in the mind that they are applied in every circumstance of life, the scholar, no matter what his subject of study, will be a cultured man. Accordingly, the failings of the over-specialized scientist or technologist are due not to the subject of study but to the neglect of matters that should be of interest. Prof. Dannatt claimed that technology when properly used is a satisfactory and efficient implement of culture, but he thinks that we shall eventually be forced to restrict the field of our technologies, and possibly to lengthen the courses so as to maintain standards. He also suggested that we must discard the foolish idea that budding technologists can be identified by examination at the age of eleven or twelve, and that their studies may safely be narrowed and restricted within no more than three or four years. We should also remove the load of specialized studies from the schools and leave them free to perform their task of providing a general basis of education. Technological studies can provide the discipline and basis essential to culture but, like other advanced studies, they need that broader basis of general knowledge which can be developed into vision and understanding.

Technology and the Universities

In his presidential address to the Association of University Teachers on May 25, when he spoke on "Technology and the Universities", Prof. J. L. Montrose, professor of law in The Queen's University, Belfast, submitted a reasoned claim that technology has not merely a place within universities, but is in fact better studied there than elsewhere. He based this claim on the creativeness of application and on the reality of scientific activity in many departments of knowledge. The qualities which constitute the life of reason can be manifested both in the discovery and in the application of knowledge. Moreover, the inclusion of technology within universities can be supported not only by theoretical arguments of the liberating character of thought about problems of the utilization of science but also by descriptive consideration of what happens in such departments—the keen interest in science of their undergraduates and the valuable contribution which the research work of their staffs makes to the understanding of Nature and to scholarship in general. Prof. Montrose summarized the qualities required to ensure that a subject is taught at a university-level with depth and perspective. It is by means of thoroughness that we can attain the broad outlook which sees details of a subject as the application of basic principles, sees principles as seminal ideas growing into the processes by which human problems are treated, and which sees the connexions between one subject and others and the whole of life. Prof. Montrose added that university teachers have not given sufficient thought to the problem of testing intellectual qualities other than the mnemonic. We should endeavour to test not solely powers of recollection and expression but also such other qualities as the ability to discover information about a subject, to apply the principles of a subject to new situations, to comprehend a new and complex statement and to analyse it in relation to criteria for testing its accuracy and, above all, to test inventiveness and imagination. Finally, Prof. Montrose stressed the importance of the quality of staff in our technological institutions and of providing conditions of service that would attract outstanding men and women.

Direction Indicators for Motor-Vehicles

On May 16 the Minister of Transport and Civil Aviation, Mr. H. Watkinson, replying to a question, stated that he has received the final report of the Road Research Laboratory on the comparative meri of the different types of direction indicators now i legal use on motor-vehicles in Britain and that h has reached the conclusion that all three types o direction indicator now permitted should continu to be legal, both to meet the needs of different kind of vehicles and also as an aid to the export trade The report is being circulated, and the Ministe intends also to circulate to interested organization proposals for the amendment of the construction an use regulations. These regulations would requir direction indicators fitted to vehicles registered afte the end of 1958 to be amber in colour, neither t exceed nor fall below certain standards of brightness and, if of the fore-and-aft flashing type, to b separated from other lights. The Laboratory ha concluded that direction indicators should be ambe in colour, with an intensity between 100 and 50 candle-power, and that this colour should not b used for other vehicle lights. They are best mounte on the side of a vehicle, roughly at the level of th driver's eye, and should emit light forward an backwards and also appreciably at right angles. N consistent evidence in favour of a flashing rathe than a steady light of equal intensity has been foun by the Laboratory, and no change in existing practic is recommended, although it is desirable that on type of indicator should be selected for genera adoption and alternatives avoided. Uniformity o type of indicator, position, intensity and rate o flash are important, and means for ensuring th observance of standards are desirable.

The Calder Hall Pile

The first of the two atomic piles in the Calder Hal Power Station, which will be the first in the world t supply electricity on a large scale from nuclea sources, has started working. Physical measurement and instrument checks are now taking place, and th gradual commissioning of the plant will follow. H.M the Queen will perform the official opening of th Station on October 17. For the first time in th history of the world, electricity on a large scale wil then be supplied from a nuclear power station to national electricity network.

Calder Hall is part of the Atomic Energy Authority' programme for power stations and is not included i the national programme, which envisages the con struction of twelve atomic power stations by elec tricity authorities during the next ten years at a estimated cost of £300 million. The Atomic Energ Authority is also building a replica of the first powe station on the same site, and another with fou reactors at Chapel Cross, Annan, Dumfriesshire These have the dual purpose of producing electricit and making plutonium for the military programme Another atomic power station at Dounreay, Caith ness, will have an experimental fast breeder reacto capable of creating more fissile material than it burns

Power from Fusion

The United Kingdom Atomic Energy Authority i holding a one-day symposium on controlled thermo nuclear energy on June 4 at Harwell which will be o a classified basis. Invitations have been sent t representatives of industrial research laboratories i addition to government research establishments an British universities. About fifty people have bee invited in addition to the Authority's own staf The object of the symposium, at which a genera account of the Authority's own project will be given is to encourage fundamental research work along lines which will assist the work of the Authority in this field. Research on the control of the thermonuclear reaction has been going on at Harwell for some time. The conference will be held in private, and no statement will be issued afterwards.

Central Pool of Officers for the Oversea Civil Service

On May 17 the Secretary of State for the Colonies, Mr. A. Lennox-Boyd, made a statement regarding the Oversea Civil Service, further details of which were given in a White Paper published the same day. Mr. Lennox-Boyd said that the Government has decided in principle to establish a central pool of officers with exceptional administrative or professional qualifications who would be employed by the Government in the United Kingdom and be made available as required for secondment to overseas Governments. The central pool will be set up as soon as possible. Meanwhile, to meet an urgent staffing position which has arisen in the territories comprising the Federation of Nigeria, it is proposed, subject to the agreement of the Nigerian Government, to introduce a scheme by which existing expatriate pensionable officers can transfer, on certain conditions, to a special list of the Oversea Civil Service, and officers so admitted will thenceforth be in the service of the Government and seconded to the local Governments. The scheme will be in a form that will permit similar arrangements to be applied to other territories if considered desirable. In reply to questions, Mr. Lennox-Boyd added that officers transferred to the special list will be paid by the employing countries, at rates prescribed by the British Government after consultation with those countries, and that H.M. Government will pay the pensions and recover the money from the Government in whose service the pensions were earned.

Fluoridation of Potable Water in Britain

In view of repeated allegations that the addition of fluoride to public water supplies might have harmful effects, the Minister of Health has again consulted the Medical Research Council. The Council has transmitted to the Minister the advice of a conference of experts, which it called to review the subject, that there is no evidence warranting alteration or abandonment of the fluoridation projects. The experts agreed in general with the conclusions of the United Kingdom Mission (1953) to the effect that, despite considerable interest and research, there is no definite evidence that the continued consumption of fluorides in water at a level of about 1 p.p.m. in drinking water is in any way harmful to health, and they consider that if any untoward effect is revealed by future research this is most unlikely to be serious.

Industrial Welfare Society

In the annual report for 1955, the director of the Industrial Welfare Society, Mr. John Marsh, suggests that side by side with the demands for scientific and technical achievement in industry, there is a great need for men who have personal qualities and who can influence workers at all levels to be self-respecting, co-operative and efficient. Personal qualities are not only needed among those concerned with management but also among the specialists. The technical specialists of industry can create human problems which sometimes offset the efficiency they set out to achieve. For example, the need for work-study engineers is undoubtedly great; but industry must select men for training in these tasks who are fundamentally sound in their knowledge and understanding of their fellow men. They must certainly know something about the effect of changes in skill on a man's reason and emotions. Among other items referred to by Mr. Marsh are the lack of clearly defined promotion systems in the majority of industrial concerns and the amazing dearth of suitable reading matter for the large number of supervisors and apprentices in industry.

A Bibliography of Plant Protection

Under this title a comprehensive work covering the year 1951 has been issued in German, English and French by the Biologische Bundersanstalt für Land- und Forstwirtschaft in Berlin-Dahlem, under the editorship of Dr. J. Barner (pp. xliv+420; Paul Parey, Berlin and Hamburg, 1955). This bibliography, which comprises more than 12,500 titles, is in continuity with the original publication on this subject begun in 1921 and already including twenty-two volumes covering the years 1914–45. The volumes covering the years 1946–50 are to follow in the near future. The original layout has been maintained and includes a general section dealing with collective works, text-books, reports of congresses, bibliographies, etc., followed by other sections on diseases and their causes, diseases and host plants, measures of plant protection and an index of authors.

University of Leeds: Appointments

Dr. C. E. Lumsden, of the Institute of Neurology, London, has been appointed professor of pathology and head of the Department of Pathology in the University of Leeds. The following have been appointed lecturers in the University: Dr. R. O. Gandy (applied mathematics), R. J. R. Hayward (Brotherton lecturer in inorganic and structural chemistry), Dr. G. E. Higginson (mechanical engineering), M. A. Jeeves (psychology), Dr. L. Mackinnon (physics), P. Sutcliffe (civil engineering) and W. H. Trickett (statistics).

University of London: Appointments

Mr. J. D. Evans, Research Fellow at Pembroke College, Cambridge, has been appointed to the University of London chair of prehistoric European archæology, tenable at the Institute of Archæology, and Dr. J. H. Birkinshaw, reader in biochemistry at the London School of Hygiene and Tropical Medicine, has been appointed to the University of London chair of biochemistry, tenable at that School. The following have been appointed to University readerships tenable at the Colleges indicated: P. T. Fink (Imperial College of Science and Technology), aeronautics; Dr. G. P. Wibberley (Wye College), agriculture with special reference to agricultural economics; and Dr. W. L. Wilcock (Imperial College of Science and Technology), instrument technology.

University of Sheffield

In the University of Sheffield the Refractories Section of the Department of Metallurgy has been created a separate Department of Refractories Technology with Prof. J. White as its head. The title of reader in electrical machinery in the University has been conferred on O. I. Butler, senior lecturer in electrical engineering. Dr. G. B. Greenough, senior lecturer in physical metallurgy, has resigned from the University on appointment as research manager, Atomic Energy Authority (Industrial Group), Windscale, Cumberland.

Announcements

DR. LEE A. DUBRIDGE, president of the California Institute of Technology, has been elected a member of the Board of Trustees of the Rockefeller Foundation, New York.

MR. T. D. WHITTET, chief pharmacist at University College Hospital London, has been elected a foreign member of the Royal Spanish Academy of Pharmacy, founded in 1589 as the Brotherhood of the Apothecaries of Madrid and one of the oldest pharmaceutical organizations in Europe.

REPLYING to questions in the House of Commons on May 15, the Parliamentary Secretary to the Ministry of Works, Mr. J. R. Bevins, said that the research associations as a whole spend about one-quarter of their budgets, or more than £1 million a year, on development. Several development companies have been formed by the research associations, and the Government is also starting some civil development contracts with scientific research associations.

THE Challenger Society is prepared to make small grants for research in marine biology or oceanography at a recognized laboratory during the year June 1956–June 1957. Applications, accompanied by details of the proposed research, should reach the Honorary Secretary, Challenger Society, British Museum (Natural History), London, S.W.7, before June 11.

A SYMPOSIUM on "Rheological Research in the Textile Industry", arranged by the British Society of Rheology, will be held at the British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, during June 7–8. Further information can be obtained from Dr. A. S. Lodge at the Association.

THE summer conference and annual meeting of the Society for Applied Bacteriology will be held in Reading on July 16–18. In addition to the usual programme, there will be a whole-day excursion to the Microbiological Research Department of the Ministry of Supply at Porton. Further information can be obtained from the honorary secretary, G. Sykes, Boots Pure Drug Co., Ltd., Microbiology Division, Standards Department, Nottingham.

THE eleventh annual physics congress of the Canadian Association of Physicists will be held in the University of Montreal during June 14–16. Included in the programme will be three symposia on the following topics: high-energy physics and accelerators; geophysics; and the teaching of high-school physics. Further information can be obtained from the Association, c/o the Department of Physics, McMaster University, Hamilton, Ontario.

THE Royal Institute of Chemistry has arranged a symposium on "Recent Advances in the Chemistry and Industrial Applications of Cereals", to be held in the University of St. Andrews during June 25–29. The three sessions will be concerned with the following topics: production of cereals; processing and testing of grain and grain products; and applications of cereals. Application forms and further information can be obtained from the Secretary of the Institute, 30 Russell Square, London, W.C.1.

AN international conference on "Chemical Engineering in the Coal Industry", sponsored by the National Coal Board, will be held during June 26–29 in the new laboratories of the Board's Coal Research Establishment at Stoke Orchard, near Cheltenham, Gloucestershire. The conference will comprise four technical sessions: physical and chemical pre-treatment of coal; fluid bed carbonization; briquette carbonization; and liquid by-products. Seven papers given by British, French, German, Dutch and American workers will be read and discussed. English, French and German will be the working languages. Attendance will be by invitation only.

AN international congress on automation, organized by the Department of Mechanics of the Conservatoire National des Arts et Métiers, Ministry of Public Education, will be held in Paris at the Conservatoire National during June 18–24. The aims of the congress are to consider certain aspects of general automation and its application to various scientific, technical, economic and psychological fields. It will be divided into three sections: general automation; applied automation; and automation and production. Further information can be obtained from the Secrétariat du Congrès International de l'Automatique, Chaire de Mécanique, C.N.A.M., 292 rue Saint-Martin, Paris 3^{e}.

UNDER the auspices of the International Institute of Embryology a congress on developmental biology will be held in the United States at Brown University during July 23–26, and will be followed by a conference on cytodifferentiation during July 27–31, sponsored by the International Union of Biological Sciences. Applications for both meetings should be sent as soon as possible to Prof. J. Walter Wilson, Department of Biology, Brown University, Providence 12, Rhode Island. Correspondence about the meetings should be sent to G. A. Norton, Developmental Biology Conference Series 1956, National Academy of Sciences, National Research Council, Division of Biology, 2101 Constitution Avenue, Washington 25, D.C.

THE fourth of the annual courses arranged by the Italian Physical Society at the Villa Monastero, Varenna, Lake Como, will be held this year during July 15–August 4 and will be on the magnetic properties of matter. The course will be in English and French, and lectures will be given by the following: C. J. Gorter (Kamerlingh Onnes Laboratory, Leyden), C. Kittel (University of California, Berkeley), N. Kurti (Clarendon Laboratory, Oxford), L. Néel (Laboratoire d'Électrostatique et de Physique du Métal, Grenoble), M. H. L. Pryce (H. H. Wills Physical Laboratory, Bristol), E. M. Purcell (Harvard University), and J. H. Van Vleck (Harvard University). The fee for the course is 30,000 lire (or 25,000 lire for shared accommodation). Applications should be sent at once to the director of the course, Prof. L. Giulotto, Istituto di Fisica dell'Università, Pavia.

ERRATUM. In the article entitled Colonial Research in the British Commonwealth in *Nature* of March 3, on p. 418, reference was made to the work at the Freshwater Field Station at Birnin Kebbi, in Northern Nigeria; it was incorrectly stated that a study of marine invertebrate fauna was in progress. This work is being carried out at Freetown, Sierra Leone. Birnin Kebbi, on the River Sokoto, deals with freshwater investigations, mainly on the fish in the area.

SYMPOSIUM ON THE NEUROHYPOPHYSIS

AN international symposium on the neurohypophysis, arranged by the Colston Research ociety and the University of Bristol, was held in ristol during April 9–12. A generous grant from he Wellcome Trust made it possible to extend ivitations to workers from the United States and anada. Prof. H. Heller (Bristol), director of the ymposium, welcomed the participants and pointed ut that this was the first international meeting ntirely devoted to the subject. He reminded his udience that it was also a scientific anniversary, nce it was fifty years ago that Sir Henry Dale had iscovered the oxytocic effect of posterior pituitary xtracts.

Sir Henry Dale then opened the symposium. In a iscinating survey of the history of the subject, he ecalled that the first evidence for the presence of a iologically active principle in the pituitary gland as obtained by G. Oliver, a Harrogate physician ho, having observed the pressor effect of adrenal xtract, proceeded in collaboration with E. A. chäfer to test extracts of other endocrine glands on ie blood pressure of anæsthetized animals. Sir Henry then mentioned his early experiments on the hemistry of the posterior pituitary principles, which lready then—in 1909—suggested that they were eptides, and described the first separation of oxyocin from vasopressin by H. W. Dudley in his iboratory, work which found its brilliant conclusion nly recently in the establishment of the chemical onstitution of the active peptides by V. du Vigneaud id his co-workers. Similarly, the old difficulty of nderstanding how an organ consisting of neuroglia nd nerve fibres could produce hormones has only ecently been overcome by including the neuroecretory cells in the hypothalamus in the neuroypophysial system. Based on these developments id on recent unpublished work by Dr. Catherine ebb, Sir Henry drew an interesting parallel between ie results of pituitary stalk section and the cutting a cholinergic nerve: in both cases the active rinciple(s) disappears rapidly distal to the cut and cumulates proximally.

The rest of the session was devoted to the morphogical aspect of neurohypophysial secretion. Prof. W. Bargmann (Kiel), reviewing the relation between eurohypophysial structure and function, stressed ie parallelism between the demonstrable amounts neurosecretory material in the neurohypophysis id its hormone content in a variety of physiological id experimental conditions. He discussed the site origin of the neurohypophysial hormones and entioned the unpublished finding of W. Hild that ituicytes in tissue culture are unable to elaborate ie hormones. These cells may, however, be conerned in their release. In conclusion, Prof. Bargann directed attention to the fact that neuroecretory fibres also enter the pars tuberalis and pars itermedia. In the discussion, Prof. B. Hanstrom und) mentioned the rarity of such fibres in the irs intermedia of some mammalian forms, a finding ith which Prof. Bargmann agreed. Dr. H. Rodeck Düsseldorf) gave new evidence for the lack of neuroecretory material in new-born animals and in fants, and Profs. C. Fromageot (Paris) and H. B. in Dyke (New York) agreed that no firm statement can as yet be made as to the chemical nature of the neurosecretory substance.

Prof. Hanström, in a comprehensive and stimulating survey, showed the close similarity in the architecture of the neurosecretory systems of invertebrates and vertebrates. Crustaceans and insects, for example, have not only neurosecretory cells in their brains but also specific storage organs for the neurosecretory material elaborated. In the discussion, Dr. P. A. Jewell (London) described the histological appearance of the neurohypophysis of dogs which have been continuously hydrated for ten days.

The day concluded by the annual reception of the Colston Research Society in the Great Hall of the University, at which the Lord Mayor, the Vice-Chancellor of the University and the immediate past-president of the Colston Research Society, the Bishop of Bristol, were present. The president of the Society, Prof. Macgregor Skene, explained the origin and purpose of the Colston Research Society, and Sir Lionel Whitby, the guest speaker, gave a masterly address on the importance of endocrinology in clinical medicine.

The second day of the symposium was opened with a paper by Prof. C. Fromageot (Paris). He and Dr. R. Acher have investigated the active protein which can be obtained from ox pituitary glands and have found that its pressor and oxytocic activities behave towards chemical and enzymatic agents exactly like the pure polypeptides. Mild processes like counter-current distribution and electrodialysis, which do not involve hydrolysis, dissociate the active protein into substances responsible for the oxytocic and pressor activities and at least one inert protein. This suggested the possibility of a differential release of the hormones *in vivo*. Prof. Fromageot adduced evidence for such difference in hormone release in lactating rats. Prof. H. Croxatto (Santiago, Chile) analysed the chemical and biological properties of polypeptides with posterior pituitary-like activities which can be obtained by the action of enzymes on blood proteins. Though similar in many ways, these artificial peptides differ in some respects from vasopressin and oxytocin. The paper gave rise to discussion on, among other topics, Prof. Croxatto's suggestion that his peptides may be connected with the 'unspecific' antidiuretic and oxytocic effects so frequently encountered in tests with biological material. The third paper of the morning was read by Prof. H. B. van Dyke (New York), who, with characteristic thoroughness and lucidity, reported on problems concerned with the storage and liberation of the neurohypophysial hormones. The relative distribution in the hypothalamic nuclei and the neural lobe differs from species to species; the dog's hypothalamus, for example, is much richer in vasopressin, whereas camel tissue contains more oxytocin. Depletion of hormones stored in the posterior lobe, if severe, affects both hormones, although the teleological requirement may be only for one. In lactating dogs both principles are depleted from the neural lobe; but the depletion of oxytocin is greater. Prof. van Dyke then adduced most interesting new evidence on two forms of vasopressin occurring in mammalian glands. Only hog extracts contain lysine vasopressin; all other mammalian extracts tested (including those of human glands) seem to contain arginine-vasopressin, which has a relatively higher antidiuretic potency than hog vasopressin. In the discussion, Dr. S. J. Folley (Reading) and Prof. G. W. Harris (London) pointed out that differences in hormone ratios found during lactation in different species may be related to different suckling habits.

The afternoon session, under the chairmanship of Prof. J. M. Yoffey (Bristol), was occupied by papers on the metabolism and fate of the neurohypophysial principle. Prof. H. Heller (Bristol) surveyed the subject and queried the applicability of many *in vitro* experiments with body fluids and tissues. Recent results obtained in his laboratory (in collaboration with Dr. S. M. A. Zaidi, of Lahore) show that the kidneys and liver in the intact rat inactivate exogenous and endogenous vasopressin with very great rapidity. In the discussion, Dr. F. Gross (Basle) quoted supporting evidence, and Prof. Fromageot explained that there are three different chemical reactions conceivable by which vasopressin can be quickly inactivated. Prof. R. L. Noble (London, Ontario), in his paper on the excretion of posterior pituitary principles in the urine, described a new method for the extraction of vasopressin from body fluids which allows a consistent recovery of 85–90 per cent of added hormone. He then reported on the occurrence of antidiuretic activity in human urine in conditions like dehydration, fainting, emotional upsets and electro-convulsive therapy.

The third day of the symposium began with a paper by Dr. M. Ginsburg (Bristol), who described experiments which suggest that vasopressin may play a part in maintaining the blood pressure after hæmorrhage. Discussing a variety of stimuli to the neurohypophysis, he emphasized that stimuli for the release of hormones must be distinguished from those which lead to an increase of production of the active principles. He then described experiments in collaboration with Mrs. L. Brown, in which by means of injections of hypertonic solutions into the internal carotid they have unsuccessfully attempted to produce antidiuretic effects in the rat, and enumerated factors which might have prevented such responses. This led to a long discussion on the efficacy of osmotic stimuli to the neurohypophysis, in which Drs. P. A. Jewell (London), M. Pickford (Edinburgh), D. F. Cole (Newcastle), H. E. de Wardener (London), J. C. Sloper (London), H. Croxatto (Santiago) and F. Morel (Paris) participated.

A paper read by Dr. B. Andersson (Stockholm) extended the field of the symposium in a most interesting manner by showing that electrical stimulation of certain areas of the hypothalamus by the elegant 'indirect' method developed by G. W. Harris, or by direct injection of hypertonic sodium chloride solution, induces polydipsia in the goat. This 'drinking area' overlaps partially with that from which antidiuresis can be elicited. This raises the interesting possibility of a dual role of the hypothalamic osmoreceptors in regulating both water intake and water output. Dr. B. A. Cross (Cambridge) pointed out that he has found in the rabbit that stimulation of the paraventricular nucleus results in the release of oxytocin, but that Dr. Andersson has shown for the first time that antidiuretic hormone also can be released by stimulating the same hypothalamic area. Dr. Mary Pickford (Edinburgh), in a paper with Dr. F. B. Brooks (Philadelphia), described experiments which make it possible that oxytocin, by influencing electrolyte excretion, has a physiological action on the kidney This possibility had been envisaged in the rat by Dicker and Heller and Heller and Stephenson; bu Pickford and Brooks have now shown that in certai circumstances oxytocin modifies renal sodium an potassium excretion in the dog also.

The afternoon session was devoted to papers o the mechanism of action of the antidiuretic hormone Prof. H. Wirz (Basle), by accomplishing the astonishing feat of puncturing single distal tubules of th concentrating or diluting rat kidney and analysin the fluid obtained, has been able to support th concepts of H. W. Smith on the site of action of th antidiuretic hormone in the renal tubule. He agree with Dr. W. H. Sawyer (New York), the followin speaker, in postulating that the essential action c the hormone consists in altering the permeability c a section or of sections of the distal tubular epitheliur to water. Both speakers also agreed in the revolutionary assumption that the antidiuretic hormone i not directly concerned in the elaboration of hypertonic urine. Equally interesting was Dr. Sawyer' suggestion that the increase in tubular water absorption, which he has found to be caused in frogs b neurohypophysial extracts, is based on the sam mechanism as their action on the frog's skin.

The first paper on the last day of the symposiur was by Drs. S. J. Folley and A. T. Cowie (Reading who gave an admirable survey of the relations of th neurohypophysial hormones to the mammary glanc The interesting concept was mentioned that th release of the lactogenic and galactopoietic factor from the anterior lobe may be controlled by oxytocin thus uniting the main phases of lactation – mil secretion and milk ejection. Experiments by Folle and Benson relevant to this hypothesis are givin encouraging results. A vivid discussion, in which th chairman of the session, Sir Solly Zuckerman (Bi mingham), Prof. G. W. Harris and Drs. M. Pickforc F. Stutinsky (Paris), I. Chester Jones (Liverpool) an J. C. Sloper took part, developed on the question c the reorganization of the cut pituitary stalk. paper by R. J. Fitzpatrick (Bristol) on the relatio of oxytocin to uterine function followed. He showe that different parts of the uterus vary quantitativel in their response to oxytocin. This was interprete in relation to the requirements for sperm transpoi and the expulsion of the fœtus at term. The thir speaker of the morning, Dr. J. M. Walker (Oxford described experiments with G. W. Bisset in whicl utilizing a method for the extraction of oxytocin an vasopressin from blood, they have investigated th release of the hormone under the influence of drug He made the important point that pharmacologicall the hypophysial synapse differs from that in per pheral ganglia.

The last session dealt with adrenocortical–neurc hypophysial relationships. Dr. R. Gaunt (Summi N.J.), after a critical review of the problems ir volved, reported on new work with C. W. Lloy and J. J. Chart. Their most interesting findin perhaps is that hydrocortisone-like steroids eithe inhibit the release or facilitate the synthesis c vasopressin and of neurosecretory material.

Dr. I. Chester Jones (Liverpool) continued t unravel the relationship between the neurohypc physis and the adrenals by describing the morphc logical and functional changes in adrenalectomize rats with diabetes insipidus. Dr. F. Stutinsky the compared the effect of the ingestion of hypertoni salt solutions on the adrenal cortex of normal ra and animals with diabetes insipidus, and Dr. Lucie Arvy (Paris) showed slides which gave the first suggestion that the neurohypophysis is implicated in the osmoregulation of teleost fishes.

The pleasant atmosphere and the apparently general enjoyment in the symposium can be attributed not only to the restricted number of participants (nearly all of whom were actively engaged in research on its subject) but also to the excellent arrangements of the Colston Research Society, which housed all members in Manor Hall, a hall of residence of the University of Bristol. The scientific meetings were held in the same building, so that much unnecessary inconvenience and loss of time were avoided. The proceedings of the symposium will be published as Volume 8 of the "Colston Papers". H. Heller

EUROPEAN SEISMOLOGICAL COMMISSION

MEETINGS IN VIENNA

THE European Seismological Commission, a Commission set up by the Section for Seismology and the Physics of the Interior of the Earth of the International Union of Geodesy and Geophysics, met in the Institute of Physics of the University of Vienna during April 4–7 under the presidency of Prof. W. Hiller, of Stuttgart. The Commission had the support of Unesco, and nineteen countries were represented. Four topics were discussed: the organization and preparation for carrying out large explosions, particularly in Alpine regions, for seismic purposes; the progress achieved in the preparation of a European Earthquake Catalogue and a seismotectonic map of Europe; the progress made in the design and construction of seismographs, particularly those to be used to record near earthquakes, and the testing of such instruments; and microseisms.

The methods of seismic prospecting for minerals (particularly for possible oil-bearing structures) by letting off small quantities of explosives and receiving the reflected and refracted sound waves on geophones or seismographs are by now well known, and the subject has an extensive literature of its own. It was by this means that the British oilfield at Eakring was discovered. Only one explosion in Great Britain has been large enough to send waves down to penetrate all the layers of the Earth's crust, and this explosion was accidental—namely, the Burton-on-Trent explosion of November 27, 1944. In 1909 A. Mohorovičić found a discontinuity at the base of the continental layers of the Earth's crust in south-east Europe at a depth of 60 km., now called the Mohorovičić discontinuity. Its depth varies over the Earth, but it is almost always present; in France it is estimated to be at a depth of 38 km., and under the Central Appalachians in the United States it is 40–50 km. The possible variation of the depth of the Mohorovičić discontinuity under mountain regions such as the Alps in Europe is particularly interesting, and it is proposed to try to find such depths by using the methods of seismic prospecting with sufficient quantities of explosives so that the P-waves which are generated will penetrate below the discontinuity. The time and place of the explosion, being known, will give fewer unknowns in the calculations than with natural earthquakes, and the arrival times of the reflected and refracted waves, being approximately known, will render possible the use of faster than normal paper speeds in the seismographs and thus greater accuracy in the time measurement. Moreover, since the explosion point is known, it will be possible to arrange the positions of the seismographs to advantage both in azimuth and distance.

The first experiments in western Europe will be carried out by the French during the second half of August 1956 at Briançon. The first explosions will be set off in the middle of a lake which is situated at a height of 2,500 m. above sea-level, and there will be five successive explosions of 1, 2, 2, 5 and 10 tonnes. The first ones will give experience of the best methods, and the whole series will give an idea of the optimum or minimum quantity of explosive necessary for the purpose. The French will set up seismographs situated along two lines which will intersect at right angles at the lake. The explosions will also be recorded by seismographs in Germany, Italy and perhaps in Czechoslovakia. As soon as the results of this work have been studied, the French seismologists propose to make a further series of similar experiments from a lake situated 40–50 km. to the east of the first one, so that records may be obtained over the same ground but in the reverse direction. This is so that true wave velocities may be determined in the manner usual in seismic prospecting. The second series of explosions will probably be held in 1957. As soon as the results of the first French experiments are known, similar explosion experiments will be made in the Eastern Alps, probably in the Hohe Tauern, east of Innsbruck in Austria, but these will not be possible this year.

Experiments in the U.S.S.R. along these lines have already taken place, organized by the Geophysical Institute of the U.S.S.R. Academy of Sciences under Academician G. A. Gamburtzev, the results being communicated to the Vienna meeting by Prof. E. F. Savarensky. The method used by the Russians is called the *GSZ* method and makes use of explosions of 50–300 kgm. of material. The distance between the explosion point and reception point may be up to 400 km. The charges are usually placed in reservoirs, lakes or rivers and are exploded during meteorologically quiet times at night. The effective sensitivity of the reception devices is increased by properly regulated frequency ranges with a maximum amplification, by the increase of the general sensitivity of the equipment under a low level of internal noise and by use of methods of bunching reception. The registration of waves, including radiation of wavelength shorter than usually recorded hitherto, is effected by the use of many-channel stations which permits the most effective correlation methods. Receptors are arranged in different azimuths, and note is taken of the polarization of the oscillations. Different types of waves are distinguished (longitudinal, transverse and surface), as are also differences between single waves and waves resulting from complex interference. Separate crossings of profiles and also groups of reception points are used, the shot point being static.

In particular, large explosions have been made by these methods and for these purposes at Korkino near Chelyabinsk in the Ural Mountains, at Tula in the European part of the U.S.S.R. and in Central Asia. The *GSZ* method was used in pre-mountain and mountain regions of North Tien-Shan, in Western Turkmenia, in Pamiro-Altaisk and other regions. The section from south to north through the mountain ridges of the Kungey-Ala-Tau and Jan Karsky-

Ala-Tau shows two roots going deep into the Mohorovičić discontinuity. The granitic layer shows no roots, but the Mohorovičić discontinuity repeats, with some distortions and with greater amplitudes, the surface relief. It is noteworthy that the foci of all natural earthquakes in the district originate near the basaltic layer, and that the large negative gravity anomaly (up to 250 mgl.) in the district depends mainly on the form of the Mohorovičić discontinuity and not on the granitic layer. The *GSZ* method of deep seismic sounding has thus been used in the U.S.S.R. to study the peculiarities of relief of the internal crustal layers of the Earth (sedimentary, granitic, basaltic), especially in mountain regions; to study these surfaces near deep geological faults; and to give a quantitative physical explanation of the peculiarities of the regional gravitational field. At the Vienna meeting E. Tillotson described the work of Dr. M. N. Hill, of Cambridge, and his co-workers, who use explosions at sea in order to determine the structure of the sea bed. In this method use is made of sono-radio buoys. Prof. H. Menzel and his colleagues at Hamburg intend to follow this method in order to elucidate the very interesting geological structures between Germany and Denmark on one hand, and Norway and Sweden on the other.

Reports from countries represented at the meeting, and also twelve papers, were read concerning the proposed seismo-tectonic map of Europe and the making of the European Earthquake Catalogue. This project is now locally well advanced, and the collection and correlation of the data were placed in the hands of Dr. M. Båth, of Upsala, with the assistance of six colleagues strategically placed in Europe. It is intended, when the map has been completed, to shade it to show the different degrees of seismicity.

Six papers were read at the Vienna meeting, and a good deal of discussion took place, concerning short-period seismographs for the registration of near earthquakes. One paper, presented by Prof. W. Hiller, concerned the new short-period seismographs with magnetic amplification for recording on smoked paper, the prototypes of which have been set up in Stuttgart. The European Seismological Commission recommended the standardization of the constants of short-period electromagnetic seismographs so far as local circumstances permit. Each instrument should have a period (T_m) of the movement of the ground corresponding to a maximum sensitivity between 0·6 and 1·0 sec., and damping coefficients α and β of the pendulum and galvanometer for the seismograph without equivalent reaction, greater than or equal to 0·6. It was left to a small committee under Prof. F. Gassman, of Zurich, to investigate the best methods of testing short-period instruments by shaking-table experiments.

Three papers on microseisms were read, and the Commission passed a resolution requesting the Seismological Commission of the International Geophysical Year to give as soon as possible all the necessary directives for making as complete an investigation as possible of microseismic activity during the International Geophysical Year. Prof. K. E. Bullen, of Sydney, president of the Section of Seismology and the Physics of the Earth's Interior, then gave a lecture on his present tentative views concerning the structure of the Earth with its mantle, core and inner core, and the structure of some of the planets.

Additional members of the European Seismological Commission were then agreed upon from Czechoslovakia, Lebanon, Poland, Rumania, Switzerland (in place of Dr. Wanner, deceased) and the U.S.S.R. Officers elected were: *President*, Prof. P. Caloi (Rome); *Vice-President*, Prof. W. Hiller (Stuttgart); and *Secretary*, Elie Peterschmitt (Strasbourg). The next meeting of the Commission will be held in Utrecht during Whitsuntide 1958.

ERNEST TILLOTSON

RADIO-FREQUENCY PHYSICS

CONFERENCE IN GENEVA

THE 'Colloque A.M.P.E.R.E.' (Atomes et Molécules par Etudes Radio-Electriques) is an organization inspired by Prof. R. Freymann, of the University of Rennes, which was set up soon after the end of the Second World War as a means of ensuring fruitful contact between French research workers interested in any branch of physics that is concerned with the use of radio frequencies (including the microwave region). It was also part of an effort to re-establish scientific research in France, which had suffered very heavily in the War and was quite unfamiliar with the great advances made during the years of hostilities. The subjects at the annual conferences include dielectric constant and loss, magnetic permeability and loss, nuclear magnetic resonance, quadrupole magnetic resonance, paramagnetic resonance, ferromagnetic resonance and associated effects, and microwave spectroscopy. Although primarily a French organization, interest in it has become more general, and it would now be better described as European, although, of course, any scientist is welcome. It has been a matter of considerable pride and satisfaction to the French-speaking members that all the conferences have employed French as the principal language. I feel that this—and the colloquium itself—has helped to give the French renewed confidence and has contributed in some measure to the present renaissance of scientific research in France. It has also made many English-speaking persons appreciate the difficulties which the prevalent use of English at scientific conferences poses for many scientists.

A pattern is being established in which the annual conference is held alternately in France and elsewhere in Europe. This year's conference was held during March 21–23 in the Institute of Physics of the University of Geneva and was attended by some hundred and fifty scientific workers. That for 1957 will be held in St. Malo, Brittany, and will be organized by Prof. R. Freymann.

A special effort was made to widen the appeal of the conference this year in view of the fact that it marks the tenth anniversary of the discovery of nuclear magnetic resonance absorption. General lectures outlining the history and present situation in nuclear magnetic resonance were given by Prof. C. J. Gorter (Leyden), "Vingt années de recherches aux Pays-Bas sur les résonances magnétiques"; Prof. M. Grivet (Paris), "Exposé sur les travaux effectués par l'équipe française de résonance nucléaire"; Prof. L. Giulotto (Pavia), "Exposé sur les travaux récents effectués au Laboratoire de Pavie dans le domaine des temps de relaxation nucléaire"; Prof. R. A. Ogg (Stanford), "Application à la chimie

de la résonance magnétique nucléaire"; and Prof. A. Lösche (Leipzig), "Quelques travaux sur la résonance paramagnétique nucléaire effectués à Leipzig". A lecture by Prof. C. H. Townes (Columbia) on the measurement of time by spectroscopic methods was an apt illustration of the application of many of the ideas and techniques discussed during the conference.

Some fifty papers were presented in six sessions, fairly evenly distributed over the subjects mentioned above and representing contributions from some thirty laboratories. Preprints of almost all the papers were available before the conference; authors were allowed fifteen minutes for presentation of the gist of their papers, and the matter was then thrown open to discussion. As is usual at these conferences the discussions were unusually free and frank and therefore most valuable to all concerned. It is perhaps conducive to a free exchange of views at such a meeting that the discussion itself is not recorded or published.

It is evidently impossible to mention each paper in detail, and I am obliged to pick out the ones which seemed of more than usual interest. The first two sessions on dielectric constant and loss included several papers on measuring techniques. There were also two papers on mixtures, which still present many difficulties, by J. M. Hough and J. A. Reynolds (Hull) and by G. P. de Loor (The Hague). Study of the dielectric properties of hydrogen-bonded liquids (R. Arnoult *et al.* (Lille) and C. Brot (Paris)) continues to produce interesting results. G. Offergeld (Brussels) described dielectric measurements on a series of methacrylate polymers. R. Freymann and his group (Rennes) presented papers on dielectric effects in various solids and particularly in selenium and zinc sulphide, showing the effect on dielectric properties of illumination at 3650 A. They also showed that one of the dielectric absorption regions in solid camphor is in reality due to fenchone impurity.

The third session, on electron resonance of various types, included several papers on free radicals and particularly on DPPH. R. Gabillard (Geneva) and J. Berlande (Paris) described ingenious uses of electron resonance in the control and measurement of magnetic fields in particle accelerators. Measurements on ferrites still attract considerable interest in view of their great technical importance; several papers in the fourth session were concerned with these and in particular with the Faraday effect (F. Mayer, of Grenoble), the behaviour in the resonance region (J. Pauleve, of Grenoble), and the effect of losses (J. Snieder, of The Hague). In the fifth session, J. Winter and J. Brossel (Paris) described electron resonance experiments on optically oriented sodium atoms in which they observed absorption bands at multiples of the usual Larmor frequency. D. Dautreppe and B. Dreyfus (Grenoble) discussed the effect of hydrostatic pressure on the pure quadrupole resonance frequency in *p*-dichlorobenzene; the effect found is readily interpreted in terms of the effect of the pressure on the libration frequency of the molecule in the lattice.

In the last session G. E. G. Hardeman and N. J. Poulis (Leyden) presented new results on the relaxation time for proton magnetic resonance in the antiferromagnetic crystal, hydrated copper chloride, and showed that the relaxation is due to interaction with the copper ions. W. G. Proctor (Basle) described experiments in which the nuclear resonance signal of sodium in sodium chloride is modified by subjecting the sample to ultrasonic radiation at double the Larmor frequency. J. G. Powles (London) discussed the correlation between mechanical, dielectric and nuclear resonance absorption processes in polymers. G. J. Béné, R. Beeler and D. Roux (Geneva) showed that paramagnetic resonance can now be used to measure magnetic field strength down to about 0·05 oersted using metal–ammonia solutions, which have very narrow lines. E. H. Staub (Zurich) has measured the nuclear relaxation time for the rare gas xenon and found a satisfactory explanation in terms of nuclear quadrupole interactions during interatomic collisions.

The success of the conference was due in large measure to the excellent organization of Prof. Extermann, Dr. Béné, Dr. Denis and Miss P. Cottier. A report of the conference is being published in the May issue of the *Archives des Sciences*, and copies can be obtained from the Institut de Physique, Université de Genève, price 25 Swiss francs.

J. G. POWLES

PELAGIC MOLLUSCA: SWIMMERS AND DRIFTERS

THE Malacological Society of London held an open discussion meeting in the rooms of the Linnean Society on the evening of March 14, with Prof. Alastair Graham (University of Reading) in the chair. Invitations had been issued to the staff and students of biological departments, and there was a large attendance, mainly from scientific institutions in or near London, and also from Reading, Oxford and Swansea.

Dr. J. E. Morton (Queen Mary College, London) introduced the subject of pelagic Mollusca with an account of pelagic prosobranchs. Prosobranchs became pelagic in two instances, both of them in the order Mesogastropoda. The three families, together known as the Heteropoda (Atlantidae, Carinariidae and Pterotracheidae), are actively swimming carnivores, and the family Ianthinidae are passive drifters. These two groups illustrate strongly contrasting modes of attaining the pelagic life. In the Heteropoda, the emphasis was upon the lightening and eventual loss of the now unnecessary shell, and the development of lightness and buoyancy, with the tissues becoming jelly-like and the heavy viscera restricted to an insignificant mass. The mantle cavity was fully retained in *Atlanta* and eventually lost in *Pterotrachea.* The foot was transformed into a gracefully undulating fin, and there was considerable speed of movement. Large eyes were developed, with great visual acuity. The shape of the body became fusiform, the higher families losing the planorboid spiral form of *Atlanta.* They are reminiscent of small translucent serpents, moving rapidly, and with the sharp teeth of the buccal mass taking a strong hold of smaller planktonic prey.

The Ianthinidae adopted a pelagic life in a very different way from the Heteropoda. The shell—though lightened—remains of normal size, and forms a globular body whorl with a short apex, vivid violet in colour, floating mouth uppermost. The animal has no special locomotor organs and drifts at the surface, buoyancy being conferred not by jelly-like tissues but by a raft secreted by the foot. In *Ianthina ianthina* this consists of a bubbled mass of air-filled vesicles; in *I. prolongata* and *I. exigua* it is flatter and is used also for the attachment of egg capsules to its under-surface. The teeth of the radula are long and sharp. *Ianthina* feeds on the floating siphonophore *Velella*, attaching itself to the under-surface of the siphonophore and grazing upon its living tissues, until the chitinous float is stripped bare. When feeding on *Velella*, *Ianthina* appears to lose the raft and to make use of the siphonophore not only as food but also to obtain buoyancy and transport. This specialized mode of feeding suggests an origin for the Ianthinidae among those benthic mesogastropods which are sluggish carnivores, grazing on sessile animals, including cœlenterates. *Ianthina* illustrates such a mode of feeding transferred to the pelagic level.

Dr. J. E. Forrest (Queen Mary College, London) directed attention to the interest and importance of the order Opisthobranchiata in considering the development of the free-swimming habit in the Mollusca. The order includes benthic as well as truly pelagic species, while some, essentially creepers, are yet able to adopt a swimming habit at times. It is, therefore, perhaps possible to see something of the steps by which the pelagic habit was acquired. A tendency towards a reduction of the shell characterizes this group and culminates, eventually, in its absence in the gymnosomatous pteropods and throughout the nudibranchs. The foot also has a certain plasticity and is frequently modified by the development of parapodia or wings which, arching upwards on each side, form a cloak enclosing the shell and visceral mass as, for example, in *Aplysia* and *Akera*. In the latter, parapodia are particularly well developed, and by their means the animal can periodically, and notably in the breeding season, perform vigorous and effective swimming movements the significance of which, however, is not clear.

In the Tectibranchiata, both the Bullomorpha and the Aplysiomorpha have, apparently independently, evolved pelagic representatives, the thecosomatous and gymnosomatous pteropods respectively, and of all the gastropods which have taken to this mode of life they are, perhaps, the most specialized. *Limacina*, a primitive thecosome, is in many respects intermediate, sharing benthic and pelagic features although the animal is planktonic. It has a fully coiled shell and visceral mass, swims by means of wings, and is microphagous, but still possesses a pallial ciliary feeding mechanism. The more specialized thecosomes, such as *Cavolinia*, *Creseis* and *Cymbulia*, have a greatly reduced, paper-thin shell which is no longer coiled, and swim by movements of the extensive wings spread out laterally beyond the opening of the shell. A pallial feeding mechanism no longer occurs, and the feeding tracts are limited to the now greatly reduced central part of the foot and, in some genera, the wings as well. These are minute animals, the larger species measuring perhaps 2 cm. in length, and in all their features show a complete adaptation to a pelagic habit.

In contrast, the gymnosomes, also minute, are carnivores preying, it is thought, on the smaller thecosomes. In common with them, they possess wings which serve for locomotion and also help to keep the animal afloat, but in almost all other features they stand apart. The shell is absent, the body cylindrical and the complex buccal apparatus includes series of suckers for grasping the food and paired-hook sacs in relation to the buccal cavity. They have never developed a ciliary feeding mechanism. Although conveniently considered together, the thecosomes and gymnosomes probably represent two independent lines of evolution which parallel each other in certain respects. To place them together in one order, the Pteropoda, is probably an unnatural grouping.

The nudibranchs are more conservative and have given rise to only a few pelagic forms—the rare, transparent, brilliantly luminous phyllirhoids the modifications of which follow less spectacular lines.

Dr. Anna Bidder (Cambridge) spoke of the Cephalopoda, with particular reference to the method of swimming. Jet-propulsion, the basic swimming mechanism of the Cephalopoda, is effected in two ways. In the Nautiloidea, the non-muscular mantle of which lines the living chamber of the external shell, water enters between the overlapping folds of the funnel. Proximal 'circular' muscles provide the necessary expulsive force, and distal longitudinal muscles can be used in steering and are firmly anchored to the shell through the shell muscles. In the Belemnoidea and in all living cephalopods except *Nautilus* the shell is internal or absent. The circular fibres of locomotion constitute the mass of the muscular mantle, the major muscles of the tubular funnel are longitudinal, and both systems are anchored to the guard, phragmacone and pro-ostracum or to their derivatives when present.

Fins, first known as small posterior rounded lobes, may be regarded as stabilizers during forward movement and as assisting in gentle to-and-fro or hovering movements. Fins show a wide variety in shape, size and position; they are missing in incirrate octopods only. The deep web, characteristic of the cirromorph octopods, the Vampyromorpha, and the squid *Histioteuthis* may, Dr. Bidder suggested, serve for medusa-like swimming, especially in the Cirromorpha, the small funnel and reduced mantle aperture of which seem inadequate for locomotion. Chun's figure of "*Opisthoteuthis medusoides*" was suggested by Dr. Bidder as evidence of this type of swimming.

Dr. W. J. Rees (British Museum (Natural History)) discussed the characteristics of deep-sea cephalopods and indicated that very few species have been studied alive and that the available depth records with open nets are too few to permit precise conclusions. Likewise, records from the neighbourhood of oceanic islands are unreliable because of upwelling from deep water. Despite this, the broad picture for squids is comparable with what is known for other groups, especially fish.

Dr. Rees demonstrated that the web and arm membranes (the functions of which were discussed by Dr. Bidder) increase in size in benthic octopods and hinted that bathypelagic octopods like *Amphitretus pelagicus* may have arisen from deep-water benthic forms. *Amphitretus*, with its thick gelatinous outer covering, is the only species of cephalopod known to have 'telescopic' eyes. The most remarkable deep-sea forms, however, are the Vampyromorpha and the Cirromorpha, with their paddle-shaped fins, enormous webs and the tactile cirri on the arms. *Cirrothauma murrayi* in the latter group is very fragile and is the only blind species of cephalopod known.

Epipelagic squids of the upper 500 m. are chiefly transparent larvæ of the Cranchiidae, but deeper-living species at about the threshold of light have large eyes (sometimes accompanied by light organs) and often retain powerful toothed or hooked suckers as in *Taonius pavo*. Species living at still deeper evels have a very varied range of light organs and are deep red to bluish-black in colour. The tentacles may become long and whip-like with minute suckers, as in *Mastigoteuthis* and *Bathyteuthis*. Accompanying these external features there are often reduction of radula and loss of ink sac, with a general degeneration of musculature which is largely replaced by a gelatinous layer. *Heteroteuthis dispar*, with its uminous secretion, often regarded as a deep-water species, is usually captured in the upper 300 m. Dr. Rees's contribution was illustrated with colour transparencies of the various species under consideration.

A short discussion followed, in the course of which Mr. B. B. Boycott (University College, London) suggested that analysis of the variety of fin sizes and shapes shown in the animals described by Dr. Bidder and Dr. Rees can be made in terms of the stability requirements of their differently shaped bodies and arms. He reported observations on *Sepia officinalis* and *Loligo vulgaris*. *Sepia* is slightly lighter than water, and relatively broad and short: the two fins are long, movable, muscular flaps, one on either side of the visceral mass. *Loligo* is slightly heavier than water, and relatively narrow and long: the two fins are triangular flaps confined towards the apex of the visceral mass. In both animals when swimming fast ('giant fibre response'), the fins are shut down against the body. When moving gently, waves pass down the fins corresponding to whether the animal is moving forward, backwards or turning. The major propulsive force in both cases is produced by jets of water from the funnel. If the fins are removed in *Sepia*, manœuvring is not much impaired, though the animal does not maintain its position in the water as well as usual but tends to drift towards the surface. The main defect is that it rolls when moving. The fins therefore give the animal lateral stability during gentle swimming. This is probably true also for *Loligo*; but since the funnel is at one end, the fins probably also serve to keep the apex of the visceral mass up when the animal is going forwards and down when it is going backwards. That this is so is indicated by the fact that the head is higher than the visceral mass when moving forwards and lower during backwards motion.

RECENT FLORISTIC STUDIES: BRAZIL, GUATEMALA AND TANGANYIKA

THE following floristic studies have recently been published.

In the Smithsonian Miscellaneous Collections (126, 1, pp. 1–290, with 128 illustrations; 1955), L. B. Smith has given a comprehensive account of the Bromeliaceae of Brazil, based on long and intensive observations. In preparing this work, the author has taken into account the particular interest of this group from the point of view of vegetative propagation, economic and horticultural uses—the pineapple belongs here—and, in some areas, the need for eliminating bromeliads in effecting the control of malaria. A classification of Brazilian Bromeliaceae made some twenty years ago comprised some five hundred native species; but since then 135 additional species have been discovered, and others are coming to hand. An account is given of the sources of information (herbaria and earlier published work), geographical distribution and origin, and keys to the three sub-families and their genera and species, with line drawings of representative species.

A further contribution to the "Flora of Guatemala", Part II, "Grasses", by J. R. Swallen (with the section on "Bamboos" by F. A. McClure), is published as volume 24, Part II, pp. 1–390, of *Fieldiana*, 1955 (Chicago Natural History Museum). In this treatise, the author includes 120 genera and 455 species, native and introduced. This very considerable number of species is attributed in part to the diverse habitats, from tropical lowlands to sub-alpine meadows, which the territory of Guatemala provides. The largest genera are *Panicum*, *Paspalum* and *Andropogon*, these comprising about one-third of the total grass species. In conformity with the general arrangement of this Flora, the genera and species are set out in alphabetical order. An evident disadvantage of this is that certain closely related genera and species may be widely separated in the text. More than a hundred clear line drawings add to the value of this work.

The extensive hydrobiological survey of Lake Tanganyika, undertaken during 1946–47 under Belgian auspices, has yielded a further report, in which accounts are given, by different authors, of the Characeae, Hepaticae, Pteridophyta and certain families of flowering plants of the Lake region. ("Exploration Hydrobiologique du Lac Tanganika (1946–1947): Résultats Scientifiques." *Inst. Royal des Sci. Nat. de Belgique*, 4, Fasc. 2, pp. 1–82; Brussels, 1955.)

NATIONAL OCEANOGRAPHIC COUNCIL

REPORT FOR 1954–55

THE chief instrument of the National Oceanographic Council is the National Institute of Oceanography at Wormley, near Godalming, and the two main fields of study pursued at the Institute are marine biology (centred about problems concerning the Antarctic whale fisheries) and marine physics (involving mostly studies of surface waves, wind stress, and more recently, storm surges). The annual report for 1954–55, recently issued*, shows that relatively little work is done in marine chemistry and submarine geology. A comparative analysis of publications of the two leading oceanographic institutions in the United States suggests that the scientific programme of the National Institute of Oceanography most nearly resembles that of the Woods Hole (Mass.) Oceanographic Institution. The Scripps Institution, at La Jolla, Calif., places additional emphasis on biology, geology and chemistry, in descending order, and in this sense the Scripps Institution appears to present the most balanced programme. That the National Institute of Oceanography compares so favourably with the American institutions is all the more impressive when one considers that it is about one-third the size of either of them (inasmuch as budget and total number of persons employed are an index of size).

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* Annual Report of the National Oceanographic Council, 1 April 1954–31 March, 1955. Pp. v+38. (Cambridge: At the University Press, 1956.) 5s net

The work of previous years on the measurement of ocean waves has served the National Institute of Oceanography as a nucleus for an expanding programme in the action of winds upon the sea. Directly following the Second World War, work was confined to the measurement of sea waves, computation of power spectra, and a qualitative interpretation in terms of the ocean-wide distribution of storms as revealed by weather maps. The present annual report shows that the wave studies have expanded in scope; for example, a serious attempt is being made by Dr. M. S. Longuet-Higgins to measure vertical displacement of the water surface and instantaneous atmospheric pressure at the water surface simultaneously—a type of measurement that is essential for developing a clearer physical understanding of the mechanism of wave generation. Dr. Longuet-Higgins has also developed an elegant theory of the statistical properties of a random moving surface—a form of mathematical language particularly suitable for the statement of the properties of the ocean surface and most necessary for a future physical theory of the generation, propagation and dissipation of ocean waves. Also under way are several ingenious programmes for the observation of shallow drift currents due to the wind, studies of natural oscillations and storm surges in large basins such as the North Sea, and preparations for the Institute's part in the coming International Geophysical Year.

To describe in detail each of the studies reported for 1954–55 and to name each investigator would be to reproduce the annual report in substance. My selections or omissions do not imply any evaluation or criticism; they merely reflect varying degrees of personal interest and the necessity for keeping this review brief. However, mention should be made of Dr. J. C. Swallow's newly developed neutrally buoyant float for tracing deep currents in the ocean. One hopes that the new float will lead to a re-awakening of interest in the problem of the general circulation of the ocean, a problem which has lain dormant for about twenty years largely because no adequate means existed for measuring directly the deep-sea circulation. The problem of describing the deep-sea circulation accurately—and independently of present-day hypothetical elements—is of considerable practical importance because so many eyes are cast toward the oceans as a place for the ultimate disposal of wastes from nuclear reactors. It is known that certain seas, like the Black Sea, are virtually stagnant beneath the top hundred metres and that these deep waters might possibly serve as an ideal dumping-ground for large volumes of radioactive wastes, barring a climatic catastrophe and a sudden turnover of bottom water.

The deep waters of all the oceans are isolated from the surface to a much lesser extent. The question then arises as to whether one can tolerate a fairly high level of radioactive waste in the deep ocean water without contaminating the surface. The oceanographer cannot at present give an affirmative answer to this question, but certainly Dr. Swallow's new device is the first glimmer of hope that we shall soon describe deep-sea currents more accurately. Before the War most of the effort of oceanographic institutions was directed toward exploring the large-scale ocean circulation. At present, only about 5 per cent of the publications issuing from the National Institute of Oceanography and from the Scripps Institution of Oceanography concern the general circulation of the ocean. The percentage from the Woods Hole Oceanographic Institution averages somewhat higher, due probably to its proximity to the Gulf Stream. The present paucity of investigation of the really deep sea in Britain and the United States will doubtless be remedied through the stimulus of such new techniques as that of Dr Swallow, because of the increasing pressure for definite information from those concerned with nuclear energy and as a result of theoretical advances in dynamical meteorology.

HENRY STOMMEL

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1955

THE forty-second annual report of the Carnegie United Kingdom Trust, covering the year 1955* is of special interest for its review of the quinquennium 1951–55, during which grants totalling £558,495 were paid, and for the statement of policy for the next quinquennium, which is appended. The development of the visual arts scheme, which was a new venture during 1951–55, has been most encouraging, and a larger allocation is contemplated in the new quinquennium. New life has been infused into many small museums, which have been converted into lively centres of culture and of education through recreation, and the Trust has joined with the Museums Association in urging on the Government the need for State aid to the national museums as the only real hope of retrieving a serious situation. In the field of community services the largest single determining factor during the past five years has been the Trust's awareness that problems of material want have given place to problems of personal, family and community relations, and both the Community Services Committee and the Education Committee have been concerned with research into the causes of social problems arising in families, into the effectiveness of new techniques for dealing with family problems, the development of family casework agencies, experimental projects for restoring problem families to health, demonstration homes for delinquent boys and for the homeless sick, re-training of social workers and counsellors and the development of a new university course designed to produce general practitioners in social work.

The rehousing of the Scottish Central Library and several other building projects accounted for half the Trust's expenditure during the quinquennium, but the passing of legislation which brought the Scottish Central Library, during 1955, into financial independence of the Trust completed the Trust's historic contribution towards the development of the public library system. Building projects which the Trust has recently supported are used for housing its beneficiaries or for accommodating services it wishes to support, and have been designed to meet needs which have not so far been comprehended in the provisions of the Welfare State; the Trust also emphasizes its intention to keep a proper balance between rescue work and amenity.

The statement of policy for the quinquennium 1956–60 points out that the Trust prefers to conentrate its resources in limited fields where it can make an effective contribution to development, and hat in selecting projects it distinguishes two main ypes : development work which is carried out over he country as a whole ; and experiment or investigation, which may be carried out on a local basis but with the hope that the results may be of general application and usefulness. The main branches of activity for which part of the Trust's funds have been allocated for this current quinquennium are six n number : the encouragement of amateur music and drama activities ; the encouragement of the practice of the visual arts by amateurs through grants towards the cost of occasional expert tuition for groups of three or more art clubs ; the development of the local museum service, in co-operation with the Museums Association ; the upport of the National Councils of Social Service ; the support of the efforts of the Family Welfare Association and Family Service Units to improve the quality of family life ; and projects selected by the Trust to encourage outdoor group activities. In this connexion, the Trust hopes to contribute to the resources of a national park or a national forest park and to increase the value of the parks, as well as to assist field-work in the biological sciences and archæology, and a sum of £50,000 has been provisionally earmarked for expenditure on such schemes.

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* Carnegie United Kingdom Trust. Forty-second Annual Report 1955. Pp. viii+92 (9 plates). (Dunfermline: Carnegie United Kingdom Trust, 1956.)

Reviewing the work in 1955, the report records the award of grants to sixteen museums and of exceptional grants, each of £1,000, to the Highland Folk Life Museum at Kingussie and to enable the Bowes Museum at Barnard Castle to remain open. Grants were also given to students and to museum officials to enable them to widen their professional and technical knowledge. During the past ten years nearly a hundred museums have been assisted to eorganize their basic layout, and a sum of £50,000 has been allocated for such purposes for the 1956–60 quinquennium. Support of the visual arts is being continued on the usual lines, and £15,000 has been allocated for the purpose.

The report expresses the hope that the plans which the Executive Committees of the National Councils of Social Service are now considering for increasing their free income will soon produce results commensurate with the public services it performs, but meanwhile the Trust is increasing to £8,600 its total contribution for this service in the quinquennium. The Family Welfare Association's general-purpose grant has been renewed at £2,000 for 1956, £1,750 for 1957 and £1,500 for each of the following three years, and £10,000 has been set aside for the further development of Family Service Units, of which there are now eleven established on a permanent basis in reasonably well-equipped centres, with warm support from the local authorities. A grant of £5,000 over five years was made to the Liverpool Research Service Society for the purchase and equipment of sub-standard working-class houses for the accommodation and training of homeless families, and satisfactory progress is reported. A final grant of £1,500 was made for the blind-deaf machine, 'Arcaid', to be administered by the National Institute for the Deaf. The first group of twenty-five students completed, in the summer of 1955, their four years course of training as social workers at the London School of Economics, to which the Trust made a grant of £20,000 in 1953, and a second group started in October 1955. The Trust has also agreed to finance for five years, at a cost of £25,000, the Bristol Social Project which has as its main objects the investigation of stresses and strains in a developing community and their practical prevention and control and the education of the community to a higher level of responsibility.

THE GOLGI APPARATUS AND THE ELECTRON MICROSCOPE

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IN 1951, A. J. Dalton[1] first made satisfactory electron pictures of the Golgi apparatus. In 1953, Dalton and Felix[2] published an important memoir on the Golgi apparatus of the epithelial cells of the epididymis and duodenum of the mouse. Those who previously had at their disposal only the light microscope found much food for thought in this work. Dalton and Felix described the small granules (or Dalton–Felix bodies) which probably always are associated with the Golgi apparatus. They showed that the net type of Golgi apparatus found in the epididymis really consists of a series of hollow tubes, in section much thicker on one side than the other, their cavity filled by more or less compressed vacuoles in chain form (Fig. 1). The wall of these tubes consisted of double lamellæ sweeping along the length of the Golgi apparatus. Their work agreed in broad details with the previous light microscope study by Nassonow[3]. Outside the Golgi apparatus were found comparatively large bodies which stain with neutral red and methylene blue, probably of a nutrient nature (lipochondria ?). The double membranes have also been described by French and Swedish workers, of whom Johannes Rhodin[4] may be mentioned for his study of the cells of the convoluted tubes of the kidney.

None of this work, however, answered completely some important questions which have arisen in recent years. Three of these are the supposed relation between the commonly occurring dictyosome of invertebrate somatic cells, and of all animal male germ cells, and the Golgi apparatus of higher vertebrate neurones ; another, the supposed relation between secreted material and the Golgi apparatus. Work on the latter with special reference to the pancreas has been recently dealt with by one of us[5] ; a paper by Sjostrand and Hanzon[6] not accessible to us should be consulted in addition. Another puzzling question was the nature of the so-called chromophobe part of the dictyosome, which usually had been assumed to be a coagulable material, which formed a greyish inner mass, as observed in osmium preparations under the light microscope. If this mass was an intrinsic coagulable part of the dictyosome and not vacuolar and watery, it became difficult to homologize the dictyosome and the conventional vertebrate canalicular apparatus of Golgi as conceived by Cajal, and generally speaking proved correct by Dalton and Felix[2].

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It is difficult to make satisfactory line drawings of electron photographs because of their fine ground detail. Figs. 1–6 are of the epididymis[2], the cricket spermatid (Beams, Tahmisian, Devine and Anderson, unpublished), the *Stronglycentrotus* egg (Afzelius, unpublished), the sponge *Grantia*[7], a human breast cancer cell[8] and the kidney tubule cell[4]. Now in no case does the cavity of the Golgi apparatus (*V*) show any coagulum. This would appear immediately to rule out the older view that secreted material appears inside Golgi canals or vacuoles. At least one convincing exception to this is the Golgi spaces of the bile ducts in liver cells[8]. The contractile vacuole (cortex and vacuoles) of the freshwater sponge and Protozoa does not stain vitally in neutral red, and so far as we know neither does any one of the included spaces (*V*) in Figs. 1–6.

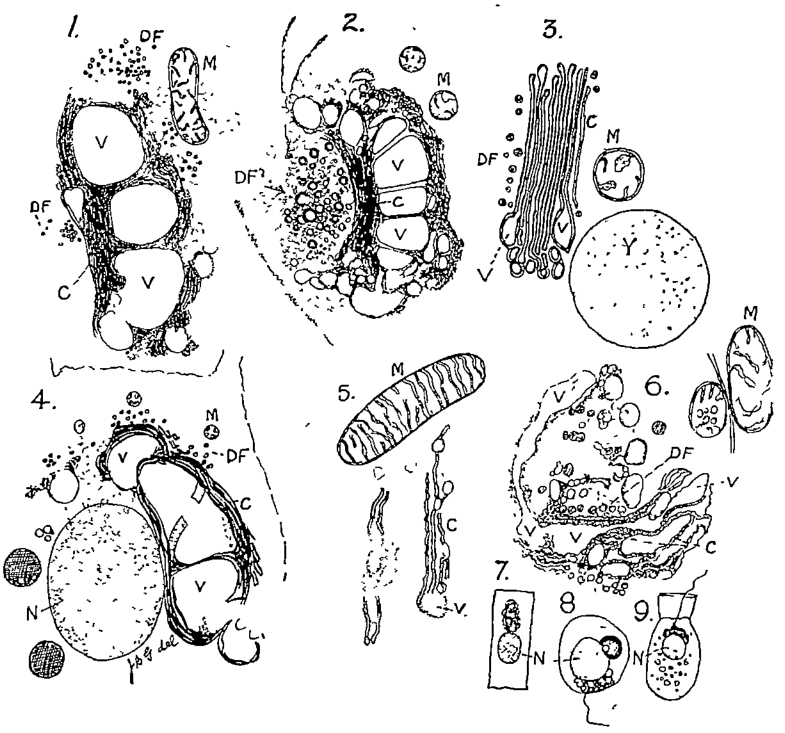

Fig. 1. Part of the Golgi net of the epididymis (Dalton and Felix). Fig. 2. Spermatid dictyosome of the cricket, *Nemobius* (Beams, Tahmisian, Devine and Anderson). Fig. 3. Dictyosome of oocyte of *Stronglycentrotus* (Afzelius). Fig 4. Dictyosome of *Grantia* choanocyte (Gatenby, Dalton and Felix). Fig. 5. Convoluted tubule cell of rabbit (Rhodin). Fig. 6. Human breast cancer, cell of a metastasis (Haguenau and Bernard). Fig. 7. Type vertebrate epithelial cell showing net apparatus above nucleus; Fig. 1 refers to part of net. Fig. 8. Insect spermatid with dictyosome on right of nucleus; refers to Fig. 2. Fig. 9. Sponge choanocyte with dictyosome; refers to Fig. 4. Fig. 6 is a cross-section of entire Golgi apparatus with elongate canal (cavern). Figs. 7–9 are from cells seen living with phase contrast

M, mitochondrion; *C*, cortical membranes; *DF*, Dalton–Felix bodies; *Y*, yolk sphere; *N*, nucleus; *V*, vacuole, cavern, canal

Turning now to the very interesting electron photograph of the cricket (*Nemobius*) spermatid dictyosome, Fig. 2, we have the usual arrangements of an included chain of vacuoles, a cortex of double membranes different and spongy on the right side of the figure, and on the extreme left a group of granules varying in size from the usual Dalton–Felix type to larger vesicles (micro-vesicles); this then is a dictyosome with four parts. Beams *et al.* consider the micro-vesicles to be pro-acrosomic, and we agree. In other photographs obtained by Beams and his group, this spherical area of micro-vesicles is found to have become surrounded by a wall, and is then undoubtedly the acrosome just before its adherence to the spermatid nucleus. At this stage the large, presumably watery vacuoles (*V*) included in Fig. 2 have almost completely disappeared. In the spermatocyte, Beams *et al.* have shown that prior to the maturation divisions the vacuoles (*V*) are ready and developed. Thus part of the preparation for the final stages of acrosome secretion appears to be the accumulation of water in the dictyosomes. It is to be hoped that further information on this point will be obtained by Beams's group. It would now appear that the site of acrosome secretion primarily is at the outside, and not the inside, of the dictyosome, and that the current idea that the dictyosome actually secretes the acrosome may need to be modified. Moreover, it is now apparently not possible to believe that the dictyosome is dehydrating the forming acrosome[5].

The electron photograph by Afzelius of the echinoderm dictyosome is interesting because the spaces which presumably could later swell up to form the chain of vacuoles clearly appear not within the double membrane, but between pairs of membranes (Fig. 3). The same appearance is found in Rhodin's examples of kidney tubule cells, in Beams's materia and in Lacy's pictures of the dictyosomes of *Patella vulgata* neurones (unpublished work).

In the past there have been differences of opinion as to the morphology of intra-cellular bodies, living or fixed, and studied with the light microscope. The electron microscopists use much thinner sections, and their results are not always easy to interpret. This certainly applies to the three distinct parts of the *Nemobius* dictyosome (plus acrosome) of Beams *et al.* (Fig. 2).

The following conclusions seem possible at this stage of work. (*a*) The cavities of the Golgi apparatus do not become filled with secretion. (*b*) The chromophile part of the Golgi apparatus is the double membranes or cortical substance, whereas the chromophobe part appears to be a system of caverns (Cajal) presumably filled with water. (*c*) Secretion takes place near but not in the Golgi apparatus, as if from the ground cytoplasm or from the mitochondria (pancreas), or perhaps from detached parts of the double membranes (Dalton–Felix bodies). (*d*) Neutral red used vitally does not initially stain the cortical substance or the chromophobe (vacuolar part), but does stain either the early secretion or mitochondria possibly when changing into secretion[9]. (*e*) The arrangement of the dictyosome into cortical substance and Dalton–Felix or small granules is the same probably from Protozoa, and certainly from sponges, up to mammalian cells. A single vacuole or chains of watery vacuoles may develop between the pairs of cortical membranes, but are not always present. These spaces apparently represent the cavity of the protozoan contractile vacuole. (*f*) The Golgi apparatus of the neurone is like that of Rhodin's kidney tubule cells (Fig. 5) and Haguenau and Bernard's cancer cell (Fig. 6), that is, a series of very long double lamellated membranes, with or without enclosed and neighbouring chains of caverns and vacuoles[9,10].

The arthropod and molluscan dictyosomes in a testis viewed with the light microscope are always approximately the same size at a given stage (Fig. 8). As might therefore be expected, the number of double membranes (that is, paired membranes) seems fairly constant for the invertebrate dictyosome, there being about twelve in both *Helix aspersa* and *Lumbricus terrestris* spermatids[10], 8–10 in the *Strongylocentrotus* oocyte dictyosomes (Afzelius, unpublished), and about 6–8 in the *Nemobius* spermatid dictyosome (Beams *et al.*). P. Grassé, N. Carasso and P. Favard[11] have published pictures of the *Discoglossus pictus* spermatid dictyosome with only four very clear membranes; in the rat neurones (Palay and Palade[9]) four or five pairs are present. There are about 6–8 in the late acrosome stage in the mouse spermatid[10]. In the mouse kidney tubule[4] there are membranes consisting of 2, 3 or 4 pairs. The cerebral cortex neurones of the mouse, in the one photograph we have seen, have similar 'strings' of 2–6 pairs of membranes[10]. In the pictures of *Lumbricus* and *Helix*, the membranes are piled in a pyramidal shape, the conventional curved outline of the living dictyosome under phase being brought about by the graduated lengths of the individual pairs[10]. Where vacuoles exist between members of pairs, the count is often difficult to make, especially where the lamellæ are more delicate and thinner in section, as in *Nemobius* (Beams *et al.*).

On the question of the nature of silver and osmium impregnation of the Golgi apparatus, which is remarkably specific, despite what has been written in controversy by some authors, it seems obvious that both the metallic and hæmatoxylin methods depend on a reaction on or in this system of close membranes.

Finally there is one question which cytologists who have no electron microscope are bound to ask. Is it worth while going on with the light microscope in any of its present various forms? After having studied electron photographs made recently by various workers, it has been concluded that the light microscope is useful for finding problems to be investigated properly by the electron microscope.

We thank Drs. Dalton, Felix, Afzelius, Lacy and Haguenau and Prof. Beams and his associates for generously sending some of their unpublished work with comments for our study. It is possible that these workers may not agree with some of our observations on the information they have been able to supply in this field.

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HISTOCHEMISTRY OF MUCOPOLYSACCHARIDE-LIKE SUBSTANCES AND ALKALINE PHOSPHATASE IN MADREPORARIA

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MUCOPOLYSACCHARIDE-LIKE compounds and non-specific phospho-monoesterases (phosphatase)[1] have been found to occur in Madreporaria. Histochemical investigations were undertaken to localize these substances in the polyps of thirty-two species of corals belonging to twelve families. All but eight of the species were tropical reef-builders collected in Jamaica. Of the non-reef-building corals, two were collected in Jamaica, three in British waters and three near Naples, Italy.

(1) *Epidermis:* The columnar supporting cells were strongly positive to phosphatase and periodic acid–Schiff tests, and orthochromatic with respect to toluidin blue. In the Dendrophylliidae, the epidermis contained little or no phosphatase activity. The mucus glands were phosphatase and periodic acid–Schiff negative but possessed an intense purplish-red γ-metachromasia. The granular glands in the stomodeal epithelium were phosphatase negative, positive to the periodic acid–Schiff test and displayed an intense purplish-black β-metachromasia. Nematocysts of the spirocyst variety were negative to phosphatase tests, faintly positive to the periodic acid–Schiff test, and were virtually unstained with toluidin blue.

(2) *Mesoglea:* This was phosphatase-negative, orthochromatic with toluidin blue and strongly stained by the periodic acid–Schiff test. The last reaction was localized both in the fibrillæ and the acellular ground substance.

(3) *Gastroderm:* The epithelial cells showed very high alkaline phosphatase activity. They also stained strongly with periodic acid–Schiff and exhibited orthochromasia with toluidin blue. In the cytoplasm of the mature ova, phosphatase and periodic acid–Schiff activities were concentrated in a narrow zone around the yolk droplets. The septal filaments and lateral mesenterial lobes, the 'absorptive zone' of Yonge and Nicholls[2], possessed higher phosphatase and periodic acid–Schiff activities than any other structure in the coral polyp. The phosphatase-negative zooxanthellæ were invariably surrounded by a strongly phosphatase-positive gastrodermal reticulum in intimate contact with the algal

surface. The large nematocysts and hyaline glands of the septal filaments were phosphatase-negative and stained only weakly with periodic acid–Schiff. None of these structures displayed metachromasia. Contractile tissue, especially the fibres of the septal retractor muscle, exhibited high phosphatase activity but stained very little with periodic acid–Schiff. The staining properties of the mucus and granular glands in the gastrodermis were the same as those for similar glands of the epidermis.

The material of the mesoglea, epidermis and gastrodermis reactive to periodic acid–Schiff showed the histochemical properties of neutral mucopolysaccharide in that it was non-metachromatic, resistant to amylase and unaffected by peptic and tryptic digestion. The material in the granular glands reactive to periodic acid–Schiff is probably a kind of acid mucopolysaccharide due to its strong metachromasia. In all cases, the periodic acid–Schiff reaction could be blocked by acetylation[3]. The pyrenoids of the zooxanthellae contained an amylase-soluble material that reacted strongly with periodic acid–Schiff. Droplets of a similar material were also observed in the lateral lobes at the base of the septal filaments. These were found only, in the presence of disintegrating zooxanthellæ in process of extrusion; hence it was concluded that the amylase-soluble material reacting with periodic acid–Schiff found at this site was not glycogen but amyloid liberated by broken-up zooxanthellæ, It is probable that the compound identified by Hosoi[4] as glycogen in *Fungia actiniformis*, a coral containing zooxanthellæ, was in fact amyloid of algal origin.

The metachromatic substances in mucus have been provisionally identified as simple acid mucopolysaccharides; but the nature of the acid mucopolysaccharide-like material in the granular glands is unknown. Preliminary studies indicate that the granular glands discharge during feeding, and that the mucus extruded at this time contains acid phosphatase.

One of the striking results of this investigation is the one-way correlation between the presence of extranuclear alkaline phosphatase and the distribution of a neutral mucopolysaccharide-like material in coral. Moog and Wenger[5] found a similar relationship in a wide variety of invertebrate and vertebrate tissues. They suggested that the mucopolysaccharide associated with phosphatase forms part of a cytoskeleton upon which enzymes may be attached in specific ways to provide suitable conditions for their activities. The localization of the phosphatase–mucopolysaccharide complex at epithelial and other selectively active surfaces in corals indicates that this enzyme may be connected with active transport. The phosphatase in the gastroderm is presumably related to food absorption; but the presence of the enzyme in the epidermis is enigmatic. It is suggested (1) that the enzyme may be concerned with flagellar movement, (2) that it may play a part in the formation and extrusion of mucus, and (3) that absorption of food and other substances may occur directly through the epidermis. The last postulate has received some support from two separate lines of evidence. It is a well-known fact that some faviid and mussid reef corals[6] can perform extracœlenteric digestion by means of septal filaments extruded through temporary openings in the edge zone of the cœnosarc. Thus, the possibility exists that direct epidermal food absorption may occur. Electron micrograph studies have shown that the free border of the supporting cells has closely spaced filiform processes which may be an adaptation for more efficient absorption of substances from the external medium[7].

Thanks are due to the Challenger Society, the Browne Fund of the Royal Society, and the British Association for support of various phases of this work, which was part of a Ph.D. thesis presented to Yale University. A detailed report of the histochemical findings will be published elsewhere.

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MEASUREMENT OF THE THICKNESS OF THIN FILMS BY MULTIPLE-BEAM INTERFERENCE

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THE multiple-beam interference method for the measurement of the thickness of thin metallic films developed by Tolansky[1] is now a well-established technique. The film, the thickness of which is to be measured, is deposited on a substrate, part of which is covered to give a sharp edge to the film. An opaque metallic reflecting layer is then deposited over the edge of the film. The step in this overlayer is measured by using it as one surface of an interferometer and viewing the multiple-beam fringe system in reflexion. Provided that the overlayer assumes the exact contour of the surface, this step-height will give the thickness of the film underneath.

Tolansky has given adequate evidence that silver fulfils the necessary requirements both in its high reflectivity and its ability to contour the surface. Some workers have tried metals other than silver using fringes of equal thickness[2,3] and fringes of equal chromatic order[4]. In both fringe systems the displacement of the fringes at the discontinuity caused by the step-edge gives the height of the step in the opaque layer. However, Avery[2] has shown that the thickness of a silver film as measured by multiple-beam interference may vary considerably with the metal used for the overlayer. It was found that the value for the thickness of a silver film was 25 per cent greater when measured using a chromium overlayer than the thickness when measured with a ilver overlayer. Avery explained this discrepancy by considering the silver film to have an aggregated tructure[5]. He suggested that atoms of silver would nter the interstices of a silver film more easily than atoms of chromium, and that this would lead to a packing-in' effect for silver on silver but not for hromium on silver. Another explanation for this iscrepancy was put forward by Scott, McLauchlin and Sennett[4]. They suggested that the structure of he chromium overlayer adjacent to the substrate might be less aggregated than that of the silver film ; but no further experiments were carried out to check he results of Avery.

The occurrence of this discrepancy was not conirmed by Heavens[3]. No evidence of 'packing-in' of he atoms of the overlayer material into the intertices of the film was observed. This disagreement may be due to the experimental conditions employed by each worker, and the lack of these details in the work of Avery makes comparison of the results very difficult.

Experiments have been carried out in this Department on the measurement of the thickness of thin ilver films, using both silver and chromium as the overlayer material. A standard experimental proedure was adopted for the deposition of these films, which were evaporated on to selected glass microcope slides. Fig. 1 shows the position on the subtrate of the silver film (W), and the overlayer films f silver (X) and chromium (Y). These three films were deposited in succession without admission of air between evaporations. A mechanical device was used to arrange the slide normally above each source n turn, at a distance of 30 cm. Assuming a point ource, the maximum possible variation in thickness ver the whole surface would not exceed 1 per cent. Since the silver film is symmetrically placed with espect to the silver source, the thicknesses at the wo ends should be identical, and this was confirmed within experimental error. The slide was cleaned with 'Teepol', hydrogen peroxide (20 vol.), dried with cotton wool, and polished with lens-cleaning issue. The surface was finally cleaned electrically *n vacuo*. The films were deposited at a pressure of 0^{-4}–10^{-5} mm. mercury. In view of its marked effect n the structure of thin metallic films[6], the rate of vaporation was considered an important experimental condition. Silver films were deposited at vaporation-rates between 1 and 60 A./sec. approximately. In each case the rates of evaporation of the ilver and chromium overlayer films were kept contant at approximately 20 A./sec. and 3 A./sec., espectively. The thicknesses of the silver films were measured by multiple-beam interference fringes of qual thickness viewed in reflexion.

The results of these investigations are shown in Table 1. They indicate that when the chromium overlayer is opaque, then there is no discrepancy in the thickness of the silver film as measured by the two different overlayers. However, when the chromium overlayer is not opaque, then a discrepancy of the type found by Avery occurs. The variation of the rate of evaporation of the silver film appears to have no effect on the results. The first two tests in Table 1 are with a non-opaque chromium overlayer, whereas the remaining tests are with opaque overlayers. The discrepancy in the thickness of the silver film as measured by X and Y is expressed as a percentage of X.

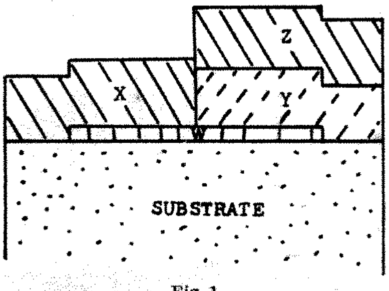

Fig. 1

Table 1

Thickness by X (A.)	Thickness by Y (A.)	Thickness by Z (A.)	Discrepancy $\frac{Y-X}{X} \times 100$	Discrepancy $\frac{Z-X}{X} \times 100$	Rate of evaporation (A./sec.)
337	395	326	17	3	28
461	562	454	22	2	22
203	215	216	6	6	11
245	262	240	7	2	3
456	466	427	2	6	35
577	620	613	7	6	16
939	924	958	2	2	57

Schulz and Scheibner[7] have shown that when a beam of light strikes a metal film at normal incidence, the phase change at reflexion can be related to the thickness of the film. This phase change becomes constant at a certain film thickness, in the case of silver at 500 A. It can be assumed that there is a similar thickness for chromium, and for films below this critical thickness the phase change will be affected by the underlying film or substrate. The discrepancy in the thickness measurements when a non-opaque chromium layer is used may then be caused by a difference in the phase change at reflexion on the two sides of the step-edge since the underlying substances are different. That is, the fringe displacement at the step-edge would consist of the displacement due to the thickness of the silver film plus a displacement due to a difference in phase change.

This proved to be the case. An opaque silver layer (Z in Fig. 1) was deposited on the chromium overlayer ; when the step in this layer was measured, a thickness for the silver film (W) was obtained which agreed with that as measured by the silver overlayer (X), as shown by the first two sets of results. It is concluded that the disappearance of the discrepancy after this final evaporation is due to the elimination of the difference in phase change. This conclusion is supported by the results of tests with an opaque chromium overlayer. There is then no change in the measured thickness value when the silver layer (Z) is deposited on the chromium. The measured height of the step in this layer is in good agreement with the values given by the silver and chromium overlayers X and Y.

The investigation is being continued to determine the critical thickness of chromium and the variation of phase change at reflexion with thickness.

One of us (P. B.) wishes to thank Metropolitan Vickers Electrical Co., Ltd., for the provision of a postgraduate scholarship to undertake this work.

[Dec. 23

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Bone treated with Ethylenediamine as a Successful Foundation Material in Cross-Species Bone Grafts

THE optimal bone graft is one which is most readily: (1) accepted with least reaction, (2) incorporated in callus formation, (3) vascularized with subsequent mineralization, and (4) absorbed (remodelled) by the host. Assuming that the constituents of bone which cause failure are contained in the organic fraction (antigens, fats, mucopolysaccharides, etc.), its removal would allow host acceptance of foreign bone. The remaining inorganic matrix might then be suitable for surgical prosthesis in situations where 'banked' bone is now required. The use of such inorganic bone transplants would, in addition, alleviate the present problems of procuring, storing and supplying whole bone.

Preliminary studies will be reported in which the inorganic matrix of heterologous bone prepared by ethylenediamine extraction was transplanted successfully. It is generally conceded that fresh autogenous bone is optimal for bone grafting. However, conditions do occur which make its use unfeasible. This would be particularly true in a national emergency. It is obviously desirable to have readily available a supply of bone graft material.

Past methods for removal of the organic fraction, which would include any antigenic constituents, have so altered the bone that it differed in composition and/or structure from that of the original bone[1-3]. Recently, Williams and Irvine[1], Peckham and Losee[4], and Singer and Armstrong[5], using ethylenediamine as the organic extractant, removed the organic material of bone with little or no change in the cation or anion composition or the X-ray diffraction powder pattern of the residue. Even the carbonate fraction, which is rather easily lost, apparently remains intact.

Other factors being equal, the speed with which acceptance, revascularization, absorption and perivascular new bone formation take place in a bone graft depends upon the ease with which the osteogenic tissues of the host can penetrate and gain attachment to the graft. With the removal of the organic constituents, bone attains an enormously increased free surface area immediately available without the need for biological debridiment (100 sq.m. per gm.)[6].

The bone used in the present work was extracted in a Soxhlet apparatus with a mixture of 14 ml. triple-distilled water and 86 ml. ethylenediamine (95–100 per cent, Eastman) for 48 hr., followed by absolute alcohol for 4 hr. (5–7 gm. bone). The latter treatment assures removal of any residual ethylenediamine, ethylenediamine carbonate, water, fat and an apparent hæmatin complex resulting from the action of ethylenediamine on red blood cells. The relatively low temperature (90–95° within the bone) required to distil the ethylenediamine results in minimal alteration in composition and structure of the inorganic matrix. After extraction, the prepare bone has a nitrogen content of less than 0·4 pe cent, is very white, apparently bacteriologicall sterile, and retains its form. It can, however, b readily shaped with a scalpel. The treated bone ca also be sterilized by boiling or autoclaving withou change in the nitrogen, calcium, phosphate, or as composition.

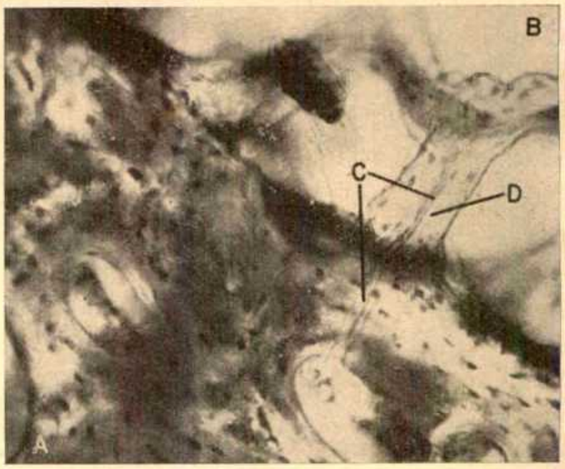

Fig. 1. Histological section of nine-week graft (hæmatoxylin and eosin). Section 100μ thick of bone demineralized with ethylenediamine-tetraacetic acid. Host bone (*A*) supplying blood vessel (*C*) for perivascular new bone formation (*D*) in "ED bone" graft (*B*). Notice vital bone cells in new bone (*D*)

Cortical defects (20 mm. × 5 mm.) were made i the shaft of the dog's tibia and filled with inla grafts of rat femur and bovine cortical femoral bon treated with ethylenediamine. Weekly radiograph were taken and intraperitoneal injections of alizari red *S*, a dye having an affinity for new bone growth were given. Six dogs received rat femoral bone graft and four dogs received bovine femoral cortical strip as donor material. The rat bone grafts were in plac six weeks and the bovine bone grafts nine weeks Gross and histological evaluation of the graft including microradiography[7] indicated apparent acceptance in all cases. A significant amount of reactiv bone formation was clearly demonstrated by th presence of alizarin red *S* at each graft site. Al grafts were covered with and included in callu formation. There was no evidence of foreign bod reaction nor sequestration. Repair was carried ou by an active invasion of blood vessels, connectiv tissue, and tissue fluids from the host into the space of the grafted bone formerly occupied by organi material (which represents about two-thirds of it original volume[8]). Almost complete revascularizatio was noted in the graft of treated bone as early a six weeks following implantation. Extensive absorption of the mineral elements of the graft occurre without the presence of osteoclasts. Absorptio was followed by a significant degree of perivascula new bone formation (Fig. 1).

If further study substantiates preliminary findings it appears that unlimited sources are immediatel available for the preparation and storing of steril supplies of bone-graft material.

We wish to thank Dr. S. N. Stein for his encouragement and valuable suggestions. The able assistanc of Lieut. S. Peckham is acknowledged. The opinion or assertions in this communication are the privat ones of the writers and are not to be construed a

official or reflecting the views of the U.S. Navy Department or the Naval Service at large.

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Two-Dimensional Electrophoresis of Serum Proteins

A METHOD of zone electrophoresis in starch gels has recently been described by one of us[1]. The high degree of resolution obtained with this method when applied to serum appears to be due to the use of a supporting medium the pore size of which approaches the molecular dimensions of some of the proteins involved, so that resolution by molecular sizes is superimposed on resolution by free solution mobilities. Consequently the starch-gel electrophoretic separations result from a qualitatively different process from that involved in free-solution electrophoresis. A combination of the two electrophoretic processes at right-angles should therefore give a much greater degree of resolution than is possible with either separately. Such a two-dimensional electrophoretic system has been tested by us, using electrophoresis on filter paper as a close approximation to that occurring in free solution. The present communication illustrates the type of result which can be obtained; a detailed description of the method will be published later.

The first electrophoresis is carried out on a 5-mm. wide strip of Schleicher and Schüll 589 *YD* filter paper using a buffer of *p*H 8·55 (Poulik, M. D., unpublished work) and of ionic strength approximately 0·1, prepared from Michaelis stock solution[2] by the addition of hydrochloric acid. The strip with the serum proteins separated according to their free-solution mobilities is then inserted into a starch gel 12 cm. in width, and a second electrophoresis is carried out at right-angles to the first. The gel is made and stained in the way described in the previous publication[1] and the starch-gel electrophoretic conditions are the same as described there for serum protein separations.

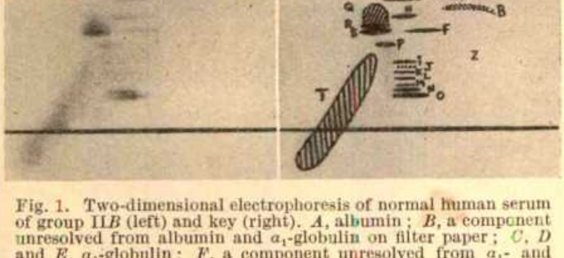

Fig. 1. Two-dimensional electrophoresis of normal human serum of group II*B* (left) and key (right). *A*, albumin; *B*, a component unresolved from albumin and α_1-globulin on filter paper; *C*, *D* and *E*, α_1-globulin; *F*, a component unresolved from α_1- and α_2-globulins on filter paper; *G* to *O*, α_2-globulin; *P*, a component unresolved from α_2- and β-globulins on filter paper; *Q*, *R* and *S*, β-globulin; *T*, γ-globulin. *Z* is a shadow introduced in the photographing and should be disregarded. The black line across the photograph indicates the position of insertion of the filter-paper strip

A photograph and explanatory diagram of the results obtained with 0·01 ml. of normal human serum of group II*B* [1,3] are shown in Fig. 1. More than fifteen resolved components can be seen even at the present stage of development of the method. The full significance of these results will be discussed in the later paper. However, we should like to point out that, in addition to an improvement in the resolutions which can be obtained, information on the distribution of molecular sizes in the various electrophoretic fractions results from this new method. For example, the α_2-globulin fraction obtained in the first filter-paper electrophoresis is resolved into more than six components by the second starch-gel electrophoresis. This indicates that there are more than six molecular size-groups present in the α_2-globulin of serum from the individual here concerned.

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Fractionation of Deoxyribonucleic Acid by Physical Procedures

THE use of an ultra-violet light absorption system for determining the sedimentation characteristics of deoxyribonucleic acid at low concentrations has already been described[1]. Further work has shown that the sedimenting boundary is stable and that the measurements can be made at concentrations of deoxyribonucleic acid as low as 10^{-5} gm./ml. It has been found for five preparations from calf thymus which have been studied[2] that the distributions of sedimentation constants at infinite dilution (for solutions in 0·2 *M* sodium chloride) covered a range from $S_0 = 10$ to at least $S_0 = 40$, and that the individual distributions differed significantly, the average sedimentation constant varying from $S_0 = 23$ to $S_0 = 29$.

To confirm that this observed distribution was due to a true heterogeneity, a solution of deoxyribonucleic acid (0·007 per cent) in 0·2 *M* sodium chloride was centrifuged in a bucket rotor for a sufficiently long time to remove all the material with $S > 20$. The supernatant was allowed to stand for 24 hr. at 4° C. and the distribution of the sedimentation coefficients was then determined. It was found that the average sedimentation coefficient was reduced from $S = 19$ to $S = 14$, and only 4 per cent of the deoxyribonucleic acid had a sedimentation coefficient greater than $S = 20$ (Fig. 1*a*). This shows that the observed distribution of sedimentation coefficients is real and also that there is no tendency for the particles of low sedimentation coefficients to aggregate on standing.

In order to determine to what extent variations in the distribution can arise during the preparative procedure, curves for the distribution of the sedimentation coefficients for the deoxyribonucleic acid in the nucleoprotein and at various stages during the removal of protein have been determined by carrying out experiments in 2·5 *M* sodium chloride, a salt concentration at which the dissociation into deoxy-

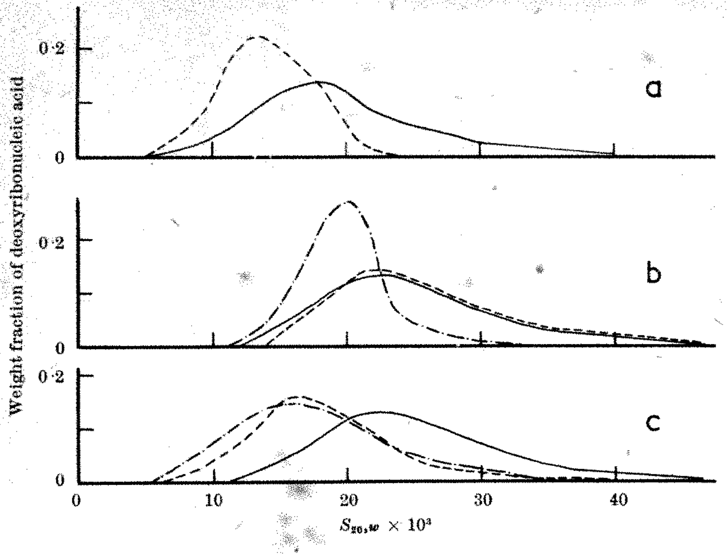

Fig. 1. Normalized distribution curves of sedimentation coefficient for deoxyribonucleic acid (DNA). The area under each curve is the same. (*a*) ———, 0·007 per cent DNA; – – – – –, DNA fraction obtained after centrifuging to remove material with $S > 20$.
(*b*) ———, DNA in nucleoprotein; – – – – –, DNA prepared by the detergent method; —·—·—, DNA prepared using amyl alcohol and chloroform.
(*c*) ———, DNA in nucleoprotein gel; —·—·—, DNA in soluble component of nucleoprotein; – – – – –, DNA in nucleoprotein gel after gel has been standing for 10 days at 4° C.

ribonucleic acid and protein is substantially complete[3]. These distributions were then compared with that observed for the final product of deoxyribonucleic acid after drying in alcohol and acetone and redissolving. Using the method of Kay *et al.*[4], in which protein is removed using the detergent dodecyl sulphate, it was found that no marked change of the distribution curve occurred at any stage during the preparation. The distribution of sedimentation coefficients for the deoxyribonucleic acid in the nucleoprotein and for the final product is shown in Fig. 1*b*. On the other hand, when deoxyribonucleic acid is prepared by the Sevag procedure[5], in which protein is removed by denaturation with amyl alcohol and chloroform, much of the material of high sedimentation coefficients is lost during the first two extractions. It can be concluded that using this method of preparation produces a fractionation of the deoxyribonucleic acid rather than a degradation or denaturation, since (*a*) after the first two extractions further treatment does not affect the distribution, (*b*) deoxyribonucleic acid of higher sedimentation coefficients can be removed from the denatured protein residues and (*c*) transforming principle when prepared in this way retains its biological activity[6]. It has been reported that deoxyribonucleic acid prepared by this method has a lower molecular weight than that prepared using the detergent method[7]. Analysis of the base composition of deoxyribonucleic acid prepared by these two methods and of that from the denatured protein residues of the Sevag extractions showed no significant differences. This confirms the conclusion of Lucy[8] that there is no marked correlation between the size of the deoxyribonucleic acid particles and their base composition.

Previous work[9] has shown that when nucleoprotein is dispersed in water, in addition to a gel phase which is not dispersed on dilution, some soluble nucleoprotein is also present. The soluble component has been isolated by centrifugation and the distribution of the sedimentation coefficients of deoxyribonucleic acid present has been determined. As shown in Fig. 1*c*, the distribution covers a range of lower sedimentation coefficients than does the distribution for the deoxyribonucleic acid in the gel phase. If the nucleoprotein gel is allowed to stand at 4° C., it eventually becomes fluid. The loss of the high viscosity is accompanied by a progressive shift of the deoxyribonucleic acid distribution curve to lower values of sedimentation coefficients (Fig. 1*c*), suggesting that the deoxyribonucleic acid is being slowly degraded, probably by a small amount of deoxyribonuclease present in the preparation. Further experiments confirmed that nucleoprotein is susceptible to degradation by deoxyribonuclease, the addition of a small amount of the enzyme to the gel causing a much more rapid loss of viscosity than was observed for the gel alone and a correspondingly more rapid shift of the distribution to lower values of sedimentation coefficients.

These results suggest that some degradation of the deoxyribonucleic acid occurs before or during the isolation of the nucleoprotein from the thymus tissue, producing the soluble component of the nucleoprotein. It seems probable that degradation of the deoxyribonucleic acid at these early stages of the preparation may be the major cause of the variations observed between different preparations of the acid made by the detergent method, since no evidence of degradation or fractionation has been observed in this process of preparation of it from the nucleoprotein. Degradation of the deoxyribonucleic acid during the preparation of the nucleoprotein would also produce breaks in the single strands of the twin helix such as have been postulated to explain the decrease in molecular weight observed on heating deoxyribonucleic acid solutions[10].

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Delayed Effect of Ipsilateral Intracarotid Infusion of Sodium Chloride on the Composition of the Parotid Saliva of Sodium-depleted Sheep

SHEEP with permanent unilateral parotid fistulæ may be maintained in good health indefinitely provided that sufficient sodium bicarbonate is added to the daily dietary intake to compensate for that lost in the hypertonic alkaline parotid saliva. It has been shown[1] that withdrawal of this supplementary sodium intake causes sodium depletion and, as depletion increases, the ratio of sodium to potassium in the parotid saliva falls progressively from a normal value of 180 : 10 to as low as 10 : 180. This response to sodium depletion is not significantly affected by changes in the potassium intake. Restoration of the dietary sodium bicarbonate supplement, in an amount sufficient to correct the sodium depletion, causes the composition of the parotid saliva to return to normal.

During the investigation of this aspect of parotid secretion, we have observed the effect of infusing a concentrated solution of sodium chloride into the ipsilateral carotid artery of sodium-depleted sheep. This caused, after a time delay of 100–150 min., a rapid increase in the ratio sodium/potassium of the parotid saliva. The rise occurred only if the infusion caused a significant change in the sodium balance of the animal.

The details of the experiments are as follows. In addition to a left parotid fistula, each sheep had a carotid loop in the neck on the same side[2]. Sodium depletion was produced by withholding or reducing the supplementary sodium bicarbonate. The degree of sodium depletion varied in the several experiments; but the ratio sodium/potassium of the parotid saliva was in all cases less than 1·0 on the day of the infusion. The procedure for sodium chloride infusion was essentially that described by Verney[3], with the modification that the experiment was performed during constant stimulation of the gland by the infusion of acetylcholine (1 : 50,000 in 5 per cent dextrose at the rate of 0·5 ml./min.) into the carotid loop. This acetylcholine infusion caused an abrupt and sustained increase in the rate of parotid salivary secretion as well as an increase in the ratio sodium/potassium to approximately unity. After a base-line period of 2–4 hr., during which the rate of parotid salivary secretion settled down to a relatively constant rate of 2–4 ml./min., and there was no further change in the ratio sodium/potassium, the sodium chloride solution was infused. This was made up to a concentration of 4 molar in distilled water, and infused into the carotid loop at a rate of 0·4 or 1·60 ml./min., using a motor-driven syringe. The saliva from the fistula was collected directly into a stainless steel tray, and the animal was conscious and unrestrained throughout the experiment.

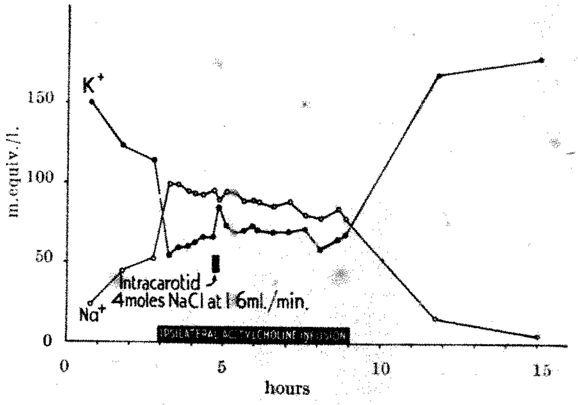

Fig. 2. Parotid fistula sheep No. 19, depleted of sodium. No change in the salivary sodium and potassium concentrations occurred after the rapid ipsilateral intracarotid infusion of 64 m.equiv. of sodium chloride (4·0 molar at 1·6 ml./min.)

In the first experiments, a total amount of 200–300 m.equiv. of sodium was infused over a period of 30–40 min. In most instances this caused an immediate small rise in the parotid salivary sodium concentration which persisted only until the end of the sodium chloride infusion. There was usually a fall in the rate of the salivary secretion during this period; but recovery occurred immediately after the infusion ceased. The ratio sodium/potassium in the saliva then returned approximately to the base-line level until 100–150 min. after the commencement of the infusion, when there was a rapid and progressive rise (Fig. 1). This was observed in three experiments in which the 4 *M* sodium chloride infusion was given at the rate of 1·60 ml./min., and in five other experiments in which approximately the same amount was infused at one-quarter that rate. The delay period was always at least 100–150 min. after the start of the sodium chloride infusion. As the total loss of sodium in the saliva during each experiment was, up to the time of the infusion, only about 60 m.equiv., the infusion caused a significant change in the sodium balance of the animal.

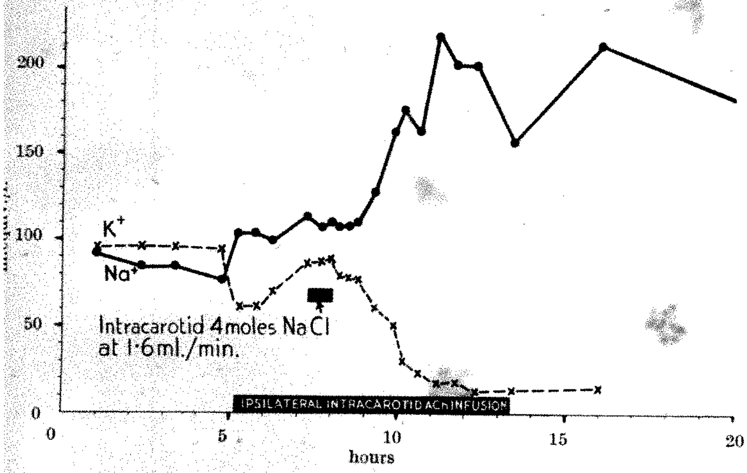

Fig. 1. Parotid fistula sheep No. 16, depleted of sodium. The delayed change in the saliva sodium and potassium concentrations after the rapid ipsilateral intracarotid infusion of 240 m.equiv. of sodium chloride (4·0 molar at 1·6 ml./min.)

Two experiments were made on sheep similarly prepared, in which the sodium chloride infusion was given at the rate of 1·60 ml./min., but for a period of only 10 min., so that the amount of sodium infused approximately equalled the amount lost in the parotid saliva during the experiment. No delayed change in the sodium/potassium ratio of the saliva occurred (Fig. 2).

Thus the delayed response to the sodium chloride infusion occurred only when the sodium balance of sodium-depleted sheep was significantly altered. Analysis of blood taken from the transverse facial artery of anæsthetized sheep has shown that the sodium concentration rises by 7–35 m.equiv./l. during the infusion of 4 *M* sodium chloride at these rates into the corresponding carotid artery. These considerations indicate that the return to a normal value of the ratio sodium/potassium in the parotid saliva was not due to a direct effect of the increased sodium ion concentration in the blood perfusing the gland. It seems likely that the site of action of the infused sodium ions was elsewhere in the body, and the time delay suggests that either a specific humoral agent was elaborated in response to the infusion, or the production of some agent necessary for the maintenance of a low salivary sodium/potassium ratio was inhibited. Investigation is proceeding to determine the site of the responsive region in the body, and the specific way in which changes in sodium balance may influence it. This experimental procedure, using a conscious undisturbed animal, should be of value in studying the biological regulation of sodium, since a change of sodium balance induces in the sensitive tissue a response of large magnitude on a short time-scale.

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Effect of Cadmium Salts on Testicular Tissue

THE physiological action of cadmium salts has been studied extensively by many authors. Morphological disturbances have been described in various organs (liver, kidney, etc.). While studying the effect of cadmium salts on protein metabolism one of us (J. P.) observed that cadmium chloride administered subcutaneously to rats produces macroscopic lesions of the testes. This seems to have escaped the notice of previous authors and therefore this phenomenon was studied more closely.

Mature male rats weighing on an average 300 gm. were given 1 ml. 0·03 *M* aqueous solution of cadmium chloride or lactate subcutaneously between the shoulder-blades. Male rats injected with an equimolar solution of sublimate served as controls together with normal animals. Rats were killed 2, 4, 6, 8, 10, 12, 24 and 48 hr. after injection. Already 2–4 hr. after injection of cadmium chloride, capillary stasis and œdema of the interstitium could be observed microscopically. 8 hr. after injection extensive hæmorrhages developed. Occasionally leucocyte infiltration, which was rarely massive, occurred. Regressive changes of spermiogenic epithelium developed 4–6 hr. after the injection of cadmium chloride (desquamation of cells, pycnosis of nuclei, karyorrhexis and lysis of nuclei). 24–48 hr. after injection all testicular tissue was severely damaged.

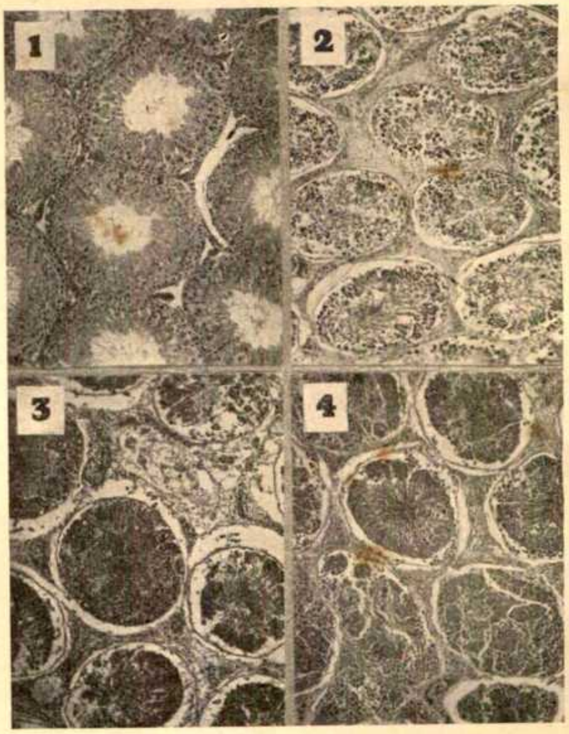

Fig. 1. Sublimate 48 hr. after application. Rat testis of normal appearance. Fig. 2. Cadmium chloride, 48 hr. after application. Collapse of tubules, œdema of intertubular spaces, desquamations and pronounced degenerative changes of the spermiogenic epithelium. Fig. 3. Cadmium lactate, 48 hr. after application. Histological picture as in Fig. 2. Fig. 4. Cadmium chloride, 12 days after application. Total necrosis of testicular tissue. (Bouin, hæmatoxylin-eosin; × c. 60)

On the following days all nuclear remain disappeared and complete testicular necrosis set in Cadmium chloride and lactate have the same effect whereas sublimate does not produce any obviou histological changes in the testes. Morphologica lesions in the ovaries of female rats after cadmiun chloride administration were not observed: bu functional changes cannot be excluded. The change described were found in the testes of all animal tested (80 males), whereas changes in other organ were only slight, except in the liver, where the varied in extent.

Work on this problem is being continued.

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IT has been shown (preceding communication) tha the subcutaneous application of small amounts o cadmium salts results in a rapid destruction of al tissues of the testicle.

Recently, Elcoate, Fischer, Mawson and Milla showed that prolonged nutritional deficiency of zin causes testicular injury[1]. It may be asked whethe e effect of cadmium on testicular tissue is not mparable to the effect of a lack of zinc, the former ing rapid and sudden. In our experiments it was ssible to protect testicular tissue of adult rats mpletely from the destructive effect of cadmium ·04 m.mole cadmium chloride/kgm. body-weight bcutaneously) by the simultaneous administration 80, 100 and 200 times the amount of zinc, injected the form of acetate subcutaneously in divided ses before, simultaneously with, and after, applica-on of cadmium.

Of all soft tissues, spermatozoa (and the prostate) ntain the largest amount of zinc. Turnover of nc is greatest in the testes[2]. Cadmium and zinc re physico-chemically very close to each other. It therefore attractive to speculate that cadmium splaces zinc from those molecular structures into hich zinc is probably incorporated during the aturation of spermatozoa. In view of the fact at it has been possible to suppress the destructive fect of cadmium on the testis by using many times e dose of zinc, a mechanism of competitive inibition between these two metals may be suggested.

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ction of an Autolytic Enzyme of *Bacillus subtilis* on the Cell Wall

Many biologically produced substances are known o lyse living micro-organisms. Among them, ysozyme has been studied most extensively for the echanism of its action, and it has been shown that his action is the dissolution of cell wall, probably he hydrolysis of mucopolysaccharide contained in t[1]. Studies on the action of autolytic enzymes, on he other hand, are few, and their site of action has ot hitherto been known. Recently, one of us bserved very rapid autolysis of amylase-producing trains of *Bacillus subtilis*[2] and isolated an autolytic ubstance(s) from the lysate[3]. Studies on this autoytic substance(s) have shown that it lyses the cell vall.

An autolytic enzyme preparation was obtained rom the lysate of *B. subtilis H* by precipitation with mmonium sulphate. Cell-wall preparation was btained from the same bacterium. Washed cells vere disrupted by boiling at 100° C. for 10 min. and, urther, by exposure to supersonic vibration. Disupted cells were digested successively with crystalline rypsin, crystalline *B. subtilis* protease and crystalline hymotrypsin. The residue seemed to consist mainly f cell wall when examined in the electron microscope. s shown in Fig. 1, this cell-wall preparation was issolved by the autolytic enzyme solution (crystalline ysozyme also dissolved it, but crystalline ribonuclease ad no effect). Electron microscope examination also onfirmed this result.

Further investigation of the mechanism of lytic ction was undertaken against living bacteria. ecently, Weibull[4] succeeded in dissolving the cell wall only, by the controlled treatment with lysozyme in sucrose, and obtained protoplast. The protoplast of our strain, *B. subtilis H*, was also formed by treatment with lysozyme in the presence of 10–15 per cent sucrose or polyethylene glycol. Therefore, the effect of high concentrations of these substances on the lytic action of the autolytic enzyme solution was examined. Complete protection was observed during the first 1–2 hr., but thereafter lysis occurred and action seemed to take place in two steps: the dissolution of the cell wall, and disruption and lysis of the resulting protoplast. When the enzyme solution was heated at 100° C. for 10 min., the autolytic activity was completely abolished. This boiled solution was added to the cell suspension in sucrose (15 per cent) together with the lysozyme solution. Complete lysis occurred, whereas only protoplast formation was observed without boiled enzyme solution. Therefore it was concluded that this enzyme solution contains a heat-stable substance(s) which causes the disruption of the protoplast in addition to the heat-labile enzyme which dissolves the cell wall.

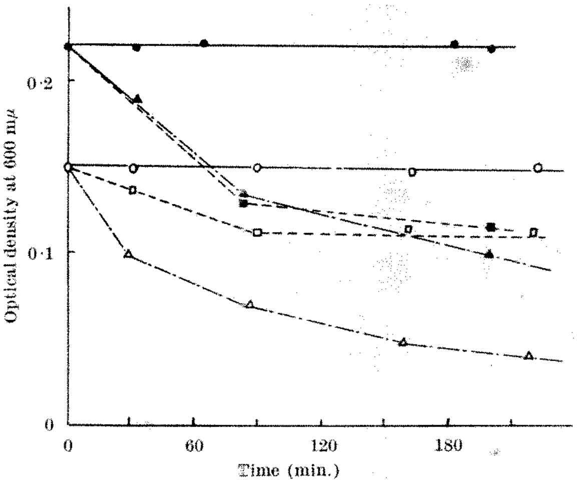

Fig. 1. Action of the autolytic enzyme solution and lysozyme on the cell-wall preparation. The cell-wall preparation was suspended in *M*/30 phosphate buffer, mixed with the autolytic enzyme solution or lysozyme solution as indicated. Total volume, 6 ml., *p*H 7·2. Rate of dissolution at 30° C. was followed by measuring the changes of optical density at 600 mμ

Set 1: ●—●, control; ■—■, plus 1 ml. autolytic enzyme solution; ▲·—·▲, plus 3 ml. autolytic enzyme solution. Set 2: ○—○, control; □—□, plus lysozyme 0·67 γ/ml.; △·—·△, plus lysozyme 6·7 γ/ml.

In view of these and other results, it seems reasonable to conclude that the primary site of action of this autolytic enzyme solution is the cell wall, probably the polysaccharide contained in it (polysaccharide was isolated from the cell and its depolymerization by this enzyme solution was demonstrated (unpublished results)). A more detailed account of this work will be published elsewhere.

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Effect of Carbon Dioxide on the Manganese Absorption of Red Beet Tissue

In an earlier publication[1] the discovery was reported of a substance extractable by water from red beetroot and capable of inhibiting the active accumulation of manganese by slices of storage tissue. It was suspected at the time that the substance might be produced by the dark fixation of respiratory carbon dioxide which, as Burton[2] showed for potatoes, may reach concentrations of about 7 per cent in bulky storage organs. I have now shown that the presence of carbon dioxide in solutions from which beetroot tissue slices are absorbing manganese reduces the rate of absorption. The reduction in rate is proportional to the concentration of carbon dioxide up to about 40 per cent, at which the rate appears to be minimal.

When slices of beetroot tissue are freed from natural inhibitor by prolonged washing in running water, inhibition of salt absorption capacity can again be produced by exposing the tissues to carbon dioxide in gaseous form before placing in the manganese solutions. The degree and duration of this condition depend on the concentration and duration of exposure to carbon dioxide. These facts support the hypothesis that a naturally occurring inhibitor of salt absorption may be a carbon dioxide fixation product. Further support is provided by the fact that a greater degree of inhibition results when beetroots are stored at temperatures of about 25° C. instead of the more usual 10° C., and when they are stored in closed containers so that respiratory carbon dioxide accumulates.

The exposure of inhibitor-free beetroot tissue to carbon dioxide concentrations of about 3 per cent (or short exposures to concentrations up to 10 per cent) when oxygen was the complementary gas produced a subsequent stimulation of manganese absorption on placing in solutions free from carbon dioxide, although higher concentrations or longer exposures produced the usual inhibition. This suggests the possibility of the formation of another fixation product or the oxidation of the inhibitor to form a metabolic stimulant. It is hoped that full results will be reported elsewhere.

Dale and Sutcliffe[3] question the significance of a water-extractable inhibiting substance in connexion with the dormancy of stored beetroot or the development of a capacity for salt absorption in slices of cut tissue, and they claim that the observations of Skelding and Rees were due to the presence of relatively indiffusible anions such as malate and citrate in the extracts. This may well have been the case, although Dale and Sutcliffe quote no figures for the organic acid content of their tissue extracts to support it. The results reported above are, however, consistent with the formation in beetroot tissue of an inhibiting substance, and the formation of acids by carbon dioxide fixation in plant tissues is well known. It could be the case that the presence of organic acids in the cytoplasm in certain concentrations is inhibitory; but if so the explanation would more probably lie in a specific action of the acid on absorption centres rather than in the presence of an ion of low mobility in the external solution. The effect of externally applied malate might also be on absorption centres. If the hypothesis put forward here as to the reason for the undoubted low level of salt absorption capacity in newly cut storage tissue is correct, an inhibiting substance ma well be of significance in the life of tuber-formin plants.

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March 20.

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A Selective Medium for the Isolation of Basidiomycetes

In the course of a programme of work involvin the isolation of wood-rotting fungi from infecte Scandinavian wood-pulp, considerable trouble wa experienced with rapidly spreading mould contaminants, particularly *Trichoderma viride*[1]. In man cases, attempts to isolate Basidiomycetes from stain known to be caused by these fungi failed, due nc only to the growth of *Trichoderma* which in a shor time covered the surface of the malt agar mediun but doubtless also to secretion of the antibiotic viridin and gliotoxin by this mould, which are activ against many fungi[2]. Experiments have shown tha *Trichoderma* isolated from wood-pulp is able to retard and in some cases prevent, the growth in artificia culture of various Basidiomycetes.

This difficulty has now largely been overcome i these laboratories by the development of a selectiv medium containing 0·006 per cent *o*-phenyl phenol which has given good results both when used for th isolation of wood-rotting fungi from wood-pulp anc also, in conjunction with an air-sampling apparatus from the air in a pulp mill. The latter work wa done in an attempt to demonstrate the presence o Basidiomycete diaspores in the aerial microflora of Norwegian pulp mill, and was very successful. Usin the selective medium, ***Fomes annosus*** was isolatec from several locations together with four other (a present unidentified) Basidiomycetes. None wa obtained by exposing plates of normal malt agar.

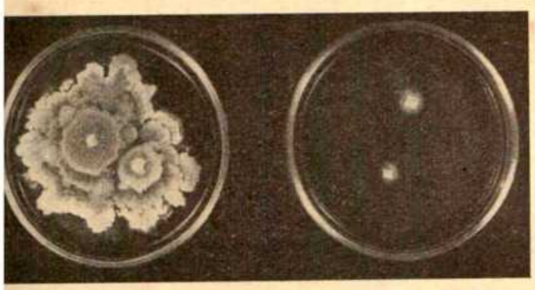
The selective medium has the following composition:

'Oxoid' desiccated malt extract	3 gm.
'Oxoid' mycological peptone	0·5 gm.
Agar-agar	2·5 gm.
o-Phenyl phenol	0·006 gm.
Distilled water	100 ml.

The medium is autoclaved at 10 lb./in.^{2} for 10 min The required amount of *o*-phenyl phenol is addec from a stock solution prepared by dissolving 1 gm in 50 ml. industrial alcohol. This solution is dilutec to 100 ml. with distilled water and is quite stable.

Extensive tests have been carried out with thi medium. We have found that several Basidiomycete isolated from wood-pulp will grow, albeit slowly, ir media containing up to 0·01 per cent w/v of *o*-pheny phenol. The growth of bacteria can at the same time be prevented by the normal method of lowering the *p*H of the medium to about 3·5 with sterile lacti acid, without affecting the selective action of the *o*-phenyl phenol towards Basidiomycetes.

At a concentration of 0·006 per cent *o*-pheny phenol, certain moulds (for example, *Cladosporium* sp., *Alternaria* sp., *Penicillium* spp.) will produce restricted colonies after about a fortnight on the medium. Also, from one pulp sample, a strain o


(1) (2)

ig. 1. Contiguous fragments of infected wood-pulp on normal id selective malt agar. (1) Only *Trichoderma* growing. (2) *Trichoderma* suppressed, Basidiomycete isolated

ichoderma was isolated which was highly resistant *o*-phenyl phenol. Nevertheless, the medium has ved to be sufficiently valuable to be used in the itine examination of infected wood-pulp.

n general, the micro-fungi appear to be much re sensitive to this chemical than the Basidio-cetes normally encountered in this work. (The y wood-rotting fungus so far observed which led to grow on the medium was *Merulius lacrymans*.) e concentration of *o*-phenyl phenol can apparently increased somewhat if desired, and it is thought it the medium could be used with advantage in isolation of Basidiomycete fungi from soil, terials frequently heavily infected with superficial ulds such as wood-pulp and bark, building boards, shwater, pulp mill whitewaters and the air.

Fig. 1 illustrates the result of placing infected gments of wood-pulp, taken from adjacent positions, normal and selective malt agar plates. Complete pression of *Trichoderma*, which was sporing freely the pulp, has been obtained with the selective dium, and the Basidiomycete responsible for the -stain under examination has been successfully lated.

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insworth and Bisby, "A Dictionary of the Fungi".

Incorporation of Carbon-14 into the Complex Polysaccharides of Plants

The carbon-14 tracer technique would appear to er a unique opportunity for investigations of the synthesis and subsequent metabolism of pectins d hemicelluloses, provided that there is a measur-le synthesis and turnover of these polysaccharides plant tissues. After allowing four mature fruiting urs, each with four to six leaves and two fruits, tached from plum trees (variety Victoria), to otosynthesize[1] in the presence of carbon-14 dioxide om 43·5 µc. barium carbonate-^{14}C), the leaf poly-charides and the water-soluble polysaccharides of e fruit mesocarp were isolated. Labelling of all the onosaccharide constituents was observed by hydro-sing the polysaccharides (*N* sulphuric acid ; 100° ; hr.), separating the products on paper chromato-ams and examining with a Geiger counter those eas containing the separated sugars. The specific tivities of the latter were determined, after elution from the paper chromatograms, as infinitely thin films on planchets (see Table 1). The incorporation of carbon-14 into the fruit mesocarp polysaccharides may be due to photosynthesis by the fruit or by translocation from the leaves.

Table 1

Monosaccharide	Specific activity (counts/min./mgm.)	
	Leaf polysaccharides	Mesocarp polysaccharides
Galacturonic acid	882	20
Galactose	1,342	31
Glucose	3,110	—
Arabinose	334	11
Xylose	180	—
Rhamnose	184	—

The highly active glucose undoubtedly arose from leaf starch. Clearly, the complex polysaccharides are biosynthesized in the leaf and mature plum fruit tissues, thus suggesting the existence of a dynamic equilibrium between these polysaccharides and their monosaccharide constituents in a manner analogous to the animal proteins. Jermyn and Isherwood[2] have made an analytical study of the cell-wall polysaccharides of pear fruit at various stages of ripening, with the conclusion that certain of the polysaccharides were being synthesized in over-ripe fruit. The synthesis of complex polysaccharides in mature fruit tissues is contrary to the classical view.

This work forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Mitochondrial *Nebenkern* of the Water-boatman

During the past few years, in the course of an investigation of the chemical composition of the acroblasts ('Golgi apparatus') in the spermatogenesis of the water-boatman (*Notonecta glauca*), I have been impressed by the structure of the mitochondrial *Nebenkern* of this animal. The male germ-cells of *Notonecta* are very large, the spermatozoon being more than a centimetre long, and the *Nebenkern* is probably the largest single body of mitochondrial origin that occurs in any organism. Its development and subsequent history were worked out long ago by Pantel and de Sinéty[1], Poisson[2] and Voïnov[3]. It is formed by the fusion of the mitochondria present in the young spermatid.

The purpose of this communication is to direct attention to the curious resemblance between the internal structure of this *Nebenkern* as seen by the light-microscope, and that of the ordinary mitochondrion as revealed in recent years by the electron microscope. Fig. 1 represents a section of the *Nebenkern* of the young spermatid of *Notonecta*. It is seen to be traversed by flat partitions, which show at

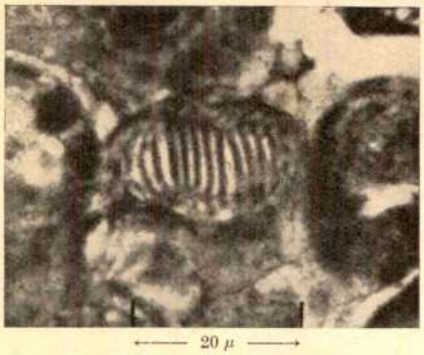

Fig. 1. The ovoid *Nebenkern* in the young spermatid of *Notonecta glauca*. Twelve partitions can be counted. (Fixed in Mann's fluid; paraffin section stained in Hirschler's hæmatoxylin)

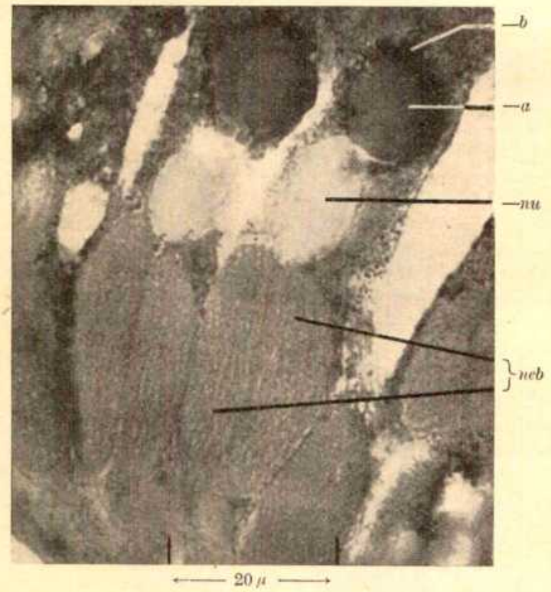

Fig. 2. Two elongating spermatids of *Notonecta glauca*. *a*, Acrosome in its vesicle; *b*, group of acroblasts; *neb*, elongating *Nebenkern*, now divided in two; *nu*, nucleus. (Weigl's method; unstained 4-μ section)

least some superficial resemblance to the cristæ mitochondriales of the electron microscopists. The scale of the objects is, however, extremely different. The mean distance from the middle of one partition to the middle of the next, in the *Nebenkern*, is about 1,600 mμ; in the ordinary mitochondrion the corresponding distance is commonly about 30–60 mμ (see, for example, Sjöstrand and Rhodin[4]). Sections passing at various angles through the *Nebenkern* show that the partitions are not arranged in the same way as the cristæ; nevertheless, it is interesting that a laminated structure exists in both objects.

In the later spermatid the *Nebenkern* divides in two and each half elongates (Fig. 2). The laminated structure is now much less evident.

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Jan. 13.

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Leafhopper Transmission of a Clover Vir
causing Green Petal Disease in Strawber

THE symptoms of green petal disease[1] of stra
berries in Britain resemble those caused by the as
yellows virus[2] in strawberries in California. In seve
localities where the disease occurs in Kent, sympto
of the aster yellows type were also found in red a
white clover (*Trifolium pratense* L. and *T. repens* I
plantain (*Plantago major* L.) and mayweed (*Anther*
cotula L.).

In the search for vectors of green petal vir
collections of mixed species of leafhoppers from he
age in and near strawberry fields were caged
diseased plantain and clover plants for appr
imately three weeks. The insects that surviv
represented only two species, *Euscelis lineola*
Brullé and *Macrosteles viridigriseus* (Edwards) (
termined by Dr. D. A. Young, U.S. National Museu
Washington, D.C.); to test them as vectors th
were transferred to successive plants of red clov
white clover, celery, mayweed, plantain, *Fraga*
vesca L. and *Duchesnea indica* Focke. In the fi
tests large numbers of insects were fed on each t
plant; later, single insects were transferred to you
seedlings of crimson clover (*T. incarnatum* L.).

Mixed colonies of *E. lineolatus* and *M. viridigris*
infected nine out of twelve clover, four of six ma
weed, and one of three celery test plants. In separ
tests with the two species of leafhoppers, *E. lineola*
colonies infected nine of fourteen clover plants, a
a further nine transmissions occurred with sin
insects. As plantain proved to be a better host th
clover for *M. viridigriseus*, most of the insects of t
species were fed on plantain test plants; these ha
developed such mild symptoms in the glasshou
that diagnosis of virus infection is uncertain. O
one definite transmission, to mayweed, has occurr
with *M. viridigriseus*.

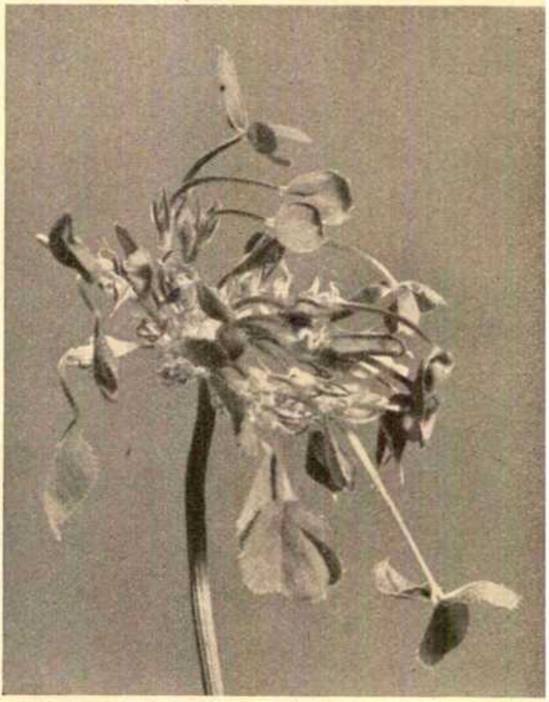
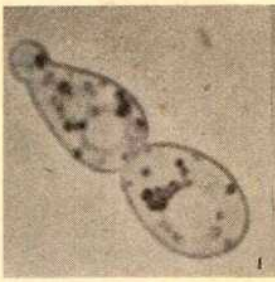


Fig. 1. Virus-induced phyllody in white clover flowers on plan
infected by *Euscelis lineolatus*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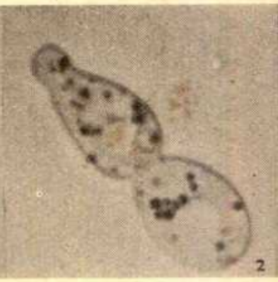
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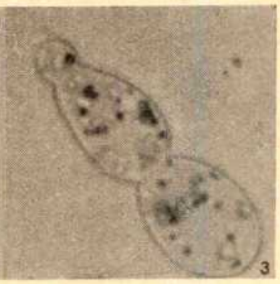
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3oth species failed to infect
strawberry and *D. indica*
plants, and the relation-
p between the leafhopper-
nsmitted virus and green
al disease was determined
transmission effected by
lder. *Cuscuta subinclusa*
and H. transferred the
us from clover to straw-
ry and *D. indica* plants,
ich developed the charac-
istic leaf and flower symp-
ns of green petal disease. Strawberry plants of
variety Lassen produced identical flower symp-
ns whether infected by dodder from clover or by
fting to green petal-infected strawberry.

The general similarity in symptoms and host-range,
d in the resistance shown by strawberry to experi-
ntal infection by leafhoppers, suggests that green
al disease may be caused by a strain of the aster
lows virus. There are, however, differences in
nptoms on all hosts, implying a distinction be-
een the green petal and both the eastern and the
stern aster yellows viruses.

The frequent occurrence of the disease in isolated
awberry fields suggests that the green petal virus
y be widespread in clover. The prominent phyllody
the clover flowers (Fig. 1) should have directed
ention to this disease, but it may have been
ributed to damage by *Dasyneura* midges or
ytoptid mites. Infected red clover plants are
nted, with yellow leaf margins and veins, and a
oliferation of axillary buds. White clover, although
veloping clear symptoms, seems less sensitive than
l, many plants of which have been killed within
few months of infection.

This is the first virus shown to be transmitted by
fhoppers in Britain.

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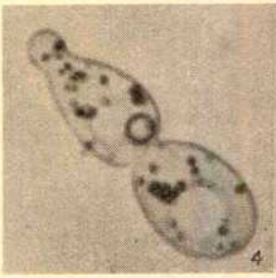
razier, N. W., and Thomas, H. E., *Plant Dis. Rep.*, 37, 272 (1953)

Cytoplasmic Structures in Yeasts

YOTSUYANAGI[1] has reported long, curved,
lindrical, occasionally branched, thread-like mito-
ondria in yeast cells by staining with tetrazolium.
though mitochondria are often clearly visible in
ing yeast cells, no other observer has ever reported
ng cylindrical cytoplasmic structures in *Saccharo-
yces*; we believe these thread-like structures are
ystals of dye rather than mitochondria.

Figs. 1, 2 and 3 show a yeast cell at three optical
els after 15 min. staining with 2,3,5 triphenyl
razolium. The mitochondria in Fig. 1, in central
us, are darkly stained structures with clear centres,
owing that the dye is deposited on the outside of
e mitochondrion. Fig. 2 shows the same structures
low focus as dark spots; a deposit of tetrazolium
forming. Fig. 3 shows the same cell in high focus;
e stained mitochondria appear as light areas due
the refraction of light by the granules. One hour
er (Fig. 4) the deposit is much darker. After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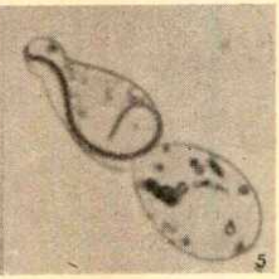
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another hour (Fig. 5) a crystal of tetrazolium extends across the cell. It is probably structures like this which Yotsuyanagi[1] and Ephrussi and Slonimski[2] have mistaken for mitochondria. In other cells crystals of dye appear as plates or short broad rods.

Ephrussi and Slonimski[2] and Yotsuyanagi[1] have proposed that three kinds of cytoplasmic granules are present in yeasts: (1) long cylindrical threads, (2) refractile granules which they do not think are mitochondria and (3) small 'true' mitochondria.

We have shown that deposits of formazan, especially the thread-like structures, are dye crystals, not resembling any normal structure present in the yeast cell.

This work was supported by a grant from the American Cancer Society administered by the Committee on Growth, National Research Council.

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THE above comment on our papers starts with the assertion that "Yotsuyanagi has reported long, curved, cylindrical, occasionally branched, thread-like mitochondria in yeast cells by staining with tetrazolium". This is incorrect; the thread-like mitochondria referred to were stained with janus green and with Altmann's fuchsin. The observation of Williams, Lindegren and Yuasa that "deposits of formazan, especially the threadlike structures, are dye crystals not resembling any normal structure present in the yeast cell" is therefore irrelevant.

On the other hand, Williams *et al.* state: "Ephrussi and Slonimski and Yotsuyanagi have proposed that three kinds of cytoplasmic granules are present in yeasts: (1) long cylindrical threads, (2) refractile granules which they do not think are mitochondria and (3) small 'true' mitochondria". Our papers show, however, that the small granular and the long thread-like mitochondria represent, in our opinion, two physiological states of the chondriome.

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Leptospirosis in Piggery Workers

It is generally believed that human cases of the type of leptospirosis known as canicola fever arise through man's contact with infected dogs, the dog being the only natural host and carrier of the infecting organism, *Leptospira canicola*. The infection in the dog may lead to a clinically recognizable disease with acute renal symptoms leading to the death of the animal; but a milder condition may occur and may escape detection. All degrees of infection give rise to the carrier state, which may persist for months or even years, during which time the leptospiras are expelled in the urine, which thereby constitutes a potential source of infection to other dogs and man.

Although the probable source of many human cases of canicola fever has been traced directly or indirectly to dogs, there have been instances where no connexion between patient and dog could be found. Four examples of such cases gave rise to an investigation into a possible alternative source of infection, the results of which present some interesting features. The patients concerned in these four cases, which arose during the years 1950–55, were all persons employed in piggeries situated within the City of Edinburgh. It seemed unlikely that the farm dogs were responsible for the infection, since they appeared healthy, and sera obtained from them failed to agglutinate *Leptospira canicola* to more than a low titre. In one of the piggeries where a single case had occurred, it was possible to obtain specimens of blood from all of the other human contacts living and working there, namely, three men and two women. Agglutination tests show that in four of these bloods, antibodies to *Leptospira canicola* were present in high titre—1/1,000 to 1/10,000. The one person whose blood failed to show any response to the agglutination test was the young wife, who was the only member of the household having no contact with the pigs.

Blood samples were taken from some of the pigs selected at random at the time of slaughter. Of seventy-six such specimens forty-six were found to have antibodies to *Leptospira canicola* giving titres of at least 1/100 (fifteen were 1/1,000 to 1/10,000). *Leptospira icterhaemorrhagiae* was agglutinated to a lesser degree. No antibodies to *Leptospira pomona*, *Leptospira hyos* or *Leptospira biflexa* were found in any of the samples tested.

These results indicate that pigs may become infected with a species of Leptospira closely related to, if not identical with, *Leptospira canicola*. If the responsible organism is indeed *Leptospira canicola*, the infection may have been introduced into the piggery in the first place by an infected dog, and once established there the infection has continued to spread directly from pig to pig.

To investigate the infectivity-rate among pig workers, blood specimens were obtained from forty-seven workers employed in twelve different pigge
(these figures include those already mentione
Agglutination tests showed that nineteen (that
40 per cent) contained a high antibody content
Leptospira canicola—1/100 to 1/10,000. *Leptos*
icterhaemorrhagiae was agglutinated to a les
degree.

An explanation of this apparently high infectivi
rate may be that the workers' hands are freque
contaminated with infected urine. The conditi
of their work seem to predispose them to cuts a
abrasions which do not heal readily. These inju
and the fact that the hands are often wet fr
frequent submersion in water will allow the lep
spira to penetrate into the skin readily.

Further inquiry regarding the health of th
workers whose bloods were positive to *Leptosp*
canicola revealed that during the past five years, f
of them had suffered from an illness diagnosed
canicola fever and, of the remaining fourteen, f
had a history suggestive of the disease. No mark
symptoms of disease in the pig have been observ
but leptospira have been seen in the urine.

Further work is in progress, and it is hoped t
the results of the complete investigation will
published in detail elsewhere at an early date.

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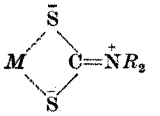
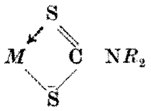
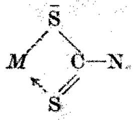
Electronic Structures of Dithiocarbamat and Xanthates

It has long been realized that the canonical fo
(I*a*) may contribute significantly to the structure
the dithiocarbamate residue in its complex co
pounds, $M(S_2CNR_2)_n$, where M is a metal atom a
n its valency, but no physical or chemical eviden
for this has yet been advanced.


(I*a*)


(I*b*)


(I*c*)

Recently, van der Kerk and his co-workers[1,2] ha
suggested that (I*a*) contributes strongly to the stru
ture of methyl derivatives (R = Me) but that i
importance decreases rapidly on ascending t
homologous series. They consider the dipolar for
(I*a*) to be responsible for the antifungal and plan
growth promoting properties of certain derivativ
of NN-dimethyldithiocarbamic acid. Since the bi
logical activities of the NN-dialkyldithiocarbama
derivatives fall rapidly on ascending the homologo
series, they conclude that the contribution of t
form (I*a*) to the structures also falls rapidly. A
the time of their later publication[2], we had examine
the infra-red spectra of a number of complex N
dimethyl- and NN-diethyldithiocarbamates and inte
preted the so-called 'thioureide ion' band[3] in ter
of the canonical form (I*a*). This band had previous
been identified in many thioureides but not sati
factorily interpreted[3,4]. Van der Kerk's publicatio

ompted us, however, to extend our investigation
higher homologues and to organic derivatives. We
w report briefly our conclusions.

In general, we find that the forms (I*a*), (I*b*) and
) contribute about equally to the structures of all
N-dialkyldithiocarbamic acid derivatives, and that
ere is no significant decrease in the importance of
e form (I*a*) on ascending the homologous series.
e canonical form of type (I*a*) probably contributes
out equally strongly to the structures of the
monoalkyldithiocarbamates, but only in a com-
ratively minor way to the structures of the
nthates.

Our evidence for this is based on an infra-red
ectral investigation of some thirty derivatives of
N-dialkyldithiocarbamic acid, and on the dipole
oments of some unsymmetrical derivatives. The
pes of compounds examined included salts, for
ample, $Na(Me_2NCS_2)$, complex salts, for example,
$(Et_2NCS_2)_3$, an ester, Me_2NCS_2Me, and a sulphide
$e_2NCS_2)_2$. All have a strong absorption band,
e 'thioureide ion' band, in the 1,542–1,480 cm.$^{-1}$
gion of the spectrum, usually around 1,500 cm.$^{-1}$.
is too high in frequency to be due to a vibration,
e form of which is largely determined by stretching
a single C—N bond, or of a double C=S bond[3];
frequency is also too high for it to be assigned to
deformation mode of the methyl groups[4], for this
uld not occur at frequencies greater than 1,480
.$^{-1}$. The only possible assignment appears to be
a polar C—N double bond, and this implies that
e canonical form (I*a*) makes an important contribu-
n to the ground-states of all NN-dialkyldithio-
rbamates.

If this conclusion is correct, unsymmetrical deriva-
es of dialkyldithiocarbamic acids should have
rge electric dipole moments, because the form I(*a*)
highly dipolar. Most complex dithiocarbamates
esumably have centro-symmetrical structures, but
ose of type $As(R_2NCS_2)_3$ must be unsymmetrical,
cause arsenic(III) has a lone pair of electrons;
e esters R_2NCS_2R must also be unsymmetrical. In
ct, the dipole moments of these two types of
rivatives are high, of the order 4·5–5·0 and 3·0
bye units respectively[5]. To account for these
oments in the esters the C—N bond must have a
nd order of 1·25–1·35, that is, the forms (I*a*), (I*b*)
d (I*c*) contribute about equally to the structure.
The unsymmetrical N-alkyldithiocarbamates have
nilar dipole moments to the corresponding NN-
alkyldithiocarbamates[5], and the spectra of the
w monoalkyl derivatives which we have examined
have an absorption band in the 1,500 cm.$^{-1}$ region.
parently their electronic structures are similar to
ose of the NN-dialkyldithiocarbamates.

The unsymmetrical xanthates have comparatively
w moments of less than 2 Debye units in the cases
$As(ROCS_2)_3$, and of the esters, $ROCS_2R$ [5]. These
e of the same order as those of the symmetrical
mplex dithiocarbamates[5], xanthates[5] and acetyl-
etonates[6]. We have therefore examined the
ectrum of $Ni(EtOCS_2)_2$, and find that it is trans-
rent in the double-bond region[7]. There is a broad
nd at 1,265 cm.$^{-1}$ which is in the right place for
unsaturated ether[8]. We conclude, therefore, that
e canonical form $-\overset{-}{S}_2C{=}\overset{+}{O}R$ contributes com-
ratively little to the structure of the xanthates.

In view of the suggestion of van der Kerk and his
-workers, we examined a homologous series of
pper NN-dialkyldithiocarbamates. Our observations are recorded in Table 1. It is evident that the C=N frequency is almost independent of the size of the alkyl groups, and such change as we observe in the solid state is mainly due to crystal forces. It appears that the observations of van der Kerk and his co-workers cannot be explained as due to the much greater contribution of form (I*a*) to the structures of the lower homologues. Perhaps increasing lipoid- or decreasing water-solubility may provide an explanation of the decreasing biological activity as the series is ascended.

Table 1. C=N STRETCHING FREQUENCIES (cm.$^{-1}$) OF CUPRIC NN-DIALKYLDITHIOCARBAMATES, $Cu(R_2NCS_2)_2$, IN CHLOROFORM SOLUTION (± 2 cm.$^{-1}$) AND IN THE CRYSTALLINE STATE

R	Me	Et	Pr^n	Bu^n	Pr^i
Solution	insol.	1,505	1,502	1,505	1,490
Solid	1,524	1,508	1,501	1,497	1,493

The greater contribution of the canonical form of type (I*a*) to the structure of the dithiocarbamates than to that of the xanthates undoubtedly arises from the greater mesomeric electron-releasing tendency of the —N*R*$_2$ group as compared with the —O*R* group. In the dithiocarbamates, this greater electron drift into the sulphur atoms will increase their electron donor capacity, and decrease the electron affinity of their *d*-orbitals as compared with the sulphur atoms in the corresponding xanthates. Thus the dithiocarbamate ion should form stronger complexes, with less tendency to dative π-bond formation from the metal to the sulphur atoms, than the xanthate ion. This may well provide some explanation of the rather striking differences between the chemistry of the complex dithiocarbamates and complex xanthates[9].

Full details of this work will be published elsewhere.

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Akers Research Laboratories,
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The Frythe,
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Jan. 18.

[1] Van der Kerk, G. J. M., and Klöpping, H. L., *Rec. Trav. Chim.*, **71**, 1179 (1952).

[2] Van der Kerk, G. J. M., van Raalte, M. H., Sijpesteijn, A. K., and van der Veen, R., *Nature*, **176**, 308 (1955).

[3] Randall, H. M., Fowler, R. G., Fuson, N., and Dangl, J. R., "Infra-red Determination of Organic Structures", 5 (Van Nostrand, New York, 1949).

[4] Mann, J., *Trans. Inst. Rubber Indust.*, **27**, 232 (1951).

[5] Malatesta, L., *Gazz. Chim. Ital.*, **69**, 629 (1939); **70**, 541 (1940).

[6] Finn, A. E., Hampson, G. C., and Sutton, L. E., *J. Chem. Soc.*, 1254 (1938).

[7] cf. Zinc O-*iso*propylxanthate Bellamy, L. J., "The Infra-red Spectra of Complex Molecules", 294 (Methuen, London, 1954).

[8] Tschamler, H., and Leutner, R., *Monatsh.*, **83**, 1502 (1952).

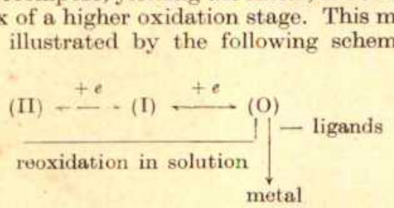
[9] Krebs, H., Weber, E. F., and Fassbender, H., *Z. anorg. Chem.*, **276**, 128 (1954).

Formation and Reduction of Zero-Valent Metal Complexes studied Polarographically

IN the course of the reduction of inorganic compounds the electron is always accepted by the lowest unoccupied (or singly occupied) orbital in the depolarizing particle, regardless of whether this orbital is localized in the central metal atom (or some ligand-atom) or whether it is an unlocalized molecular orbital. After the acceptance of the electron, a rearrangement of electrons and ligands takes place leading to the most stable configuration of the particle with one more electron formed in the reduction. The rate and mechanism of the electrode process depend on the rate and mechanism of this rearrangement.

The electronic structure of the particle determines whether the acceptance of the first electron will cause a great rearrangement, leading in some cases to the decomposition of the particle, or whether the second electron can be accepted immediately.

The reduction of transition metal ions in oxidation stage + 2 is a special case of the latter mechanism[1]. The inner *d*-orbitals of these ions are not fully occupied by electrons localized in the metal atom, and the electron can be accepted by these orbitals during the reduction. In complexes with most ligands, the ion in oxidation stage + 1 thus formed is sufficiently stable to accept the second electron while forming a complex containing the metal in the zero oxidation stage. The rearrangement or decomposition of the particle does not take place until the second electron has been accepted. The zero-valent complex may either decompose, yielding the metal, or reoxidize to a complex of a higher oxidation stage. This mechanism can be illustrated by the following scheme:



The mechanism of the chemical reactions of the zero-valent complexes may be complicated (for example, due to dismutation).

The formation of metal complexes in low oxidation stages has been demonstrated during the reduction of nickel (II)-complexes. The height of the reduction wave of the ion $Ni(CN)_4^{2-}$ corresponds to the acceptance of two electrons per nickel atom. During the reduction of $Ni(CN)_4^{2-}$, a red colour and the evolution of hydrogen at the electrode surface are observed. This effect can be ascribed only to the oxidation of the ion $Ni(CN)_4^{4-}$, formed as a primary product of the electrode reaction, to the ion $Ni_2(CN)_6^{4-}$, which is not reducible. Other experiments support this conclusion. The oscillopolarographic curves for d*V*/d*t* versus *V* (Fig. 1) point to one reversible redox process, corresponding to the reversible reduction of $Ni(CN)_4^{2-}$ and oxidation of $Ni(CN)_4^{4-}$; and also to one irreversible anodic process, corresponding to the oxidation of the ion $Ni_2(CN)_6^{4-}$, formed by the reacti of $Ni(CN)_4^{4-}$ with water. Polarography with t Kalousek commutator[2] points to the same processe The form of the reduction wave of the ion $Ni(CN)_4$ is in agreement with the proposed mechanism a may be deduced theoretically. The height of t cathodic wave of $Ni(CN)_4^{2-}$ in solutions with high concentration of cyanide ions or in acid solutions greater than would correspond to a two-electr process. This increase of current can be ascribed the regeneration of the ion $Ni(CN)_4^{2-}$ by oxidati of $Ni(CN)_4^{4-}$ ion with water.

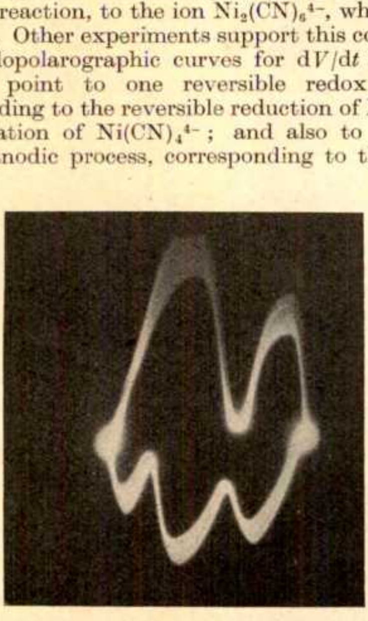


Fig. 1. Oscillographic curve for d*V*/d*t* versus *V* of $Ni(CN)_4^{2-}$ in 0·1 *M* sodium cyanide

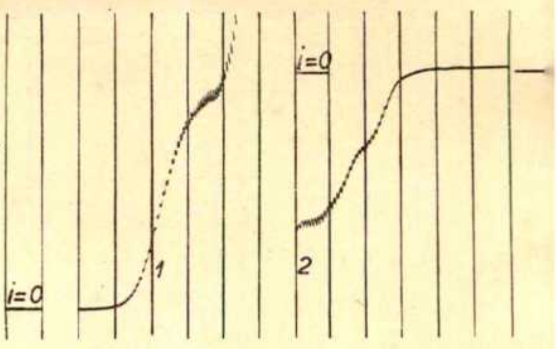


Fig. 2. Polarographic curves of $Fe(CO)_5$ and $Fe(CO)_4^{2-}$. Curve 1: $1{\cdot}5 \times 10^{-3}$ *M* $Fe(CO)_5$, from −1·2 V. (satd. cal. elect.), 205 mV./ absc. Curve 2: 1×10^{-3} *M* $Fe(CO)_4^{2-}$, from − 0·3 V. (satd. cal. elect.), 150 mV./absc. Electrolyte: 0·3 *M* $(CH_3)_4NCl$, absolute ethanol; nitrogen atm., *S* = 1·50

These experiments show that the ion $Ni(CN)_4$ is not reduced to the metal, as stated by Hume a Kolthoff[3], but to the ion $Ni(CN)_4^{4-}$, which is quick inactivated by a chemical reaction. Partial depositi of metallic nickel was observed only in acid solution The decomposition of the ion $Ni(CN)_4^{4-}$ in acid sol tion is caused by the tendency to form undissociate molecules of hydrogen cyanide.

The complexes of nickel (II) with dipyrid ethylenediamine, pyridine, ammonia and chlorid (in 5 *M* calcium chloride), were also shown to primarily reduced to zero-valent complexes of nick which are very rapidly decomposed to the metal oxidized to a higher oxidation stage. The life-ti of these zero-valent complexes is shorter than 0·01 se

From the study of nickel (II)-complexes, it follow that the formation of zero-valent complexes as primary product of electrode reaction is very probab in the reduction of the complexes of all transiti metals in oxidation stage + 2 with ligands which a not easily reducible. By the assumption of t formation of low-valent metal complexes, man catalytic effects of transition metals at the droppi mercury electrode, especially the Brdička reactio can be explained.

The stable zero-valent metal complexes wi *d*-orbitals not fully occupied by electrons localize in the metal atom can be further reduced at t dropping mercury electrode. An example of th behaviour is the reduction of iron pentacarbon which gives in ethanolic solution a well-develope reduction wave at − 1·7 V. (satd. calomel electrod (Fig. 2), followed by a large catalytic current at − 2 The height of the reduction wave corresponds to tw electrons for each iron atom. The product of t reduction is the ion $Fe(CO)_4^{2-}$, as was demonstrate by polarography with the Kalousek commutato The ion $Fe(CO)_4^{2-}$ is oxidized at the droppi mercury electrode in two successive steps (Fig.

some compound of zero-valent iron different from $e(CO)_5$ and $Fe_3(CO)_{12}$, as could be again demonrated by the Kalousek commutator.

This work will be described in detail elsewhere.

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zechoslovak Academy of Science,
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March 12.

lček, A. A., *Chem. listy*, **49**, 479 (1955); *Coll. Czech. Chem. Comm.*, **20**, 894 (1955); *J. Electrochem. Soc.*, **102**, 354 (1955).

Kalousek, M., *Chem. listy*, **40**, 149 (1946); *Coll. Czech. Chem. Comm.*, **13**, 107 (1948).

ume, D. M., and Kolthoff, I. M., *J. Amer. Chem. Soc.*, **72**, 4423 (1950).

Improving the Characteristics of the Cyclotron Beam

REPORTS[1] of existing fixed-frequency cyclotrons dicate that near the maximum energy the ratio etween internal and external beam current is about ve to one, with the maximum current limited by eating of the septum by the stray beam. If the ternal beam could be more accurately aligned at e deflector and the stray beam removed, a larger xternal beam, better focused and with less energy-read, could be produced.

In the cyclotron, groups of particles leaving the n source become bunched in phase[2] and, given a able dee voltage, would follow nearly the same ath, arriving at the deflector after the same number turns. It is not usual to provide such stability, d many cyclotrons operate with quite a large mains pple. This produces a range of conditions at the eflector. For example, if there is a 6 per cent ripple the dee voltage, different groups of particles may between 66 and 74 turns. The energy and position particles within a single group are nearly the same. ue to precession of the particle orbits, however, e energy and position, and hence the extraction ficiency, may differ widely from one group to the xt.

Theory indicates that stabilization of the dee ltage to some 0·25 per cent would improve the aracteristics of the beam. The reduction in both ergy-spread and angular spread would then make easier to focus on remote targets, while selection the optimum particle group would give increased traction efficiency. There would be a further lvantage; a beam which follows a single path to e deflector makes it possible to place beam-defining its on the dee interface. By intercepting the stray articles, particularly those which would strike the des of the deflector, these slits ould collimate the beam and crease the extraction efficiency ill further.

A vertical slit has been tried ear the ion source on the Medal Research Council's 45-in. clotron and found to produce a rresponding narrowing of the eam at larger radii. The sides the slit can be made to interpt any portion of the first rn without impeding the suceding one, while the proximity the slit to the dees seems to ve no adverse effects. It is exected that in the final arrangement the slit near the ion source will be about ¼ in. wide by ¾ in. high and situated at 1¼ in. radius, with a second slit ⅛ in. wide, giving finer adjustment, placed just before the deflector. The beam current striking the two sides of this second slit could provide a convenient way of stabilizing the voltage.

The theory, which will be submitted for publication elsewhere, is based upon numerical plots of the first turns, precession calculations, study of the extraction conditions, and upon calculations[3] on the phase excursion through the machine. Some confirmation of the correctness of the theory is apparent in a report[4] on experiments with the internal beam of the University of Birmingham cyclotron. In this report stops are suggested for the reduction of beam pulse-length.

This work was done in connexion with the construction of the Medical Research Council's 45-in. cyclotron. I wish to thank Mr. J. W. Gallop for his interest and encouragement and also Mr. D. D. Vonberg and Mr. P. J. Waterton for many helpful discussions.

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Jan. 5.

[1] Gallop, J. W., "Notes on a Tour of American Fixed Frequency Cyclotrons in the Autumn of 1950".

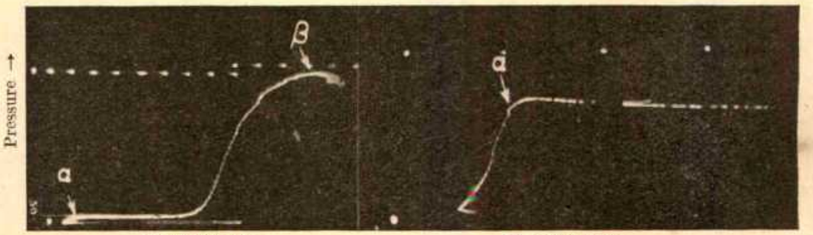
[2] Bohm, D., and Foldy, L., *Phys. Rev.*, **72**, 649 (1947).

[3] Vonberg, D. D., Internal Technical Memorandum No. 17.

[4] Konrad, M., Ph.D. thesis, University of Birmingham.

Adsorption Spectrum of Nitrogen on Tungsten

IT has recently been shown[1] that even at low coverages of a fraction of a monolayer, nitrogen is simultaneously adsorbed on tungsten in different states of binding, of which three have so far been isolated. The temperatures above which these individual species are unstable have been estimated semi-quantitatively as 800° K. for state α, 2,000° K. for β and 200° K. for γ. In order to define the spectrum of binding energies of the molecular species adsorbed on the surface, it is necessary to measure the concentration of adsorbed entities as a function of sorbent temperature. We have now been able to do this by a simultaneous recording of the rise in pressure and the increase in electrical resistance when the tungsten



(*a*) (*b*)

Fig. 1 (*a*). Desorption of nitrogen from tungsten with increasing temperature; filament initially at 298° K. Temperature range 298°–2,000° K. The instantaneous pressure is proportional to the amount of gas desorbed

(*b*). Desorption of nitrogen from tungsten initially at 298° K. Temperature range 298°–1,000° K

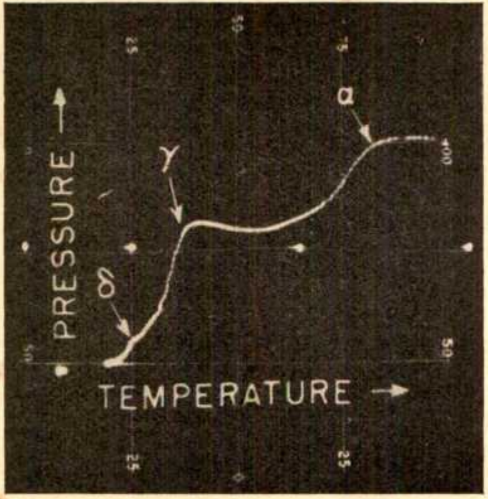


Fig. 2. Desorption of nitrogen from tungsten filament initially at 80° K. Temperature range 80°–750° K.

wire sample is heated in a flash-filament cell. Since the variation of electrical resistance of tungsten with temperature is known, the flash filament can be used both as adsorption sample and resistance thermometer.

In our system the pressure is monitored by an inverted ion gauge, the ion current from which is amplified with a vibrating-reed electrometer and displayed as ordinate on a cathode-ray oscilloscope. The adsorption filament is made one arm of a 10-kc./s. bridge, so that a change in filament temperature results in an unbalance which can be recorded on the abscissa of the oscilloscope[2]. Fig. 1 shows the resulting pressure vs. temperature plot for nitrogen adsorbed on a tungsten filament initially held at 298° K.; here the increase in the pressure (above the base line) corresponding to a given temperature is proportional to the total number of molecules evolved up to that temperature. Two regions over which desorption occurs are very clearly defined. After an initial evolution of gas only slightly above room temperature (the α-peak), desorption stops; for the initial stages of adsorption the material in the chemisorbed β-peak only begins to be evolved at 1,400° K., and is completely removed at 1,900° K. Fig. 1*b* gives an enlarged view of the low-temperature region of the burst, showing the α-peak alone, desorption of which appears to be complete at 650° K.

The details of adsorption in states of low binding energy are revealed in Fig. 2, showing a pressure vs. temperature trace for a filament cooled with liquid nitrogen to an initial temperature of 80° K. It appears that in addition to the α- and γ-peaks previously reported[1], a fourth level, δ, contributes significantly to adsorption at this low temperature. The temperature-ranges over which evolution of gas occurs are: level α, 300–650° K.; β, 1,400–1,900° K.; γ, 140–250° K.; δ, 100–140° K. We estimate a heat of desorption of approximately 85 k.cal. for nitrogen in state-β; the interactions in the other levels are significantly lower, and for γ and δ are presumably of the same order as commonly found in physical adsorption.

It has already been shown that nitrogen in state-α does not appear to participate significantly in the increase in population of state-β which can be observed with time[1]. Preliminary measurements which will be reported in greater detail at a late date, indicate that at $T = 80°$ K. there is no significant exchange between levels γ and β, but tha exchange between δ and the other levels does occur

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Dec. 14.

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[1] Ehrlich, G., *J. Chem. Phys.*, **23**, 1543 (1955); and in the press.

[2] An adsorption spectrometer, utilizing a d.c. bridge circuit, has bee described by Hagstrum, H. D., *Rev. Sci. Instr.*, **24**, 1122 (1953

The Prefix 'Nor' in Chemical Nomenclature

In his review of the new edition of "The Extra Pharmacopoeia" (Martindale), Vol. 2, Prof. J. H Gaddum (*Nature*, Feb. 25, p. 350) states, "surely *no* means 'N ohne Radikal' and not 'the next lower homologue' ". I have seen this explanation of the prefix 'nor' given several times in medical publications bu never in a chemical text-book, and I suspect tha "N ohne Radikal" is a mnemonic invented by a German pharmacologist to assist his students to remember the constitutions of *nor*adrenaline, *nor*ephedrine and similar compounds. However thi may be, the fact remains that the prefix *nor* is used for many compounds which contain no nitrogen a all; for example, *nor*pinic acid, *nor*œstrone, *nor*equilenin, etc. The statement made in Martindale i therefore perfectly correct.

It might be, of course, that this is simply an extension of the original use of the prefix 'nor', which certainly does not appear to be derived from Latin or Greek.

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THE first use of the prefix 'nor' appears to be in a paper by Matthiessen and Foster[1] published in 1868 They were studying the nitrogen-free substance opianic acid formed by the oxidation of narcotine and obtained evidence that it contained two methy groups. They had used the term 'normal opianic acid' to mean the completely demethylated compound, and they then used the contraction 'methyl noropianic acid' for the monomethyl derivative Since that time the prefix has generally been used to denote the replacement of one or more methy groups by H, or the disappearance of CH_2 from a carbon chain, but its use may leave the resulting structure in doubt. I apologize for supporting a false etymological theory.

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[1] Matthiessen, A., and Foster, G. C., *J. Chem. Soc.*, 358 (1868).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 4

University of London (in the Assembly Hall, Institute of Educa- on, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. E. R. Hamilton: Education in Nigeria".*

Tuesday, June 5

Wright-Fleming Institute of Microbiology (at St. Mary's ospital Medical School, London, W.2), at 5 p.m.—Prof. C. H. tuart-Harris: "Recent Studies in Acute Respiratory Disease"* lmroth Wright Lecture).

Imperial College of Science and Technology (in the Main hemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), t 5.30 p.m.—Prof. Geoffrey Wilkinson. "Inorganic Chemistry—ome Views on the Renaissance" (Inaugural Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at .30 p.m.—Sir Lawrence Bragg, F.R.S.: "Atoms and Molecules". Lecture for Fourth Form Pupils.) (Further Lecture on June 6.)

Wednesday, June 6

Geological Society of London (at Burlington House, Piccadilly, ondon, W.1), at 5 p.m.—Prof. R. M. Shackleton: "Downward-icing Structures of the Highland Border"; Dr. R. J. Firman: Fissure Metasomatism in Volcanic Rocks Adjacent to the Shap ranite".

Thursday, June 7

Royal Society (at Burlington House, Piccadilly, London, W.1), t 4.30 p.m.—Mr. H. Charnock, Mr. J. R. D. Francis and Mr. P. A. heppard: "An Investigation of Wind Structure in the Trades—negada 1953".

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

Chemical Society (at Burlington House, Piccadilly, London, W.1), t 7.30 p.m.—Prof G. T. Seaborg (University of California): "Present tatus of the Transuranium Elements" (Centenary Lecture).

Friday, June 8

British Society for Research on Ageing (at the Ciba Founda-ion, 41 Portland Place, London, W.1), at 4 p.m.—Annual General Meeting. 4.30 p.m.—Mr. K. J. Franklin, Mr. S. B. Carter and Mr. . J. Lindop: "Examples of Reactions to Standard Stimuli at Various ges"; Mr H. B. Fell: "Effect of Vitamin A on Embryonic Epi-ermis of Different Ages".

British Psychological Society, Industrial Section (in the epartment of Psychology, Birkbeck College, Malet Street, London, V.C.1), at 6 p.m.—Symposium on "Psychology and Design".

Royal Institution (at 21 Albemarle Street, London, W.1), at p.m.—Mr. Eric Newton: "The Relationship between Form and ontent in the Arts".

Saturday, June 9

British Psychological Society (in the Gustave Tuck Theatre, niversity College, Gower Street, London, W.C.1), at 2.30 p.m.—rof. G. J. Renier: "No Man's Land: In Defence of the Borderline Vorker".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or efore the dates mentioned:

Lecturer in Engineering—The Registrar, University College, ardiff (June 8).

Lecturer in Mathematics, and a Lecturer in Physics, at Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on olonial Colleges, 1 Woburn Square, London, W.C.1 (June 8).

Assistant Experimental Officer (with a university degree in otany, zoology or microbiology and some training in chemistry) in he Marine Laboratory, Aberdeen, for duties which consist of the aintenance of algae cultures and assistance in research on the physiol-ogy of marine algae—The Establishment Officer, Scottish Home epartment, Room 364, St. Andrew's House, Edinburgh 1 (June 9).

Assistant Experimental Officer (with G.C.E. advanced level in athematics and physics, and an interest in the mathematical treat-ent of data) in the Department of Scientific and Industrial Research, Ditton Laboratory, near Maidstone, Kent, for work on ngineering and physical problems of refrigeration applied to food reservation—The Ministry of Labour and National Service, Tech-ical and Scientific Register (K), 26 King Street, London, S.W.1, uoting C.359/6A (June 9).

Lecturers (Grade II) (2) in the Department of Physics—The egistrar, The University, Birmingham 15 (June 9).

Physicists (2) (one with experience in electronics and the other radiotherapy), to work in a laboratory engaged in experimental nd routine work for the medical staff—The House Governor, King's ollege Hospital, Denmark Hill, London, S.E.5 (June 9).

Laboratory Steward in the Department of Physics at the niversity College of Rhodesia and Nyasaland—The Secretary, Inter-niversity Council for Higher Education Overseas, 29 Woburn Square, ondon, W.C.1 (June 11).

Lecturer and Assistant Lecturer (with special qualification in organic chemistry) in Chemistry—The Registrar, The University Manchester (June 11).

Lecturer in the Department of Mechanical Engineering—The Registrar, The University, Leeds 2 (June 11).

Research Student (with an honours degree in sociology, psychology or anthropology) to undertake research on educational problems in the Centre for the Study of Education—The Registrar, University College of the West Indies, Mona, Jamaica (June 11).

Research Assistant (preferably with an honours degree in botany and specialized in mycology) for work on potato gangrene—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (June 15).

Tutorial Students in Biochemistry, Botany, Civil Engineering, Geology, Mathematics, Physics, Physiology and Zoology—The Registrar, King's College, Strand, London, W.C.2 (June 15).

Assistant Librarian (graduate in pure or applied science and some experience in a scientific or technical library) in the Science and Technology Section of the University Library—The Librarian, The University, Edmund Street, Birmingham (June 16).

Biochemist or Organic Chemist (with either medical qualifications or a suitable chemistry degree) in the Pathology Division of the Pneumoconiosis Research Unit of the Council for Scientific and Industrial Research—The Director, South African Institute for Medical Research, P.O. Box 1038, Johannesburg, South Africa (June 16).

Lecturer in Psychology—The Joint Clerk to the University Court, College Gate, St. Andrews (June 16).

Reader in Applied Thermodynamics in the University and Head of the Department of Mechanical Engineering in Robert Gordon's Technical College—The Secretary, The University, Aberdeen (June 16).

Demonstrator in the School of Chemistry—The Registrar, The University, Leeds 2 (June 18).

Lecturer in Civil Engineering—The Registrar, The University, Sheffield (June 18).

Lecturer in Applied Mathematics—The Secretary, The University, 38 North Bailey, Durham (June 20).

Inorganic Chemist or Fuel Technologist (with a university honours degree in science with inorganic chemistry as a major subject or in fuel technology, and preferably with research experience) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, North Ryde, Sydney, N.S.W., Australia, to undertake research into problems relating to dew-point and deposit-forming phenomena connected with the burning of Australian coals as part of general investigations into the efficient utilization of these coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (June 22).

Demonstrator in the Department of Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (June 23).

Experimental Officer (graduate in botany with an ecological background and experience or special interest in field botany and natural history, or equivalent qualifications) as Assistant to the Regional Officer, East Anglia, based at Norwich, for duties which include assisting with biological surveys and management of nature reserves and other sites, liaison with Naturalists, Local Authorities, landowners and others, with some administrative work concerning general inquiries, conservation problems, issue of permits, etc.—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (June 25).

Assistant Lecturer or Lecturer (with a degree or diploma in horticulture and sound practical experience) in Horticulture, at Canterbury Agricultural College, University of New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 30).

Assistant or Lecturer in Statistics—Joint Clerk to the University Court (University of St. Andrews), Queen's College, Dundee (June 30).

Lecturer in Theoretical Chemistry—The Registrar, University College of North Staffordshire, Keele, Staffs (June 30).

Lecturers (3) in Microbiology—The Registrar, The University, Birmingham 15 (June 30).

Senior Fellow in the Department of Geophysics, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 30).

Assistant Director of Research in Chemical Engineering—The Secretary of the Appointments Committee, Department of Chemical Engineering, Tennis Court Road, Cambridge (July 7).

Chair of Physics in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, and The Registrar, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa (July 15).

Lecturer in Biochemistry; Lecturer in Psychology; Lecturer in Organic Chemistry; and a Lecturer in Physical Chemistry—The Registrar, University of Adelaide, Adelaide, South Australia (July 16).

Senior Professional Officer (with a university degree in science or engineering or equivalent qualification, and a minimum of four years research or industrial experience in refractories or ceramics) for duties which are concerned with the testing and investigation of ceramic materials of South African origin—The Director, Government Metallurgical Laboratory, University of the Witwatersrand, Milner Park, Johannesburg, South Africa (July 31).

Senior and Junior Research Fellows (with a first- or second-class honours degree in an appropriate subject, and able to show evidence of a very high standard of ability in research) at Government Scientific Establishments for research into subjects of importance to H.M. Government—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4567/56 (October 31).

Assistant, Grade A, to teach pure and applied mathematics; and an Assistant, Grade A, to teach physics—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant Lecturer in Physics (Grade B); a Lecturer in Mathematics, and an Assistant Lecturer in Mathematics (Grade B)—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3

Biochemist, to work on meat; and a Chemist and Physicist, to work on fats—The Director of Research, British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey.

Chair of Aircraft Economics and Production—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

Deputy Director (with a good honours degree in metallurgy and prepared to live in the Cambridge area) of Research—Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

Hospital Physicist (Senior grade) in the Department of Radiotherapy, Essex County Hospital, Colchester, for work with X-ray therapy apparatus and radium—The Group Secretary, Hospital Management Committee, 14 Pope's Lane, Colchester, Essex.

Laboratory Assistant (with some skill in glass-blowing)—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Lecturer in Agricultural Chemistry (Animal Nutrition), and a Lecturer (with a degree in science or agriculture) in Agricultural Zoology—The Bursar, Harper Adams Agricultural College, Newport, Salop.

Lecturer (with good academic qualifications and experience in the food industry) in Food Science—The Secretary, Royal Technical College, Glasgow.

Mathematicians (with, or obtaining, a first- or second-class honours degree) at various Ministry of Supply Experimental Establishments, for work in numerous fields of interest, including aerodynamic and structural problems arising in supersonic flight; application of mathematical techniques to control and heat transfer problems of guided missiles; radio propagation; application of high-speed computing techniques to fluid dynamics and solid-mechanics, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.198/6A.

Nuclear Physicist (Group Leader) (with a first-class honours degree in physics and research experience in the study of ionized gases), to lead a team in the field of controlled thermonuclear reactions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 1165/34.

Research Assistant (with qualifications in mathematics, physics or chemistry, and preferably with experience of large-scale computing) in the Department of Inorganic and Structural Chemistry, to be a member of a small group engaged in preparing programmes for, and carrying out, extensive crystallographic and other scientific calculations on electronic digital computers—Prof. E. G. Cox, School of Chemistry, The University, Leeds 2.

Research Scholars and Fellows in the Textile Department—The Principal, Technical College, Bradford 7.

Senior Lecturer in Physics—Northern Polytechnic, Holloway, London, N.7

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 57, Section A, No. 7: Embeddings of Möbius Bands in 3-Dimensional Space. By R. H. Kyle. Pp. 131–136. 1*s*. Vol. 57, Section A, No. 8: Double Scattering of Pseudoscalar Mesons By Alexander H. Barrass. Pp. 137–150. 2*s*. Vol. 57, Section A, No. 9: Note on the Initial-Value Problem for the Wave Equation in *N* Dimensions. By J. R. Pounder and J. L. Synge. Pp. 151–160. 1*s*. 6*d*. Vol. 57, Section A, No. 10: Size, Mobility and Charge of Multiply Charged Ions. By P. J. Noland and T. C. O'Connor. Pp. 161–172. 1*s*. Vol. 57, Section A, No. 11: The Gravitational Displacement of Spectral Lines. By W. H. McCrea. Pp. 173–182. 1*s*. 6*d*. Vol. 57, Section B, No. 12: The Tertiary Volcanic Succession in the Western Part of the Antrim Plateau. By E. M. Patterson. Pp. 155–178+plates 6–8. 3*s*. 6*d*. Vol. 57, Section B, No. 13: Productorthis in Ireland. By Alwyn Williams Pp. 179–184+plate 9. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd., 1955 and 1956.) [203

British Museum (Natural History). Instructions for Collectors No. 11: Fossils, Minerals and Rocks. Pp. 16. (London: British Museum (Natural History), 1956.) 1*s*. [203

University of Leeds. Annual Report of the Librarian, Session 1954–55. Pp. 12. (Leeds: The University, 1955.) [203

Building Research Station Digest. No. 84: (January, 1956): The Fire Resistance of Prestressed Concrete. Chlorinated Rubber Paints. Colliery Shale as Hardcore or Filling. Corrosion and Damage to Lead in Valley Gutters. Pp. 3. 3*d*. No. 85 (February, 1956): Questions and Answers. Pp. 3. 3*d* (London: H.M. Stationery Office, 1956.) [203

A World to Gain. the Story of the International Conference on the Peaceful Uses of Atomic Energy, held at Geneva, 1955. Prepared by the Atomic Sciences Committee of the Association of Scientific Workers. Pp. iv+23. (London: Association of Scientific Workers, and the Labour Research Department, 1956.) 1*s*. 6*d*. [203

Proceedings of the British Society of Animal Production, 1955. Edited by I. L Mason and G. Wiener. Pp. 122. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 15*s*. [203

Register of Research in the Social Sciences in Progress and in Plan, with a Directory of Research Institutions. No. 12, 1955 Pp. v+168. (London: Cambridge University Press, 1956. Published for The National Institute of Economic and Social Research, London.) 25*s*. net. [203

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 665, Vol. 239 (15 March 1956): The Quaternary Deposits at Hoxne, Suffolk. By R. G. West Pp. 265–356+plates 4–6. 34*s*. No. 666, Vol. 239 (15 March 1956): Quantitative Studies on Tissue Transplantation Immunity. 3: Actively Acquired Tolerance. By R. E. Billingham, L. Brent and P. B. Medawar. Pp. 357–414+plates 7–8. 28*s*. (London Royal Society, 1956.) [203

Department of Scientific and Industrial Research. Report for the year 1954–55. Pp. 321. (Cmd. 9690) (London: H.M. Stationery Office, 1956.) 7*s*. 6*d*. net. [223

Future Numbers of University Students: the Desperate Need for Technologists. By Lord Simon of Wythenshawe. (Reprinted from *Universities Quarterly*, February 1956.) Pp. 15. (London: Turnstile Press, Ltd., 1956.) 1*s*. [223

Ministry of Fuel and Power. British Trials in Underground Gasification, 1949–1955. Pp. iv+90. (London: H.M. Stationery Office, 1956.) 8*s*. net. [223

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 957, Vol. 249 (22 March 1956): The Theory of Flame Phenomena with a Chain Reaction. By D. B. Spalding. Pp. 1–25. 8*s*. No. 958, Vol. 249 (22 March 1956): The Forced Flow Due to Heating of a Rotating Liquid. By T. V. Davies. Pp. 27–64. 12*s*. (London: Royal Society, 1956.) [223

Department of Scientific and Industrial Research Bill (H.L.) Pp. ii+4. (London: H.M. Stationery Office, 1956.) 6*d*. net. [233

Ministry of Health. Memorandum on Vaccination Against Smallpox. Pp. 8. (London: H.M. Stationery Office, 1956.) 6*d*. net. [233

Other Countries

Czechoslovak Academy of Sciences: Astronomical Institute. Publication No. 28: The Outline of the Theory of Distribution and Occurrence of Sunspots on the Solar Disc. By Miloslav Kopecky. Pp. 60. (Praha: Czechoslovak Academy of Sciences, Astronomical Institute, 1956.) 203

World Health Organization. Technical Report Series No. 101: Poliomyelitis Vaccination: a Preliminary Review. Pp. 40. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 1 Swiss franc; 1*s*. 9*d*. net.; 0.30 dollars [203

Union of South Africa: Department of Education, Arts and Science. Archaeological Survey. Archaeological Series No 7: The Distribution of Prehistoric Rock Engravings and Paintings in South Africa. By Dr. C. van Riet Lowe. Pp. iii+58 (6 figures and 1 map). (Johannesburg Archaeological Survey, Union Education Department, 1956.) 10*s* [203

A Criticism of the Theory of Relativity. A book review of Møller's "The Theory of Relativity" as viewed by the Rational Theory of Relativity. By F. Harrison Stamper. Pp. 13. (Los Angeles: F. Harrison Stamper, 1956.) [203

Ceylon: Department of Fisheries. Fisheries Research Station. Progress Reports—Biological and Technological. No. 1. Pp. 23. Bulletin No. 3: Commercial Utilization of Dolphins (Porpoises) in Ceylon. By A. W. Lantz and C. Cunasekera. Pp. 14. Administration Report of the Acting Director of Fisheries for 1954. Pp. 30. 90 cents. (Colombo: Government Publications Bureau, 1955.) [203

International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd, 1954. Vol. 10, Part 7: Commission 7 on Radioelectronics. Pp. 140. (Brussels: International Scientific Radio Union, 1956.) 150 Belgian francs; 21*s* 6*d*.; 3 dollars. [203

East Africa High Commission. East African Meteorological Department. Summary of Meteorological Observations for 1954. Part 1: Kenya. Pp. 33. Part 2: Tanganyika. Pp. 31. Part 3: Uganda: Pp. 16. Part 4: Zanzibar. Pp. 4. (Nairobi: East African Meteorological Department, 1955.) [203

New Zealand. National Art Gallery and Dominion Museum. Report of the Board of Trustees for the year ended 31 March 1955. Pp. 19. (Wellington: Government Printer, 1955.) [203

Rhodes University: Department of Ichthyology. Ichthyological Bulletin No. 1: The Parrot Fishes of the Family Callyodontidae of the Western Indian Ocean. By Prof. J. L. B. Smith. Pp. 23+5 plates. (Grahamstown: Department of Ichthyology, Rhodes University, 1956.) 12*s*. 6*d*. [203

United States Department of the Interior. Fish and Wildlife Service. Research Report 40: Survival and Spawning of Gill-Net-Marked Red Salmon. By Philip R. Nelson and Carl E. Abegglen. Pp. ii+19 (3 plates). 20 cents. Research Report 41: Fish and Shellfish Preferences of Household Consumers. By W. H. Stolting, M. J. Garfield and D. R. Alexander. Pp. ii+115. 65 cents. Fishery Bulletin 100: Pink Salmon Tagging Experiments in Icy Strait and Upper Chatham Strait, 1950. By Carl H. Elling and Paul T. Macy. Pp. ii+331–372. 40 cents. Fishery Bulletin 101: Factors Associated with Fluctuations in Abundance of Hudson River Shad. By Gerald B. Talbot. Pp. ii+373–414. 35 cents. Fishery Bulletin 102: Limnological Effects of Fertilizing Bare Lake, Alaska. By Philip R. Nelson and W. T. Edmundson. Pp. ii+415–436. 20 cents. Fishery Bulletin 103. Limnological Study of the Lakes in Convict Creek Basin, Mono County, California. By Norman Reimers, John A. Maciolek and Edwin P. Pister. Pp iii+437–504. 50 cents. Fishery Bulletin 104: The Gas Bladder and Its Relation to the Inner Ear in *Sardinops Caerulea* and *Engaulis Mordax*. By Charles P. O'Connell. Pp. ii+505–534. 25 cents. Circular 33: Control of Small Predators. By Bob L. Burkholder. Pp. 8. 5 cents. Circular 34: Distribution of American Gallinaceous Game Birds. By John W. Aldrich and Allen J. Duvall. Pp. ii+30. 30 cents. (Washington, D.C.: Government Printing Office, 1955.) [203

Berichte des Deutschen Wetterdienstes. Nr. 21 (Band 3): Die flugklimatologischen Verhältnisse deutscher Verkehrflughäfen. Von Hans Guss und Herbert Regula. Pp. 12 mit 24 Abbildungen und 19 Tabellen im Anhang. Nr. 22 (Band 4): Die Meteorologische Tagung in Frankfurt a.M. vom 17. bus 19. Oktober 1955. Pp. 147. (Bad Kissingen: Deutschen Wetterdienstes, 1955 and 1956.) [203

Transactions of the American Philosophical Society. (New Series.) Vol. 45, Part 6: The Lower Palaeolithic Site of Markkleeberg and Other Comparable Localities near Leipzig. By Rudolf Grahmann. Edited by Hallam L. Movius, Jr. Pp. ii+509–688. (Philadelphia American Philosophical Society, 1955.) 2 dollars. [203

Report of the Haffkine Institute for the year 1954. Pp. iii+74. (Bombay: Government Book Depot; London: High Commissioner for India, 1955.) 6 annas; 8*d*. [223

National Research Council, Ottawa. Technical Information Service. T.I.S. Report No. 45 (October 1955): Survey of Continuous Fermentation Processes (An Annotated Bibliography). By Muriel E. Whalley. Pp. 29. T.I.S. Information Notes. No. 21–55: Proper Storage of Coated Abrasives. Pp. 2. (Ottawa: National Research Council, 1955.) [64

New Books

Electromagnetically Enriched Isotopes and Mass Spectrometry

Edited by M. L. Smith, *Atomic Energy Research Establishment, Harwell.*

This volume contains the proceedings of the Conference on Electromagnetically Enriched Isotopes held at Harwell in September 1955. The thirty papers are published in full, together with the ensuing discussions, and fall into three main categories which can broadly be described as follows: First there is illustrated the great range in the scale of the work from the small analytical mass spectrometers, to the large mass separators which provide gramme samples of the isotopes of all the elements for general distribution. Secondly, there are accounts of two approaches to the study of nuclear structure and reactions, one of which involves irradiation of separated isotopes followed by examination of the products, and the other irradiation of a natural element and then direct mass assignment and examination. Finally, several papers review work in a number of fields using enriched isotopes and assess the trends for the future. Price 45s.

Quantitative Methods of Organic Microanalysis

by S. J. Clark, Ph.D., A.R.I.C., *British Nylon Spinners Ltd.*

This book has been written for the practising microanalyst, to provide working details of modern methods of organic microanalysis which have proved reliable in use in both academic and industrial laboratories. Many of the techniques described are comparatively new and represent improvements over the older methods in respect of accuracy and precision, speed or simplicity: others enable determinations to be performed in a routine manner hardly possible ten years ago. Sufficient detail is included in the description of each method to allow the reader to set up and become proficient in its operation.

The determination of all the common elements and groups is described, together with those for which reliable methods have only recently been developed. Price 30s.

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[1]Determination of ribonuclease activity
Brown, Dekker & Todd, *J. Chem. Soc.* 2715 (1952)
Markham & Smith, *Biochem. J.* **52**, 552 (1952)
Richards, *Compt. rend. Lab. Carlsberg, Ser. chim.* **29**, No. 17, 315–21 (1955)

For general reference to cyclic nucleotides and their behaviour with enzymes see
Whitfield, Heppel & Markham, *Biochem. J.* **60**, No. 1, 15–19 (1955)

LECTURES AND COURSES

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

A Course of Six Lectures on "Properties and Industrial Applications of Powdered Materials" will be given by Dr. H. Heywood, M.I.Mech.E., M.I.Chem.E., on June 18, 19, and 20, 1956

Further information may be obtained from the Deputy Registrar, City and Guilds College, Exhibition Road, S.W.7.

UNIVERSITY OF SHEFFIELD

COURSES IN APPLIED MECHANICS

Graduates and others are invited to lectures, tutorial classes and practical work in Electronics, Stress Analysis, Plasticity Metrology, Gears, Servomechanisms, Lubrication, and Vibration Consideration given to individual needs Facilities for research work on specific problems.

Details from: Professor W. A. Tuplin, D.Sc., M.I.Mech E., the University, St. George's Square, Sheffield, 1.

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OFFICIAL APPOINTMENTS

COMMONWEALTH of AUSTRALIA

C.S.I.R.O. DIVISION OF BUILDING RESEARCH

RESEARCH ON PAINTING OF PLASTER SURFACES (APPOINTMENT NO. 390/238)

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a research position at the Division of Building Research, Highett (near Melbourne), Victoria. In co-operation with the Paint Industry the Division is about to undertake an investigation into the problems associated with the painting of plaster surfaces, a matter of considerable importance to the building industry which will involve both basic and applied research The appointee will co-operate with another research officer who will be making a study of the chemical and physical characteristics of fibrous plaster. Contact will be maintained with manufacturers and some field work, requiring interstate travel, will be necessary. Applicants should possess a university honours degree in science, with chemistry as a major subject, and with post-graduate research experience. Experience in paint technology is preferable but not essential. Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer (£A.1,263 to £A.1,888 per annum) or Senior Research Officer (£A.1,998 to £A.2,273 per annum). By arrangement with the successful candidate the appointment would be considered either for an indefinite period or initially on a short term basis of three years First-class sea fares will be paid to Australia for the appointee and for his wife and family At the end of a short term appointment return fares will also be met by the Organization. The appointment is conditional upon a satisfactory medical examination and, for an indefinite appointment the successful applicant will be required to contribute to and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, referring to Appointment No 390/238, and stating full name, date and place of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by the names and addresses of three referees and copies of not more than four, testimonials should reach the undersigned not later than July 7, 1956

W. IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2.

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WEST MIDLANDS DIVISION

Applications are invited for the post of Assistant to the Divisional Chief Scientist in the grade of Senior Scientist (£1,700 to £2,000). Candidates should have good academic qualifications and experience in the organization of work programmes at a large industrial laboratory.

Applications to the Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

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For further information apply to the Meteorology Section, Cavendish Laboratory, Cambridge.

DURHAM COLLEGES IN THE UNIVERSITY OF DURHAM

Applications are invited for a Research Fellowship in Chemistry. The Fellow will be expected to carry out original work on a radiochemical topic in the Londonderry Laboratory for Radiochemistry. The Fellowship will carry an annual salary of £650 to £750, together with the benefits of the F.S.S.U. scheme and family allowances The appointment will begin at a date to be arranged, and will be tenable for two years with the possibility of an extension

Further details may be obtained from the Secretary, 38 North Bailey, Durham, to whom applications (three copies), together with the names of three referees, should be sent by June 16 1956 Candidates from overseas may send one copy only.

DURHAM COLLEGES IN THE UNIVERSITY OF DURHAM

Applications are invited for a Research Studentship in Radiochemistry. This Studentship, of the value of £300 per annum, is tenable for two years in the first instance, with possible renewal for a third year. Candidates should have a good honours degree in chemistry from a British university, but applications from candidates expecting to graduate in 1956 will be considered The successful candidate will be expected to undertake original research leading to a higher degree.

Further details may be obtained from the Secretary, 38 North Bailey, Durham, to whom applications (three copies), together with the names of two referees, should be sent by June 16, 1956.

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF AGRICULTURAL SCIENCES

Applications are invited from honours graduates or from candidates who expect to graduate this summer for the following Demonstratorships (a) Agricultural Botany, preferably with interest in Plant Physiology (b) Microbiology, with interest in Dairying or Soil Microbiology (c) Agricultural Chemistry, with qualifications in Agricultural Chemistry or Chemistry. (d) Agricultural Zoology, with qualifications in Agricultural Zoology or Zoology. Salary scale £350 by £50 to £400

Forms of application and conditions of appointment from Mr. H Pickbourne, Registrar.

BIOCHEMIST, RECENT GRADUATE, REquired for Department of Clinical Research, to assist in research programme relating to certain biochemical aspects of mental illness under direction of senior biochemist. Salary £500 to £600, according to qualifications and experience—Applications, stating qualifications, age, and, in the case of National Servicemen, approximate date of release, should be sent to the Physician Superintendent, Crichton Royal Mental Hospital, Dumfries.

THE RESEARCH INSTITUTE (ANIMAL Virus Diseases), Pirbright, Surrey, invite applications for a post of Research Assistant (female). Applicants should have a degree in chemistry or physics and an interest in the physical chemistry of biological systems. The post is superannuable and the salary in accordance with the Assistant Experimental Officer grade, which is £429 at age 21 rising by ten increments to the maximum of £634 per annum.—Applications, accompanied by the names of three persons to whom reference can be made, should be addressed to the Secretary

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UNIVERSITY OF NOTTINGHA

DEPARTMENT OF ECONOMICS

Applications are invited for the appointn of Research Lecturer or Assistant Lecturer Statistics. Salary scales Lecturer, £650 by to £1,350; Assistant Lecturer, £550 by £50 £650. Superannuation and children's allowan Form of application and conditions of app ment from the undersigned.

H PICKBOURN
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THE BRITISH SOCIETY FOR RESEAR in Agricultural Engineering has vacancies for Assistant Experimental Officers in the Horti tural Engineering Department, one to work heating and ventilating problems, the other cultivation machinery problems. Inter.B. H N C. or equivalent essential, and industrial research experience in engineering or physics sirable. Salary scale £382 at age 20 rising £706, with starting salary limited to £559 at 26.—Application forms from Secretary, N.I.A Wrest Park, Silsoe, Beds.

SENIOR TECHNICAL ASSISTANT quired for development work in Bacteriolo Laboratory. Duties will include supervision routine technical work and training of tech staff. Salary on scale £500 to £700 per annun Apply, by letter, to Professor Todd, Royal T nical College, Glasgow.

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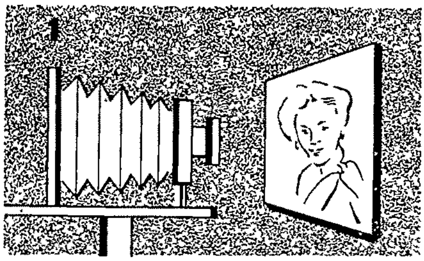

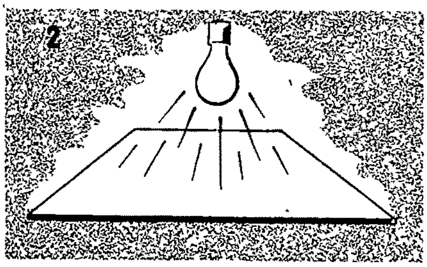

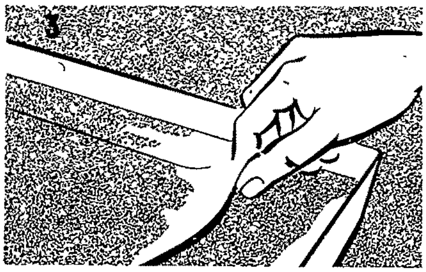

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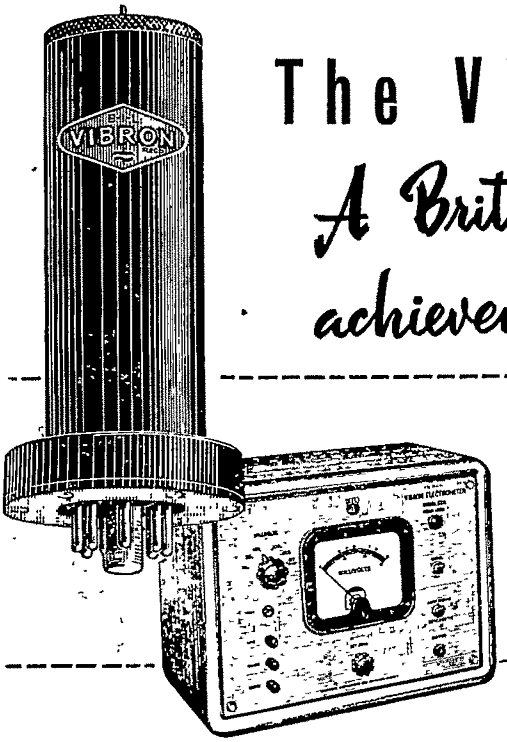

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THE COLONIAL DEVELOPMENT CORPORATION

HE annual report of the Colonial Development Corporation for the year ended December 31, 55*, is cast in the staccato form that has char-erized the report since Lord Reith assumed the irmanship of the Corporation; but this year, for first time, the accounts show a surplus of £409,233 er paying all outgoings, including £307,000 Colonial ice interest.

Ten new projects were initiated by the Colonial velopment Corporation during the year, and, h the completion of the Barton Ramie and rongo investigations, and the appointment of receiver for the Falkland Islands Freezer Co., l., there are sixty-three continuing projects and estigations compared with fifty-six in the previous ar, representing a total capital of £54·8 million. these projects, eighteen, representing £7·5 million, in the Caribbean; seven (£15·4 million) in the r East; thirteen (£13 million) in East Africa; (£6 million) in Central Africa; eleven (£9·86 llion) in the High Commission Territories; and ht (£2·9 million) in West Africa. Functionally, elve projects and 20 per cent of deployed capital December 31, 1955, were in agriculture; six and l per cent in animal products; six and 6·9 per cent factories; one and 0·3 per cent in fisheries; five d 12 per cent in forestry; one and 0·7 per cent in tels; ten and 13 per cent in minerals; seven and ·9 per cent in property and housing; six and ·3 per cent in power; and eight and 4·5 per cent transport and communications.

On direct projects and subsidiary companies, the rporation had a net operating profit of £113,165 ring the year, in spite of the disappearance of ulanga profits of £216,718 in 1954 with the sale the Corporation's controlling influence from nuary 1, 1955. The 'redding-up process' is now tually completed, and the Corporation by and large free to devote its energies to constructive purposes volving normal commercial or calculated risks. ie 'Special Losses' were assessed on December 31, 55, at some £8 million, and it is clear that the vernment must now face the outstanding financial ues involved in dealing with these losses incurred fore the Corporation was built up. The Corporation oposes to disregard this Special Losses Account in justing its policies to meet the requirement of the verseas Resources Development Act that it should y its way taking one year with another, and it w suggests that the whole of this Account—not erely a part—should be accepted as eligible for terest waiver, and that this should be done by nverting the £8 million into equity capital in cordance with the precedence of the International ınk for Reconstruction and Development and the ternational Finance Corporation.

This is not the only way in which the Government uld help to promote a more vigorous policy, nor is it the only point at which there is a clash between the Corporation and the official view. The latter has interpreted the Overseas Resources Development Act so as to make *ultra vires* several projects for housing and road development in Singapore and Malaya, Kenya, Nyasaland, Southern and Northern Rhodesia and West Africa, involving more than £7·5 million; but on legal advice the Corporation has declined to accept the official legal view, and awaits the validating and enabling legislation promised by the Secretary of State. The Corporation in this report also points to the desirability of co-ordinating its funds with Colonial Development and Welfare Funds, suggesting that the Government might meet essential but financially unremunerative projects, leaving the remainder to the Corporation and its partners. Only exceptionally should the Corporation undertake work of great potential benefit but doubtful profitability.

In spite of its staccato phrases, the report is thus a challenge to realistic thinking and planning of such resources as Britain is able to devote to the economic development of the dependent territories of the British Commonwealth. It is the duty of the Colonial Development Corporation to assist such development and with special regard to the interests of the inhabitants of those territories. The Corporation is not, however, responsible for comprehensive planning, or for social services such as health and education. These, the report suggests with reason, are, or should be, financed from Colonial Development and Welfare Funds or other government funds. Similarly, government plans should include such services as power, communications and housing. The Corporation's terms of reference are commercial, and profitability is a decisive factor in the selection of projects and the method of executing them. The Corporation should only be expected to help in the capital development of basic services when no other means of finance is available.

The formulation and acceptance of clearly defined policies on such lines would go far to establish the Corporation on a satisfactory commercial basis; but more important, it would provide the Corporation with the assurance of continuity which it seeks, and the clear definition of fields of work which are as essential for harmonious co-operation as they are for preventing wasted effort and overlapping. As is well emphasized, development in the dependent territories of the British Commonwealth is always a dynamic process in which social conditions and agricultural and industrial techniques are continually changing. The report points out that the tropical territories in which the Corporation mostly operates can scarcely look forward to more favourable economic conditions than in 1955. The Corporation itself benefited from the high prices of rubber and improved prices for hardwoods, but the two copper projects will not start producing until late in the present year. Prices of other Corporation products, such as hemp, rice, hide and bananas, tended to drop, and synthetic substitutes are threatening raw materials traditionally grown in the tropics, among which the Corporation is directly interested in rubber, hemp, tung oil, and, through tanning materials, in leather, though its interest in ramie has ceased. Moreover, the production of foodstuffs in developed countries can be so increased by application of fertilizers and use of mechanical equipment as to undercut producers in less-developed and more remote lands.

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* Colonial Development Corporation. Annual Report and Statement Accounts for Year to 31.12.55. Pp. v+55. (London: H.M. tionery Office, 1956.) 2s. 6d. net.

These are all factors of which the Corporation must take account in attempting to assess the profitability of projects in ten or twenty years time, and in selecting projects accordingly. Increasing association with local people in such projects through smallholding and co-operative schemes will not make decisions easier ; but the Government, by taking the financial decisions suggested above and by delineating more carefully the spheres of responsibility, could undoubtedly help the Corporation, to raise the standard of living in these areas. Even more directly, Government policy could contribute to provide assured markets for the efficient grower of tropical produce ; and the dissolution of the Overseas Food Corporation on March 31, 1955, places even greater responsibility in this connexion on both the Colonial Office and the Tanganyika and other African Governments.

CHEMISTRY AND BIOCHEMISTRY OF FATS

The Lipids

Their Chemistry and Biochemistry. By Prof. Harry J. Deuel, Jr., Vol. 2 : Biochemistry—Digestion, Absorption, Transport and Storage. Pp. xxvi + 919. (New York : Interscience Publishers, Inc. ; London : Interscience Publishers Ltd., 1955.) 25 dollars.

Fat Metabolism

A Symposium on the Clinical and Biochemical Aspects of Fat Utilization in Health and Disease. Edited by Victor A. Najjar. Pp. viii + 185. (Baltimore : Johns Hopkins Press ; London : Oxford University Press, 1954.) 36*s*. net.

The Chemistry of Lipids of Biochemical Significance

By J. A. Lovern. (Methuen's Monographs on Biochemical Subjects.) Pp. xiii + 132. (London : Methuen and Co., Ltd. ; New York : John Wiley and Sons, Inc., 1955.) 8*s*. 6*d*. net.

THE collection of the greater part of the available information in the vast and rapidly developing field of lipid biochemistry and its integration into a readable text are a remarkable achievement. It is not, however, possible to be both comprehensive and critical over such a wide field. The late Prof. H. J. Deuel, jun., in "The Lipids : Their Chemistry and Biochemistry" (Vol. 2), chose the former course. All the main contributions on the digestion, absorption, transport and storage of lipids are recorded in this book. Where differences of opinion exist, the views of each side are clearly and fairly presented. The author was one of the most active contributors to new knowledge in this field, and he had definite views on most of the problems discussed in this work. These are indicated, but are not forcefu imposed ; the reader is left to formulate his o conclusions. This is an excellent book for the m advanced student. It is likely to serve as a standa work in this field for many years.

The symposium on "Fat Metabolism", edited V. A. Najjar, is an entirely different type of wo which consists of a series of short lectures by leadi authorities. There are eleven main contributio These include papers by H. H. Gordon and J. Ma on obesity, and a contribution on the clinical aspe of hyperlipæmia by L. E. Holt. H. C. Meng c scribes the preparation and use of fat emulsions intravenous alimentation, and the role of the lipæn clearing factor in fat transport is considered C. B. Anfinsen. Fatty-acid oxidation and synthes lipogenesis *in vitro* and the role of coenzyme A such reactions form the subject of three communi tions by A. L. Lehninger, S. Gurin and F. Lipmar respectively. Phospholipid synthesis, by A. Ko berg, and cholesterol metabolism in relation atherosclerosis, by R. G. Langdon, complete remarkable collection of papers. Four contributic to discussion are also given. The only other asp that might perhaps have been included with so advantage is the role of the intestine in fat me bolism. This book is an excellent introduction current problems in fat metabolism, especially those interested in the medical aspects. As will expected, each contribution is both authoritati and lucid.

Dr. J. A. Lovern's monograph on the "Chemis of Lipids of Biochemical Significance" is a conc account of the more important background knowled required for biochemical studies in this field. T first chapter is concerned with the structure of lipi a matter that is much under discussion at the prese time. A useful section on separation and analy follows, which reflects the extensive experience t author has had in this field. Having dealt with t study of separated lipids, the forms in which th occur in the tissues, with special reference to lip proteins, and their turnover, are discussed at so length. Finally, a brief chapter on the functions lipids concludes a record of the main features current problems in lipid chemistry that should pro useful to any biochemist.

A. C. FRAZER

POWER AND ENERGY FROM TH WINDS

The Generation of Electricity by Wind Power

By E. W. Golding. (Spon's Electrical Engineeri Series.) Pp. xvi + 318 + 28 plates. (London : and F. N. Spon, Ltd., 1955.) 50*s*. net.

BEFORE the industrial potentialities of nucle fuels began to be clearly realized, the Wi Power Committee of the Electrical Research Assoc tion intensified its study of the winds as a supp mentary source of synchronous electric power. all-important impelling factor was the scarcity coal for the generation of electricity ; but importar was attached to an experiment made in the Unit States in which a 1,200-kW. wind-driven generat had been operated successfully in parallel with major electricity supply system. The Americ wind turbine had indeed failed mechanically after w hundred hours of operation; but it had shown at there is no physically insurmountable obstacle the way of developing wind-driven generators of latively large capacity.

Denmark, France, Germany, Italy and the U.S.S.R. ave also done work of great interest in assessing e energy-producing prospects of wind-power and constructing and devising wind-driven generators. ast experience was carefully reviewed. The fact at some ten thousand corn-grinding mills had been erforming a valuable function in Great Britain prior the development of the steam engine was, and is, gnificant. It was estimated that there are several undred sites in Britain which might be used for stablishing wind-driven electric generators of capa-ities of the order of 1,000 kW. each.

The author of this book, Mr. E. W. Golding, was harged with the tasks of examining the problems f measuring and harnessing the power and energy f the winds at suitable sites. He and his staff roceeded to their work with due expedition and great nthusiasm. Precise and convenient means of easuring wind velocities over the wide range ncountered in practice were developed and applied t a sufficient number of sites to obtain the data equired by aerodynamic experts, the potential uilders of efficient wind turbines.

It so happened that the development of heli-opters, on one hand, and of jet aircraft, on the other, roused the interest of propeller designers in the wind heel, which promised to provide a new outlet for heir factories. As a result, John Brown and Co., td., produced a 100-kW. machine for the North of cotland Hydro-electric Board which is installed on osta Head, Orkney, while the Enfield Cable Co. roduced through De Havilland (Propellers), Ltd., n Andreau machine of the same kilowatt rating or the British Electricity Authority. The latter achine is still on a temporary site near St. Albans. hese two experimental installations cover almost he extreme range of types of wind wheel, electrical enerating plant and wind speed conditions. At osta Head, wind speeds approaching 100 m.p.h. are requently encountered and it is exceptional to have eriods approaching dead calm, whereas at St. lbans wind speeds seldom reach even 30 m.p.h.

No account of the performance of these plants as yet been published; but it is now doubtless ossible for the responsible parties to assess, more ealistically than ever before, what power and energy an be obtained from comparatively large wind-driven lectric generators. The work put into these two xperiments has been of the highest class in all espects. The firm of John Brown has experienced lmost every practical difficulty which can be ncountered, and the major burden has been borne y two resolute and competent men, as a supplement o their everyday occupations. They could give an pic account of their problems, which far surpass in ifficulty those of the earlier lighthouse pioneers.

Golding's book is interesting, informative and arnest. The author has deservedly gained a leading lace among the few who continue to maintain an ctive interest in wind-power. He provides excellent eferences to relevant literature from all countries. e does full justice to most of the foreign achieve-ents; but he might have made more effective use f the highly objective studies of Electricité de rance. He likewise appears to have overlooked he numerous wind machines in service on the coast f Portugal, near Lisbon. There one can see installations ranging from the original Don Quixote type to the most modern propeller types, indications of the suitability of the wind regime, on one hand, and of the local cost of electricity, on the other. Table 32 would have been far more valuable had he included the weights of materials of construction of the machine. I must, however, abstain from emulating Goethe's "Rezensent', and I therefore commend the book as being a most valuable and up-to-date source of reference.

In conclusion, I suggest that the attempt to produce large amounts of synchronous electrical power and energy from the winds is less realistic in present circumstances than a Belgian proposal to use medium- or small-power plants to generate energy partly in electrical form and partly as hot water not necessarily electrically heated. There are many farms and isolated communities which could be rendered more economic and habitable given these amenities. Production of machines of this class might be more generally useful than the procedure hitherto followed.

C. W. MARSHALL

PRINCIPLES AND APPLICATIONS OF PHYSICS

Principles and Applications of Physics

By Dr. Otto Blüh, in collaboration with Joseph Denison Elder. Pp. xiv+866. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 45*s*. net.

BOTH in its aim, which is wider, and in its presentation of the subject, which seems more appropriate for reflexion and consolidation than for a serial course, this book differs from the conventional physics text-book. The standard is such that most of it could be understood by sixth-form boys, and it would be useful to students in the early stages of a university course in physics. The authors survey the subject as a whole, tracing the developments of the concepts of modern physics, and the interaction of new discoveries and scientific thought at different periods. This treatment should make it acceptable also to non-specialists and students of the humanities who (given some initial elementary grounding) seek a sound interpretation of physics; such readers, whom the authors have borne in mind, will find it both intelligible and in sympathy with their own outlook

The book is divided into ten parts. Part 1, on the methods of physics, contains some introductory mathematics. Parts 2–6 deal with mechanics, energy, fields of force, oscillations and waves, and thermodynamics. Each part groups together phenomena linked by a common principle—heat, electrical energy, and radiation as forms of energy, gravitation, electrostatics, and electromagnetism as fields of force, optics and acoustics with other examples of wave motion. The authors call this a phenomenological and mathematical approach, in which formal analogies are used. They are probably right; and it is certainly done well.

Parts 7–9, on the kinetic theory, particles, and atomic and nuclear physics, offer less scope for originality of treatment, and indeed by this time the really difficult part of the work is over. In its more recent developments physics deals either with particles that are easily pictured, or with symbols that are beyond any visualization; the apparently simple concepts of macroscopic physics are the elusive ones. Who can doubt, for example, that the picture shown of stationary waves around Bohr orbits was really in people's minds in the early days of wave-mechanics ? Or that this, in itself, is a much easier idea to understand than, say, the principle of virtual work, or even that notorious source of misunderstanding when it was first discovered, Ohm's law ? In directing attention to the quite different kind of mental effort needed to master the early fundamentals, the authors have really implicitly diagnosed the fault that hinders the progress of so many students, a feeling that physics began with the twentieth century. Needless to say, the rigours of modern physics are themselves explained here very clearly.

The title might almost suggest a bias towards applied physics, but in fact only representative applications are explained at all fully. These include the circulation of the blood, thermionic valves and radio circuits, frequency modulation, three-phase power supplies, the implications of recent red-shift observations with the 200-in. reflector, and many uses of radioisotopes. The numerous brief allusions to well-known applications are relevant. Most teachers, incidentally, would treat thermometry and electrolysis rather differently nowadays.

Part 10, on the scope and importance of the physical sciences, is rather more difficult to assess. I can only say that, if I had read a book of this kind as a student, I should have realized then that philosophy is something more than the extrapolation of a classical education ; and that, oddly enough, the term 'natural philosophy' means what it states. Among many issues discussed are the status of the term 'law' in the exact sciences, the fallibility of scientific method when taken beyond its proper province, and the general education of both the scientist and the non-scientist. It has been said that the way to broaden the general education of the physicist is by encouraging a thorough understanding of his subject, and its impact on people's minds and affairs. From this point of view the later chapters of the book are particularly valuable.

G. R. Noakes

LUMINESCENCE OF BIOLOGICAL SYSTEMS

The Luminescence of Biological Systems

Edited by Frank H. Johnson. (Proceedings of the Conference on Luminescence March 28–April 2, 1954, sponsored by the Committee on Photobiology of the National Academy of Sciences—National Research Council, and supported by the National Science Foundation.) Pp. xiv+452. (Washington, D.C.: American Association for the Advancement of Science, 1955.) 7 dollars.

The production of light by many living organisms is a very striking characteristic and has been recognized since the earliest times. Pliny observed the glowing of rotting wood, Aristotle had an account of the light emitted by putrefying fish, and Boyle in 1667 examined the luminescence of stored meat. The early papers of Paul Panceri in 1873 on *Pyrosoma*, *Pholas* and *Phyllirhoë* are classics.

This book is an account of the proceedings of the conference on luminescence, held at Asilomar, Pacific Grove, Calif., during March 28–April 2, 1954, and the papers and the main discussion of each are given verbatim. The first paper, a survey of luminous organisms. is by Prof. Newton Harvey, a pioneer i this field and celebrated for his classic and extensiv investigations into the subject of luminescenc This is a very lucid account of the state of the existin knowledge of the problem, with stimulating suggestions for further work. Methods are described wit a wealth of detail. Drs. R. S. Becker and M. Kash follow with a discussion of luminescence spectroscop involving the role of chlorophyll, and the electron state of this pigment which is concerned with th first reaction in the utilization of energy by the pigment system. The luminescence properties of porphyrin molecules are being studied by these worker with special reference to the chlorophylls, and th singlet-triplet split in molecules is considered.

Perhaps the most interesting and informativ chapter, at any rate for porphyrin workers, is that c C. Stacy French on fluorescence spectrophotometr He describes apparatus in detail, and follows up wit a most useful account of the absorption and fluorescence spectra of the chlorophylls and their derivative data which are not readily accessible in the literatur Wilhelmsen *et al.* have a paper on chemiluminescenc kinetics of the 2 : 3 dihydrophthalazine 1 : 4 dione and a mechanism for the reaction is proposed, base on the ionization, in basic solution, of the enol form shifting the equilibrium in their favour. Oxidatio of the ionized portion would then involve loss of th charge, and reaction with more oxygen would lea eventually to a molecule which, when excreted would emit light.

Two deeply interesting chapters are those dealin with the chemistry of *Cypridina* luciferin by Drs Tsuji, Chase and Harvey, and the biochemistry o firefly luminescence by Drs. McElroy and Hastings The first contains much detail regarding the preparation and purification of luciferin (chromatograph and electrophoresis) and a study of degradatio products. The second describes purification method for luciferin and luciferase from *Photinus pyralis*, an gives some properties of the luminescent system including the possible role of adenosine triphosphate The biochemistry of bacterial luminescence is ver fully discussed by Dr. Strehler, with some pointer as to the mechanism involved, which seems to includ the participation of reduced flavin mononucleotide Intracellular luminescence is introduced by Dr. Fran Johnson, the editor, and includes a study of th kinetics of bacterial luminescence *in vitro*.

From the biochemical mechanisms of luminescence the reader moves to the physiological control o luminescence, the subject of Dr. Nicol's paper which is further discussed and extended by Dr. Buck Dr. Nicol's main concern is with neurocontrol there are two effector systems, muscles and photocytes, which depend on one conductor system Oxygenation may be a limiting factor. The surve of luminous organisms of the Far East, by Dr Haneda, is a fascinating and most useful contribution it contains several very fine photographs. The symposium ends with two short papers, one on marine dinoflagellates by Dr. Ryther, and one by Drs. Haxo an Sweeney on bioluminescence in *Gonyaulax polyedra*.

The sequence of the contributions could be criticized ; for example, the papers on control of luminescence would have been more logically placed afte the papers on firefly luminescence, and the very fin survey of Haneda after the introduction by Harvey The paper is good, the print clear and the photograph have been reproduced well. There is a good index

G. Y. Kennedy

Proceedings of the International Conference of Theoretical Physics, Kyoto and Tokyo, September 1953

Held under the auspices of The International Union of Pure and Applied Physics. Organized by The Science Council of Japan, with the collaboration of Kyoto University and The Physical Society of Japan. Supported by U.N.E.S.C.O. and The Rockefeller Foundation. Pp. xxviii + 942. (Tokyo: Science Council of Japan, 1954.) n.p.

THE 1953 conference on theoretical physics in Japan was remarkable for a number of reasons: the wide range of topics treated by the eighty-four distinguished foreign visitors and the local participants; the fact that this was the first purely scientific international conference ever held in Japan; the hospitality bestowed on the fortunate guests; and the magnificence of this volume recording the proceedings. It all does full justice to the devotion accorded to theoretical physics in Japan, and the high achievement in the subject there.

The conference was concerned principally with the two broad domains of field theory and solid-state physics. In the former (Part 1 of the report), there was much deliberation on the various technical difficulties of non-local theory, intermediate and strong coupling theory, nuclear forces, etc. Part 2 is a shorter section on nuclear physics, mainly the shell model. The remaining, major portion of the volume comprises Part 3 on statistical mechanics, Part 4 on molecules and solids, and Part 5 on liquid helium and superconductivity.

Nearly as much space is devoted to discussions as to the actual papers, giving a picture of a lively and informal conference. Survey talks are an important feature, and altogether the book offers a valuable insight into the state of theoretical physics at the time, and the thoughts occupying the leading workers. However, this amounts largely to journalism, though on the grand scale, and already much water has flowed under the bridges of theoretical physics since the conference.

Yearbook of the United Nations, 1954

Pp. xii + 656. (New York: United Nations; London: H.M. Stationery Office, 1955.) 10.50 dollars; 70*s*.

AS a reference work the value of this "Yearbook" appears to reside in the appendixes—which set forth the structure of the United Nations, the matters considered by the Principal Organs during 1954, the delegations to the General Assembly and the Councils, and the information centres and regional information centres—and in the documentary notes with which the several chapters are provided. These chapters themselves, however, although designed to facilitate the understanding of the work of the United Nations during the past year, appear to have rather a limited value except in official circles.

While the size and price of such an admirably printed and produced book restricts its general use, the chapters dealing with topics of interest to the scientist, such as the economic development of under-developed areas or the work of the United Nations Educational, Scientific and Cultural Organization or other specialized agencies, are not sufficiently detailed to preclude reference to the reports of various committees or other bodies. Something much more condensed might be of great value; even if there were discarded the material which gives a certain lack of realism to the treatment of questions regarding non-self-governing territories and the trusteeship system, some doubts may still be entertained as to the practicability of dealing readably in one volume with all the varied activities of the United Nations Organization.

Dictionary of Magic

By Harry E. Wedeck. (Midcentury Reference Library.) Pp. viii + 105. (New York: Philosophical Library, 1956.) 3 dollars.

THIS little book is a convenient compilation of names, terms and expressions used in magic and occultism generally, although it would have been improved had the author made a rather better selection of his material and arranged it somewhat differently. The subject is so vast that all that could be expected in a book of this size is a very brief and condensed list, which, for the general reader, is likely to prove of some use since it is unlikely that he would have by him the larger works by such authors as Collin de Plancy, Spence, Verneuil or even the shorter glossary by Ernest Bosc.

Although the author has managed to include some entries not easily found elsewhere, he has done so at the expense of omitting more important items, and it is sometimes difficult to see on what basis the selection has been made. Moreover, persons are listed under their first names; and such entries as "Last witch", "New", or "Plato", who is said to have censured sorcerers that were hired to practise incantations, seem of doubtful utility. A little more care would have avoided these faults and also minor errors such as the spelling of "Bavan" for "Bavent" and the confusion between the two Moras, which is more excusable since this confusion was made both by Summers and, following him, by Prof. E. M. Butler in her valuable study of ritual magic.

E. J. DINGWALL

Variational Principles in Dynamics and Quantum Theory

By Dr. Wolfgang Yourgrau and Stanley Madelstam. Pp. ix + 155. (London: Sir Isaac Pitman and Sons, Ltd., 1955.) 25*s*. net.

THE central importance of 'action' principles in modern theoretical physics fully justifies the authors in their attempt to provide a historical and critical exposition. Early chapters discuss the contributions of Fermat and Maupertuis; Dr. Akakia is not mentioned explicitly, but the authors appear to imply that König knew that the famous Leibniz letter was spurious—Is this quite certain? Then there is a technical section, dealing with the definitive work of Euler, Lagrange and Hamilton, and its applications to electrodynamics and quantum theory. Finally, a chapter on the philosophical aspects of action principles tries to maintain a balanced position, but inclines on the whole to the side of Planck rather than of Mach.

Thus two books have been cramped into a hundred and fifty pages, and on the whole it is the technical side which has suffered; for example, the extraordinary prescience of Hamilton's views is not adequately emphasized, and some technical ideas are brought in hurriedly and without due preparation, such as the relativistic interpretation of the modified Lagrangian function. Nevertheless, the mingling of historical and technical development is stimulating, and should assist the reader to a thorough realization of the immense value of the concept of action variation.

BRITISH ASSOCIATION MEETING IN SHEFFIELD

DURING August 29–September 5 this year, the British Association will hold its annual meeting in Sheffield. Sheffield has many advantages as a place of meeting for the British Association. One of the major centres of industry, exceedingly busy and dependent in almost every branch on the continuous application of scientific discovery, a visit provides a fine stimulus to any scientist; but, unlike most industrial centres, Sheffield is a surprisingly pleasant city, especially on its west and south sides, and it is set in surroundings of great natural beauty immediately accessible by bus or even on foot. Full advantage of these is being taken in the arrangements for the meeting. It is perhaps singularly appropriate that Sheffield should be chosen for the meeting this year, for a century ago, at the Cheltenham meeting in 1856, Bessemer made the first public announcement of his revolutionary steel-making process, for which shortly after he set up his own works in Sheffield.

The accommodation for the meeting will be divided between two centres. In the middle of the city, within easy reach of the railway stations and served by public transport from every district, will be the Reception Room (the Central Technical School—in the former Firth College). Within a few yards of this are the City Hall, where the large general meetings will be held, and the Cutlers' Hall, which will provide a convenient social centre. The section meetings will all be held in the University area, mostly in the University buildings. These are within easy walking distance of the Reception Centre; but, for the meeting, special buses for members will circulate between the Reception Centre and the section rooms, in addition to the regular public transport.

The inaugural meeting on the evening of Wednesday, August 29, will, as on a number of such occasions, be preceded by a short degree congregation, when the chancellor of the University, the Earl of Halifax, will confer honorary doctorates on Sir Raymond Priestley, president of the Association, and on Sir George Thomson and Sir Charles Goodeve, the presidents of Sections A and B, respectively. The president's address will be on "Twentieth Century Man against Antarctica", a subject most apposite and topical in view of the attention which is focused this year on the further exploration of the Antarctic by several important expeditions. Sir Raymond Priestley can speak with authority on this, because not only did he accompany both Shackleton and Scott to the Antarctic, but also he is still intimately associated with Antarctic exploration and development.

The two evening discourses will be on "The Growth of Biochemistry", by Prof. F. G. Young (August 31), and "The International Geophysical Year", by Prof. Sydney Chapman, chairman of the International Committee organizing the International Geophysical Year (September 3)—another subject of great topical interest.

It is, however, a prime object of the Association "to bring the objects of science more before the public eye". Many citizens who may be hesitant immediately to become members may yet wish to know more of what science means and to see at close quarters some of its leading figures. With them in mind, two further illustrated evening lectures have been arranged, freely open to the public, on "Antarctic Adventure", by Sir Raymond Priestley (August 30), and "The Future Development of Atomic Energy", by Sir John Cockcroft (September 4).

All these meetings will be held in the Main (Oval) Hall of the City Hall, which, seating 2,700, should accommodate the audiences in comfort.

But the heart of the gathering is in the meetings of the sections, and here will be encountered the richness and variety that have so long characterized the British Association. To summarize the very varied subjects that will be dealt with in presidential addresses and sectional communications would need a separate article. Here it may suffice to say that, while most aspects of scientific endeavour seem to be included, there will be, as is appropriate in a major centre of industry, a slight but appreciable emphasis on matters of industrial and technological importance, an emphasis reflected even in the proceedings of Section H, the general theme of which is to be "The Primitive Technology of Glass and Metals".

As in previous years, there will be an official service in Sheffield Cathedral on the Sunday morning, and other churches will hold special services. For the Sunday evening, the Local Committee has arranged for members a concert in the City Hall by the Hallé Orchestra and the Sheffield Philharmonic Choir, under Sir John Barbirolli and Mr. Herman Lindars.

A number of exhibitions have been arranged for the meeting, including one of polar rations, one of scientific glassware, and special displays at the City Museum and at the Graves Art Gallery, where there will also be a demonstration of the processes of picture restoration on an 'open evening'. It is hoped to arrange a display in honour of the Bessemer centenary, and, following the excellent lead given at Bristol, there will be an exhibition of "Science in Schools", organized by Mr. Stanley Moffett, director of education for Sheffield, and science masters and mistresses throughout the region. It is hoped to make this exhibition a fully 'live' show with most of the demonstrations and experiments actually working. A completely new departure will be a special exhibition of books *about* science arranged by the National Book League and staged in the Central Library. The professional scientist can generally find and assess the worth of technical books in his own field; but it is seldom that he can tell a lay friend where to find a book that explains the essentials in simple language—and outside his own field he is often quite lost. Here should be at least one answer to a difficult question, for which a great many members, scientists and laymen alike, may well be grateful. The regular showings of scientific films, begun in Bristol, will be continued in Sheffield in the convenient and well-equipped Library Theatre. Visitors to Sheffield will also be invited to inspect, in the same building, the Commercial and Technical Section of the Public Library, which provides a very important service for industry, commerce and the student.

The problem of housing the large number of members expected has been carefully studied. In particular, the whole accommodation of the University halls of residence and of the training colleges throughout the area has been reserved. Several of these are very recently built and are fine examples of collegiate architecture. Some are in former great houses, such as Wentworth Woodhouse, magnificently situated and of great historic interest as well as substantial comfort. Special bus services, free to residents, will run at appropriate times between the more distant of these and the meeting centres. Members wishing to stay in hotels should make early bookings. Arrangements have also been completed for ample private accommodation for those preferring it.

The main catering centre will be the lower floor of the City Hall; here a large restaurant with both cafeteria and waitress service will enable members to take lunch and other meals close to the Reception Centre and to the main bus station for excursions. Light refreshments will be available also in the University Union, there will be coffee points near all section rooms, and a mobile canteen on the Association's bus station will supply packed meals on demand.

Some 140 general and sectional excursions have been planned, and a member who so wishes will have little difficulty in getting, within the week, a general idea of the heavy and light industries of the area and in appreciating the glorious countryside in which they are set. A special bus station, within easy reach of the University and Reception Centre, will be brought into use solely for the Association, and nearly every excursion will start and end there.

Under the title of "Sheffield and its Region", an extensively illustrated scientific survey of some 330 pages by twenty-seven contributors under the editorship of Prof. D. L. Linton will be presented to members attending the meeting. In three parts, the first gives an account of what may be termed the natural history, pre-history and history of the region; the second treats of "The City of Sheffield" and deals with aspects of its economic development, with the growth of its social institutions, with its contributions to art and science, and with its present characteristics and plans for the future. The third part, under the heading "The Region Today", deals with some of the industries by which the inhabitants of the region gain their livelihood and with the towns, outside Sheffield, in which they live.

The community of Sheffield looks forward eagerly to receiving its distinguished visitors, who are assured of a cordial welcome. This will be the third time that the Association has met in Sheffield. The first was in 1879, with Henry Clifton Sorby as one of the local secretaries, when Crookes demonstrated many of the properties of cathode rays. That year was an important one in Sheffield, for a few weeks after the members of the Association had dispersed, Prince Leopold, youngest son of Queen Victoria, opened Mark Firth's foundation, Firth College, from which the University has grown. The second occasion was in 1910. The depression in the Sheffield industries during the inter-war years probably accounts for the long interval between the second and the present meetings. The Local Committee now hopes that, in a city and region so devoted to the applications of science, there may be a large enrolment of local members, and trusts that the occasion may prove memorable both in Sheffield and to all those who visit it.

LEWIS EVANS (1700–56): A SCIENTIST IN COLONIAL AMERICA

By Prof. GEORGE W. WHITE
Department of Geology, University of Illinois

LEWIS EVANS, who died two hundred years ago on June 11, earned his living as a professional engineer and cartographer; he was a geographer and natural scientist as well. He was born in 1700 at Llangwnadl, near Pwlheli, Carnarvonshire, Wales[1]. It is not known how and when he came to Colonial America; but in 1736 he was a surveyor and mapmaker in Philadelphia. He had associations with Benjamin Franklin, purchased books from him, and probably did some drafting and engraving for him. He travelled extensively with John Bartram, Botanist to the King; gave much information to Peter Kalm, the Swedish scientific traveller; and provided geographical and other service to Governor Thomas Pownall. These men and others of the time quote Evans's scientific opinions in their writings approvingly and at some length.

Evans made valuable observations on plants, animals, and meteorology, and in other fields of science. His knowledge of astronomy and physics ('natural philosophy'), including electricity, was such that he gave series of lectures on these subjects in 1751 in Philadelphia, Newark and New York. Thirteen lectures made up the series in New York. His maps of the middle-Atlantic Colonies went through more than twenty editions, although most of them were printed without credit to Evans. His topographical descriptions formed the physiographical groundwork for American geographical description (again usually without credit) for more than fifty years. His most important scientific contributions were his penetrating geological observations about eastern North America and the respectable theories, some of them far in advance of his time, that he based on them[2].

Evans travelled extensively through the middle Atlantic Colonies across the Coastal Plain, Piedmont, the folded Appalachian Mountains, and made at least one journey across the Appalachian Plateau to Lake Ontario. These observations were the basis of his maps of 1749 and 1752[3] of Pennsylvania and of his famous map of the Middle Atlantic Colonies of 1755[4]. In his journal[5] of a trip in 1743 to Lake Ontario (published by Governor Thomas Pownall in 1776), Evans noted the fossils in the Palæozoic rocks and understood their marine origin. He recognized that the present Appalachian ridges with their even skyline were erosional remnants and that the sediment derived from the erosion now forms the Coastal Plain. He says[6] the mountains " . . . were formerly but one large Plain, inclining with a considerable Slant towards the Sea; that this has been worn into its present Appearance of Ridges, with Vales between them, by the Rains of the Heavens and Waters of the Earth washing away the Soil from the upper Parts, and carrying it down to Seawards. That the Soil thus carried down and lodged in various Places hath in a Series of Ages formed the lower Plains of the Jerseys, Pennsylvania, Maryland, Virginia, and the Carolinas".

Near Lake Ontario Evans saw the raised beaches of the Pleistocene Great Lakes and correctly interpreted them as marking once higher water-levels. He further recorded at some length in his journal his opinion that the lakes had been partly drained, causing what is now called 'isostatic rebound'[7]: "This Part of America, disburthened of such a Load of Waters, would of course rise, as the immediate Effect of the shifting of the Center of Gravity in the Globe at once or by Degrees, much or little".

In his maps of 1749 and 1752 Evans recorded geological notes and filled in one extensive blank part with a lengthy description of the "Endless [Appalachian] Mountains". In his map of 1755 he could find no space for geological notes and published them separately in a booklet of 36 pages, "An Analysis of a General Map of the Middle British Colonies . . .", in which he gave a clear statement of the physiographical and geological provinces of what is now the eastern part of the United States, including New England. His classification (but not his terminology) of the separate physiographical provinces is that still in use. He expressed his regret that the map had no room for sections in several directions to show not only the hills and valleys on the upper surface, but also[8]: " . . . on the lower, the Nature of the Soil, Substrata and particular Fossils may be exprest. It was with Regret I was obliged to omit it. But in some future Maps of Separate Colonies, I hope to be furnished with more Room".

Evans had a keen realization of geopolitical realities—too insistently expressed for his own personal good and for his scientific future. He knew the richness of the country west of the mountains and the necessity of firmly attaching this heartland to the eastern provinces. This country he called the "Ohio country" and said is "The Flower of the whole Globe" and "the finest Country on Earth"[9]. He expressed most emphatically and pungently his opinion that the Colonial authorities were misguided, careless, stupid, and possibly even treasonable in allowing the French to penetrate from Canada into the territory west of the mountains and south of the Great Lakes—the territory now known as the "Middle West". Evans was sure any intelligent Briton could see that this land must be reserved for English settlement. This forthright, correct, but somewhat intemperate criticism of authority was poorly received; charges were preferred and he was jailed in New York in the spring of 1756. Evans, suffering from a "lingering indisposition", was released on June 8, on "his Majesty's Writt of Habeus Corpus", but died three days later on June 11.

It is tempting to speculate that had Evans lived a few more years, and devoted himself to cartography and science, maps of separate colonies would have been produced accompanied by geological sections and probably by further geological descriptions. He might have taken additional part in the developing studies of electricity and possibly in other phases of natural science. What he had already done ensures him a place in the history of science in Colonial America.

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[1] Biographical information will be found in Stevens, H. N., "Lewis Evans, his Map of the Middle British Colonies . . ." (H. Stevens, Son and Stiles, London, 1905, 1920, 1924). Wroth, L. C., "An American Bookshelf 1755" (University of Pennsylvania Press, 1934). Gipson, L. H., "Lewis Evans" (Historical Society of Philadelphia, 1939).

[2] White, G. W., "Lewis Evans' Contributions to Early American Geology, 1743–1755", *Trans. Ill. Acad. Sci.*, **44**, 152 (1951).

[3] Evans, Lewis, "A Map of Pennsylvania, New Jersey, New York . . ." (Philadelphia, 1749, 1752).

[4] Evans, Lewis, "A General Map of the Middle British Colonies . . ." (B. Franklin and D. Hall, Philadelphia, 1755).

[5] Pownall, Thomas, "A Topographical Description of Such Parts of North America as are Contained in the (Annexed) Map of the Middle British Colonies in North America" (J. Almon, London, 1776)

[6] *Ibid.*, p. 29.

[7] White, G. W., "Lewis Evans' Early American Notice of Isostasy", *Science*, **114**, 302 (1951).

[8] Evans, Lewis, "An Analysis of a General Map of the Middle British Colonies . . ." (B. Franklin and D. Hall, Philadelphia, 1755); also facsimile reprint in Gipson, *op. cit.*, p. iv.

[9] *Ibid.*, pp. 28–38.

THE IVEAGH GEOLOGICAL LABORATORY, TRINITY COLLEGE, DUBLIN

By Prof. W. D. GILL

The reconstructed Iveagh Geological Laboratory at Trinity College, Dublin, was formally reopened on May 10 by the Chancellor of the University of Dublin, the Right Hon. the Earl of Iveagh, K.G., before a company of Fellows and staff of the College, and guests including many distinguished geologists from universities, the Civil Service and industry in Ireland and Britain. Before the reopening ceremony, the Chancellor had conferred the degree of Sc.D. (*honoris causa*) on Sir Harold Jeffreys (Cambridge), Prof. P. H. Kuenen (Gröningen) and Prof. H. H. Read (London).

The Chancellor recalled the deep impression made on him as a young man by Prof. John Joly. It was through his father's friendship with Joly, and his admiration for his work, that the association of the School of Geology and the Iveagh family had sprung. The abiding record of this friendship is an endowment of £10,000 to assist the work of this School.

The Iveagh Geological Laboratory is housed in the Museum Building, built under the influence of the principles of Ruskin between 1853 and 1857 to accommodate the Schools of Engineering and Geology. The building is certainly important and interesting, though perhaps controversial from the architectural and æsthetic points of view. The great columns of Irish marbles, including particularly fine samples of serpentine marble from Connemara, which support the arches of the Byzantine interior, are very impressive. Both engineering and geology were provided with very large museums, occupying the full 90 ft. of the width of the building at either end. These rooms covered 3,150 sq. ft. of floor space and were some 30 ft. high. The provision of teaching and research facilities was, however, on a greatly disproportionate scale, and could not be much improved. The main reconstruction has been the building of an upper floor in the old Geology Museum. A museum of type, figured, and reference collections now occupies 1,250 sq. ft. of the upper floor, the remainder being taken up by a mapping and photogrammetrical laboratory, a library and a research laboratory. Various oil companies and their associates have contributed generously towards the provision of photogrammetrical equipment, which is used both by geologists and geographers, and their generosity is recorded on a plaque on the wall of the photogrammetrical laboratory.

The floor of the former museum contains the main teaching laboratories and staff rooms. The three laboratories (elementary 956 sq. ft., palæontology 660 sq. ft., and petrology 550 sq. ft.) are dual-purpose rooms, permitting the fullest integration of lectures with practical demonstrations.

From the old accommodation at the level of the main hall of the building is retained a block of rooms, including the photographic room, preparation room and a laboratory for the research unit engaged under the direction of Mr. G. F. Mitchell, in Quaternary studies.

To offset the loss of display space in the new museum, the entrance hall has been furnished with wall cases, which display selections from the fine mineral and fossil collections, together with 'teaching gallery' exhibits intended to present various aspects of geology to the students of many departments who come to lectures in other parts of the building. On either side of the entrance hall stand skeletons of *Cervus giganteus*, perhaps the most famous of Irish fossil animals.

To the staff of the School of Geology has fallen the onerous task of removing, storing and replacing the museum collections. It was rewarding, however, to discover during this work the history of the School, and to see the stamp of those who made it. It is clear that the chair of geology was created in conjunction with the establishment of the School of Engineering in 1841; John Phillips was the first professor, followed after two years by Thomas Oldham. Although Oldham's main career lay in India, he forged a link between Irish and Indian geology which was to last until the end of the century. Ball, Meddlicott and Wynne are names common to the books of Trinity College and to the pioneering surveys of the Geological Survey of India. Meddlicott was prizeman in chemistry and geology in 1850. Oldham sent many specimens of minerals, rocks and fossils (including the Siwalik mammals) from India to enrich the collections. Oldham was followed by Samuel Haughton, whose interests and achievements ranged from the emplacement of granite to the fossil mammals of post-glacial times, and who finally became a distinguished medical scientist. Until 1881, the chair of mineralogy had a separate tenure. The first holder, James Apjohn, was also University professor of chemistry. The superlative quality of the mineral collections undoubtedly reflects the industry of collectors early in this field. To Prof. W. J. Sollas, who held the chair of geology for fourteen years before he went to Oxford, is owed the acquisition of the Huxley types of the Jarrow amphibia, and a great variety of type and figured specimens of his era. Most of the systematic collections of Irish rocks were started by him. John Joly's many-sided genius probably gave the School of Geology its highest and widest known reputation. Like many of its most distinguished sons, Joly came to the science of geology from the School of Engineering—and this, in the old days, meant through mineralogy. Joly remained throughout his life a keen collector of minerals, and his large collection, recently presented by Mrs. Henry Dixon, is particularly rich in metamorphic minerals.

The work of the late Prof. L. B. Smyth on the Carboniferous rocks and fossils of Ireland deserves wider recognition than it has received either in Trinity College or elsewhere. This unassuming man left a complete record of his meticulous comparative and descriptive work, which forms an invaluable foundation on which to build a study of the stratigraphy of the Carboniferous rocks covering two-thirds of the country. The fossils upon which the teaching of invertebrate palæontology is based also bear the stamp of a palæontologist of rare ability.

With this rich harvest from the labours of so many distinguished forbears, and the provision of up-to-date teaching and research facilities, the School of Geology in Trinity should be able to maintain the high reputation earned by its graduates over the past century. The main difficulty in expanding research activity is the poor provision in Ireland for postgraduate students compared with that in Britain. There is hope, however, that this situation will be remedied in the near future. In spite of these difficulties, the School of Geology has had two full-time research students in the past two years.

As many departments of geology in British universities have found in the past decade, there is much untouched research ground in Ireland, presenting a wide range of problems to be solved. The basic mapping of the country was done between 1860 and 1880, at a time when only the bare outlines of the science were established. It is not surprising, therefore, that field geology is so frequently rewarded by the discovery of undocumented phenomena. In the past, Ireland's own contribution to the rediscovery of Irish geology has had to rely on a few outstanding individuals. It is hoped that the new provision made by Trinity College will help to expand the scope, and increase the production of geological research.

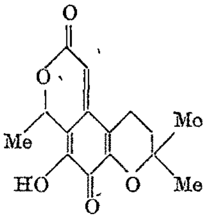
In field-mapping, petrographic and palæontological studies of Carboniferous rocks; in tectonics and the study of cleavage developed in fold systems; in field relationships and petrological studies of volcanics; in Quaternary studies, including the field-mapping and laboratory studies of drift deposits; in palæobotany and micropalæontology, there is ample scope for research workers, who will receive willing assistance from the University and from the Geological Survey of Ireland.

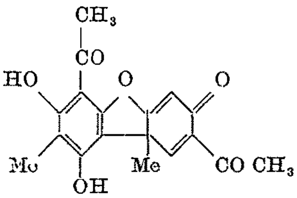
ANTIBIOTICS AND MOULD METABOLITES

THE anniversary meeting of the Chemical Society was held this year in Nottingham, on March 26, and included a symposium on "Antibiotics and Mould Metabolites", organized by Prof. A. W. Johnson. Four papers were read during the morning: "Fungal Quinones", by J. H. Birkinshaw (London School of Hygiene and Tropical Medicine); "Synthesis of some Fungal Metabolites", by D. H. R. Barton (University of Glasgow); "Azaphilones, a General Survey", by A. D. G. Powell, Alexander Robertson and W. B. Whalley (University of Liverpool) and "The Structure of Purpurogenone", by J. C. Roberts (University of Nottingham).

Dr. Birkinshaw reviewed the chemistry of the fungal quinones and paid particular attention to the structural regularities which have enabled theories of biogenesis and metabolism to be developed. Examples of simple benzoquinones were quoted as well as dibenzoquinones, 2 : 5-diphenylbenzoquinones and the naphthaquinones, including actinorhodin which is possibly a dinaphthaquinone. The hydroxy-anthraquinones form the largest group of the fungal quinones, and these were sub-divided into those containing only α-hydroxy groups and those containing β- as well as α-hydroxy groups. The latter formed two main types, those based on emodin and those based on catenarin. Other hydroxy-anthraquinones which were not included in the above groups were also discussed. Examples of dianthraquinones and related compounds were cited, as well as the case of thelephoric acid, a phenanthraquinone. Citrinin, fuscin and purpurogenone form a separate class of hemiquinones or quinomethines, and the final examples mentioned included quinols and quinhydrones, the existence of which supports the idea that the quinones are concerned in the respiratory processes of the particular organisms. In the ensuing discussion, Prof. A. J. Birch (Manchester) stressed the importance of the acetate hypothesis in deciding the position of quinone substituents and in correlating the structures of the fungal quinones in general.

Prof. Barton then read his paper on the recent syntheses in his own laboratory of two fungal metabolites, fuscin and usnic acid. Fuscin was isolated by Michael in 1948, and its reactions and degradations were studied in detail by Birkinshaw, Bracken, Michael and Raistrick. Prof. Barton then deduced structure (I), which had been reported independently by Birch, for fuscin; he provided plausible explanations of its various reactions and described the total synthesis of the compound.


(I)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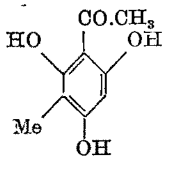
In a second section, Prof. Barton discussed the chemistry of usnic acid (II), which can be dissected into two biogenetic units of methylphloracetophenone (III). Once it had been realized that the dimer o p-cresol formed by ferricyanide oxidation should b formulated as (IV), a similar oxidation with methy phloracetophenone was found to give the expecte dimer which yielded racemic usnic acid on dehydration.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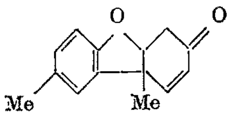
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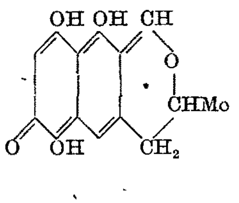
In the discussion Prof. Barton said that the dime of *p*-cresol had also been obtained by oxidation wit peroxidase by earlier workers; but even so it had no been obtained in an optically active form, probabl because the reaction had not been carried out unde proper physiological conditions.

In the third paper, by Powell, Robertson an Whalley, Dr. Whalley gave a general survey of th complex chemistry of the azaphilones, a group o five pigments: sclerotiorine, $C_{21}H_{23}O_5Cl$, from *P. sclerotiorium* van Beyma; a new pigment, rotiorine $C_{22}H_{22}O_5$ (or $C_{23}H_{24}O_5$), from the same organism monascin, $C_{21}H_{26}O_5$, and monascorubrin, $C_{22}H_{24}O_5$ both isolated from *M. purpureus* Wentii; and a new metabolite, rubropunctatin, $C_{22}H_{24}O_5$, from *M. rubriginosus* Sato. These metabolites constitute a famil of substances of hitherto unknown type, which, wit the exception of monascin, give rise with exceptiona facility to reaction products with ammonia. Henc these metabolites, which have many structura features in common (*inter alia*, the presence of lactone grouping and one or more alkyl side-chains the absence of hydroxyl groups and aromatic nuclei and the ready conversion of the 'ammonia compounds' to *iso*quinolines), are designated by th generic term azaphilones.

The extensive analytical work concerning th structure of sclerotiorine has made it possible t assign a tentative structure to this pigment.

In the final paper of the morning session, Dr Roberts discussed the isolation and structure (V) o the mould pigment purpurogenone, $C_{14}H_{12}O_5$, isolate from *P. purpurogenum* Stoll. Details were given of th various reactions of purpurogenone, including the conversion by alkali to a derivative of naphthapurpuri and the chromic acid oxidation of purpurogenon triacetate to 3-hydroxybenzene-1 : 2 : 5-tricarboxyli acid.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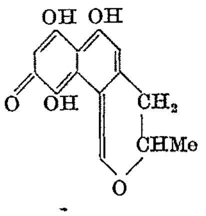
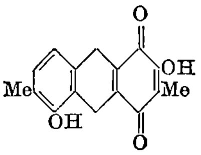

(VI)

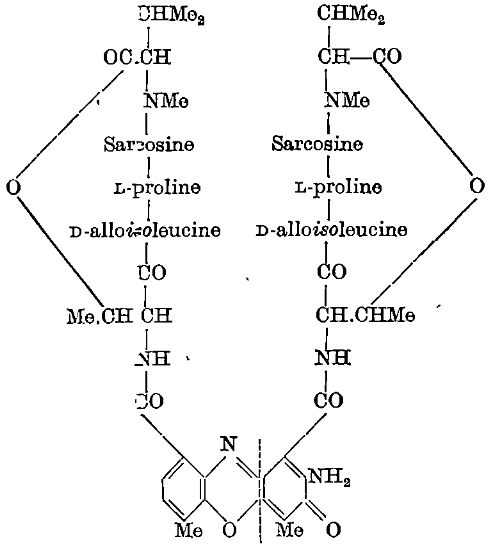
A possible biogenetic route based on the acetate hypothesis was supported. A lively discussion of various features of this novel structure occurred, and suggestions were made for distinguishing (V) from the alternative, though less likely, angular structure (VI).

In the afternoon three papers were read: "Progress in the Chemistry of Oxytetracycline and Related Compounds" by L. H. Conover (Chas. Pfizer and Co., Inc., New York); "Actinomycin", by A. W. Johnson (University of Nottingham) and "Chemistry of the Cephalosporins", by E. P. Abraham and G. G. F. Newton (University of Oxford), read by the latter.

Dr. Conover began his talk by reminding his audience of the structural relationship between terramycin (VII) and aureomycin, both derivatives of tetracycline and now officially named oxytetracycline and chlorotetracycline respectively. He then summarized briefly the degradative experiments which enabled these structures to be deduced. The main part of Dr. Conover's talk was devoted to recent work on oxytetracycline and comprised (i) the interpretation of certain aspects of the spectra and the acidities of simpler structures related to the antibiotics; (ii) the use of model compounds in elucidating the primary site of metal complexing of the antibiotics; (iii) the identification of the specific centres responsible for the three titratable acidic dissociations of the antibiotics; and (iv) some new reactions of oxytetracycline and its analogues. In the first section, evidence was presented for steric inhibition of resonance being an important factor as well as variations in the strength of hydrogen bonding in controlling the physical properties of *o*-hydroxy- and *o*-alkoxyaromatic carbonyl compounds. In the second and third sections, it was established that the site of the metal complexing is the 2-acyl-8-hydroxytetralone fragment of the molecule, and that the three acidic groups of pK_a 3·3, 7·3 and 9·1 in oxytetracycline can be attributed to the tricarbonylmethane system (VII; *A*), the ammonium cation (VII; *B*) and the phenolic β-diketone system (VII; *C*), respectively.

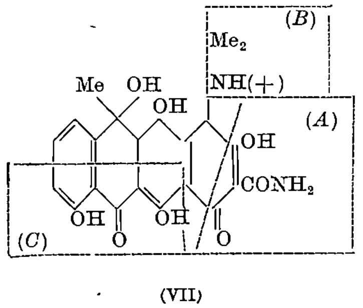


(VIII)



Actinomycin C_3 $C_{64}H_{90}O_{16}N_{12}$ (Brockmann)

(IX)

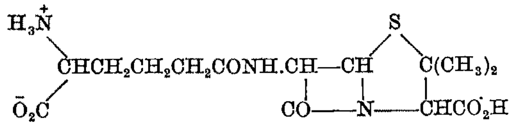


(VII)

In his final section Dr. Conover put forward theoretical mechanisms for the unexpected formation of tetramethylammonium iodide from the action of methyl iodide on oxytetracycline and postulated that the observed epimerization of the tetracycline antibiotics in acidic solution involves equilibration at C_4.

Prof. Johnson outlined the isolation, nomenclature and early work on the structure of the actinomycin group of antibiotics which have been claimed to have a certain degree of cytostatic activity. The difference between the various members of the groups lies in the composition of the peptide chain and, so far as is known, the chromophore is common to all. Until recently the only degradation product from actinomycin was the compound despeptidoactinomycin or actinomycinol, produced by the action of baryta. The structure of this compound (VIII) was announced in papers submitted from both Göttingen (Brockmann *et al.*) and Cambridge on the same day. Quite recently, Brockmann has been able to advance a complete structure (IX) for actinomycin by a careful study of the graded acid hydrolysis. This structure is remarkable because of its relation to xanthommatin, an insect pigment recently isolated and identified by Butenandt, and also because it can be synthesized *in vitro* as well as *in vivo* by the oxidative coupling of two molecules of the 6-hydroxy-5-methylanthranilic acid peptide. Variations in the peptide chain and unsymmetrical coupling can give rise to the various actinomycins.

In the final paper, Dr. Newton said that a *Cephalosporium* sp. (obtained from Prof. Brotzu) produces two groups of antibiotics. One group, cephalosporin P, contains five related antibiotics that can be extracted into solvents. The other group contains two hydrophilic substances—cephalosporin N and cephalosporin C. Cephalosporin P_1 ($C_{32}H_{48}O_8$), the major component of the cephalosporin P family, contains an αβ-unsaturated carboxyl, two hydroxyl and two acetoxy groups. The $C_{27}H_{39}$ residue is tetracyclic. Cephalosporin P_1 is related to helvolic acid ($C_{32}H_{42}O_8$). Cephalosporin N is a new type of penicillin having a residue of D-α-aminoadipic acid in the side-chain. Its physical and antibacterial properties differ strikingly from the penicillins previously encountered. Degradation studies have shown that cephalosporin N is very probably (*D*-4-amino-4-carboxy-*n*-butyl)penicillin (X).



(X)

Cephalosporin C ($C_{16}H_{21}O_8N_3S$) behaves like a penicillin in some respects but not in others. Like cephalosporin N, it contains a residue of D-α-aminoadipic acid in the side-chain and has an absorption band in its infra-red spectrum characteristic of a penicillin. Unlike cephalosporin N, it shows an absorption band ($\varepsilon_{\max.}$ 9,000) at 260 mμ, is not inactivated by penicillinase and gives no penicillamine on hydrolysis with hot acid. However, DL-valine has been isolated from the hydrolysate of cephalosporin C treated with Raney nickel.

The papers of the symposium, with bibliographies, will be published by the Chemical Society as "Special Publication No. 5", which will include also an account of the discussions following each paper.

A. W. Johnson

OBITUARIES

Dr. Stanley Whitehead

By the death of Stanley Whitehead on May 5 at the early age of fifty-three, electrical engineering has lost one of its far-sighted leaders in the research field and the Electrical Research Association a director who has considerably widened its scope and activities. He entered Oxford with an open scholarship, where he took firsts in the Final School in Physics and Mathematical Moderations. In 1925 Whitehead accepted the post of physicist in the Electrical Research Association and proceeded to a part-time study of electrical engineering at East London (Queen Mary) College, which led in 1930 to a Ph.D. and in 1952 to a D.Sc. degree of the University of London.

His early work with the Electrical Research Association led to the production of three critical surveys of dielectric phenomena covering breakdown phenomena in solid, liquid and gaseous dielectrics. This interest in dielectrics was maintained throughout his career and culminated in the monograph "Dielectric Breakdown of Solids" (Clarendon Press, Oxford, 1951), in which dielectric failure in all its aspects, for example, electronic breakdown, breakdown through thermal effects and by discharges in gaseous voids, was surveyed. His own theoretical researches on thermal breakdown and his experimental researches with colleagues on void discharges have proved useful contributions to knowledge. Problems of electrotechnical interest to which he has made contributions include those concerned with electrical transmission, cable ratings, and telephone and radio interference. During the Second World War he took a leading part, often at considerable personal risk, in the work of the Electrical Research Association on mine and bomb location.

Whitehead shouldered many responsibilities. He was chairman of the Science Abstracts Committee of the Institution of Electrical Engineers and a past chairman of the Measurements Section, honorary treasurer of the Institute of Physics, and a past vice-president and chairman of the London Branch, a past joint-secretary of the Parliamentary and Scientific Committee, and the chairman of the Committee of Directors of Research Associations. He was the chairman of the governors of his old school, Sir Walter St. Johns, of Battersea, and a governor of Battersea Grammar School. But his interest in education did not stop there; many young graduates about to embark on a career in research received guidance, and often he was instrumental in securing for them financial support. One of the rewards accorded him in 1952 which gave him great pleasure was his fellowship of Queen Mary College.

Stanley Whitehead married in 1929 Mary Lyon Morehead; they had met at Oxford, where she too had a distinguished academic career, but on the classical side. There are two children of the marriage, a boy and a girl.

R. Davis

Dr. T. Richards

Taliesin Richards, senior lecturer in the Department of Microbiology, University of Reading, died on January 13 at the early age of forty-two, having been born on November 26, 1913; his loss to the Department is great. Richards read chemistry at King's College, University of London, and obtained a B.Sc. with first-class honours in July 1936. He then entered the London School of Hygiene and Tropical Medicine to read for the postgraduate diploma in bacteriology, which he obtained in July 1937. Thus he entered the field of microbiology by postgraduate study, building upon a foundation of general chemistry a knowledge of microbial physiology and microbial forms and the techniques for studying them. He continued at the London School of Hygiene, doing research in the department of Prof. H. Raistrick, for which he obtained a Ph.D. in 1939.

In September 1939 Richards was appointed independent lecturer in charge of the, then, Agricultural Bacteriology Laboratory in the Faculty of Agriculture, University of Reading, where students reading for the degree of B.Sc. in dairying received instruction in microbiology. Richards and his colleagues were also responsible for the course for the postgraduate diploma in general bacteriology (now discontinued). These courses owed much to Richards, who moulded them during the difficult war period and after. The experience gained in the design and teaching of these courses was of much value when later (March 1951) the laboratory was absorbed into a new Department of Microbiology in the Faculties of Science and of Agriculture. Richards was appointed senior lecturer in the new Department and continued to be particularly concerned with the courses for the B.Sc. (Dairying) degree. In planning the courses for the new degree subject of microbiology in the Faculty of Science, Richards's knowledge and experience were drawn upon to great advantage, and he himself did a considerable amount of teaching in these new courses. Richards was a good teacher and took much atient interest in the problems of students both in nd out of the laboratory. He was much interested n student life in the University generally, and delighted in following the careers of his former tudents.

Richards's scientific interests covered a wide field in bacteriology. His papers included studies on the eat disinfection of *Streptococcus faecalis*, the development of media for the detection and enumeration of ipolytic micro-organisms, and the development of hemically defined media for classification in the *oli-aerogenes* group. He was an excellent microcopist and photographer. In spite of the difficult ituation in the laboratories during the War and the ater changes consequent on re-organization and development, Richards always managed to keep some personal research interests going, and to supervise a succession of research students.

Richards was an active member of the Society for Applied Bacteriology; he was elected to the committee in 1943, became an assistant editor of the *Proceedings* of the Society in 1945 and was its editor during 1948–50, until compelled by ill-health to resign. By then he had been able to carry out much work preparatory to the appearance of the *Journal of Applied Bacteriology*, and he continued until his death to give valuable assistance to his editorial successors. Richards was an active member of the Association of University Teachers and was for two years a Central Council representative of the University of Reading branch. He leaves a widow and two sons.

B. C. J. G. Knight

NEWS and VIEWS

The Queen's Birthday Honours

The following names of scientists and others associated with scientific work appear in the Queen's Birthday Honours list:

Viscount: Lord Cherwell, lately Dr. Lee's professor of experimental philosophy in the University of Oxford, for public services.

Barons: Sir Henry Cohen, professor of medicine n the University of Liverpool, for services to medicine; Sir Ronald Weeks, chairman of the National Advisory Council for Education in Industry and Commerce, and president of the British Scientific Instrument Research Association.

O.M.: Lord Hailey.

K.C.B.: Sir Gordon Radley, director-general of the General Post Office.

K.B.E.: Lord Glentanar, member of the Scottish Agricultural Advisory Council; Edmund G. Harwood, deputy secretary, Ministry of Agriculture, Fisheries and Food; Hugh N. Hume, deputy chairman, Colonial Development Corporation, and for other public services; Sir Thomas Merton, treasurer of the Royal Society.

Knights: Prof. Samuel P. Bedson, emeritus professor of bacteriology, University of London; Prof. Harry G. Champion, professor of forestry, University of Oxford; Prof. William J. Pugh, director of the Geological Survey of Great Britain and the Museum of Practical Geology (Department of Scientific and Industrial Research); Allan S. Quartermaine, president during 1951–52 of the Institution of Civil Engineers; John F. Wolfenden, vice-chancellor of the University of Reading.

C.B.: J. Anderson, chief scientist, Admiralty Signal and Radar Establishment, Portsdown, Cosham, Hants; H. S. Gilham, assistant comptroller, Patent Office (Board of Trade); J. I. Magowan, lately permanent secretary, Ministry of Agriculture, Northern Ireland.

C.M.G.: D. H. Black, chief scientific officer, Ministry of Supply; Dr. C. E. Lucas, director of marine and freshwater fishery research, Scottish Home Department.

C.B.E.: C. B. Bisset, director of the Geological Survey, Tanganyika; L. Boddington, deputy chief scientific officer, Ministry of Supply; Dr. F. P. Bowden, reader in physical chemistry, University of Cambridge; R. M. Currie, head of the Work Study Department, Imperial Chemical Industries, Ltd.; J. R. V. Dolphin, chief engineer, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority; A. S. Fortune, chief inspector, Department of Agriculture for Scotland; E. T. Green, for services to agriculture in Northern Ireland; Dr. P. D'Arcy Hart, director of the Tuberculosis Research Unit, Medical Research Council; G. V. B. Herford, deputy chief scientific officer, Pest Infestation Laboratory (Department of Scientific and Industrial Research); A. B. Mann, chief mechanical and electrical engineer, Ministry of Works; Prof. K. Mather, professor of genetics, University of Birmingham; J. E. Peat, deputy senior officer, Empire Cotton Growing Corporation, Tanganyika; J. D. Peattie, chief engineer, Central Electricity Authority; S. P. Peters, deputy director (forecasting), Meteorological Office (Air Ministry); G. Williamson, principal of the Veterinary School, Federation of Nigeria; F. N. Woodward, director of the Institute of Seaweed Research.

I.S.O.: J. F. Sinclair, principal, Ministry of Agriculture, Fisheries and Food; R. I. Wells, principal scientific officer, Air Ministry.

Directorship of the Science Museum, London: Dr. T. C. S. Morrison-Scott

Dr. T. C. S. Morrison-Scott, a principal scientific officer in the British Museum (Natural History), has been appointed director of the Science Museum, London, in succession to the late Dr. F. Sherwood Taylor. Dr. Morrison-Scott was born in 1908; he went to Christchurch, Oxford, where he read history and law, and later to the Imperial College of Science and Technology, where he graduated with first-class honours in zoology in 1935. After a period as a biology master at Eton, he became a research student at the Zoological Society of London, and joined the British Museum (Natural History) in 1936. During the Second World War, he served with the R.N.V.R., and was awarded the Distinguished Service Cross. During the earlier part of his career Dr. Morrison-Scott was mainly interested in ecology in relation to evolution. At the British Museum he was assigned to the Mammal Section of the Zoological Department, under M. A. C. Hinton, and ultimately he assumed charge of that section. After the War he also became the officer in charge of the Tring Museum. His research work has covered a wide range of mammalian topics from historical investigations into such matters as the identity of the kangaroo discovered by Captain Cook's expedition in 1770 and of the cats of ancient Egypt, to morphological investigations into the growth and succession of elephants' teeth. His major contributions have, however, been in the field of taxonomy; publications such as the Check List of Palæarctic Mammals (jointly with J. R. Ellerman, 1951) and Southern African Mammals (with J. R. Ellerman and R. W. Hayman, 1953) won immediate recognition and have become standard works of reference. In addition to his work in the Museum he has played a prominent part in other zoological affairs. He has been honorary treasurer since 1950 of the Zoological Society of London. At the thirteenth and fourteenth International Congresses of Zoology he was much involved in the activities of the Section on Zoological Nomenclature, and he is the honorary treasurer of the forthcoming fifteenth Congress in London in 1958. Among his hobbies are sailing and skiing; he is an amateur astronomer and is no mean lathe-turner.

Prehistoric European Archæology in London : Prof. J. D. Evans

Mr. J. D. Evans, whose appointment to the chair of prehistoric European archæology tenable at the University of London Institute of Archæology has recently been announced, is an outstanding product of the Department of Archæology and Anthropology at Cambridge. After taking his Tripos, in which he gained a first class with distinction, Mr. Evans entered on a course of research on the prehistoric archæology of the Mediterranean with special reference to relations between the eastern and western basins. He began by studying the Neolithic and Early Metal Age cultures of Spain, working under Santa-Ollala at Madrid and under Pericot y Garcia at Barcelona. Next he held a fellowship at the British Institute of Archæology at Ankara, during the tenure of which he took part in excavations, not only in Turkey, but as far afield as Jericho. At this stage his original plan was interrupted by an invitation from the Royal University of Malta to prepare a survey of the known monuments and archæological material from the Maltese Islands. In his paper on "The Prehistoric Culture-Sequence in the Maltese Archipelago", published in the *Proceedings of the Prehistoric Society* (19, 41; 1954), Evans made known the results of his analysis of the pottery, and he has since, in a communication to the Society of Antiquaries, of which he was elected a Fellow in 1955, published the results of his own excavations, by means of which he has been able to confirm his sequence and to relate to it the main prehistoric structures of the islands. Mr. Evans, who has held a research fellowship at Pembroke College, Cambridge, since 1953, has thus gained that broad experience of European prehistory that one has a right to expect of the successor to Prof. V. Gordon Childe.

Physics at Exeter: Dr. G. K. T. Conn

Dr. G. K. T. Conn, at present reader in physics in the University of Sheffield, has been appointed professor of physics in the University of Exeter in succession to Prof. H. O. W. Richardson, who is taking up the chair of physics at Bedford College, London. Dr. Conn graduated in mathematics and natural philosophy from the University of Aberdeen in 1933, and then spent the following five years in the Cavendish Laboratory, Cambridge, working on research problems in infra-red spectroscopy, a field which has since engaged a major part of his activities. In 1938 he was appointed to an assistant lectureship at the University of Sheffield, and it is there that he has developed his research to an impressive extent. His contributions on the optical properties of metals have made him a recognized authority in this field and have led to a substantial number of papers on new techniques covering a wide range. Recently he has extended this work to semi-conductors, and the broad field of his activities may be described as the physics of the solid state. His publications include contributions on vacuum gauges and low-pressure measurements as well as the study of the magnetic properties of solids in connexion with investigations in other fields. Dr. Conn possesses an original and inventive mind, with an unusually wide range of knowledge and general interests. His freshness of outlook at all levels of teaching and his active participation in many student activities have combined to make him an invaluable member of the physics staff at Sheffield.

Paris Academy of Sciences : Elections

Prof. M. Fréchet, formerly professor of mathematics in the University of Paris, has been elected a member of the Geometry Section of the Paris Academy of Sciences in succession to the late Prof. E. Borel. The following have been elected *correspondants* for the Geometry Section: Prof. H. Milloux, professor of differential and integral calculus in the University of Bordeaux, in succession to the late Prof. H. Dulac; Prof. C. L. Siegel, formerly professor of mathematics in the University of Frankfurt am Main, in succession to the late Prof. H. Weyl; and Prof. Marston Morse, of the Institute for Advanced Study, Princeton, in succession to the late Prof. F. Riesz.

University of Leeds : Building Developments

A gift of £21,000 has been made by Brotherton and Co., Ltd., to the University of Leeds towards the building fund for the Chemical Engineering Section of the Department of Coal Gas and Fuel Industries. This firm has for many years given substantial financial help to the University for the purpose of furthering teaching and research in the Departments of Chemical Engineering, Chemistry, Textile Industries and Colour Chemistry and Dyeing, and, in particular, the late Dr. Charles Ratcliffe Brotherton bequeathed £50,700 for the development of chemical engineering, which has been invested pending the commencement of building work. The latest gift of £21,000 to the Department of Coal Gas and Fuel Industries brings the total received during the past twelve months for new buildings for this Department to £81,660; the cost will be £615,000, of which the Government, through the University Grants Committee, will find £450,000. The steel framework for the new buildings is now in place, and it is hoped to occupy them during 1958–59.

The present scheme of development of the University includes a number of new buildings and is the most ambitious ever undertaken by the University. That for the Man-made Fibres Section of the Department of Textile Industries is in its final stages of completion, and is due to be opened by the Duke of Edinburgh on June 29 next. Good progress is being made with an extension of the buildings now occupied by the Departments of Physics and Chemistry, which was started about twelve months ago, and it is anticipated that a new building for civil engineering and a new boiler house to serve the new buildings will be started on the Woodhouse Lane site in about twelve months; at the same time, the University will start the construction of a large new arts block at the Woodhouse Lane end of University Road, and it is planned to follow this after two years with new buildings for mechanical and electrical engineering. The cost of the whole scheme will be something in the region of £4 million, the greater part of which will no doubt come from the University Grants Committee. However, it will be necessary for the University to raise £500,000 towards the cost of these new buildings and their equipment, and up to date about £208,000 has been given or promised under deeds of covenant.

University Expenditure on Research

On May 31, in reply to questions in the House of Commons on the annual expenditure on fundamental scientific research by the University Grants Committee, Mr. H. Brooke, Financial Secretary to the Treasury, explained that grants are not normally earmarked for specific purposes and that research expenditure, therefore, is not separately distinguishable. He declined to comment as to the accuracy of the estimate that the amount is about £5 million and said that he is anxious not to embark on a policy of government earmarking of grants. The arrangements for the next quinquennium, he continued, will be the right moment to decide what future grants should be.

Mechanisms of Hearing and Balance

An up-to-date picture of some of the important topics of research on the ear and mechanisms of hearing and balance is given in a recent number of the *British Medical Bulletin* (12, No. 2 (May 1956): "Symposium on Neuro-Otology", pp. 70+4 plates; 15*s*.). Some new research techniques are described and illustrated in considerable detail. For example, by use of specially designed ultra-micro methods of analysis, it has been possible to estimate some of the electrolytes and organic fractions of the different labyrinthine fluids from small animals, even though the amount of fluid obtainable was sometimes as little as 0·1 µl. There are about a dozen separate articles in this number, and they include contributions on the comparative physiology of the otolith organs, fatigue and adaptation of hearing, and a fascinating chapter on the various types of inherited disorder of the labyrinth which are found in the different kinds of 'dancing' mice. This chapter ends with the sentence: "Further progress will largely depend on the degree of co-operation with specialists in related fields". It is just such publications as the present one which will increase that co-operation, by making clear to specialists in one field of research what is going on in related fields.

Rock Paintings and Engravings in Hyderabad

An interesting article has been prepared by Colonel D. H. Gordon and Dr. F. R. Allchin on some finds of rock paintings and engravings to the north of the Tungabhadra River in the Benakal Forest, Hyderabad (*Man*, July 1955). They were discovered by Leonard Munn, who photographed them and then copied them in colour on the photographs, and the dossier is now in the departmental library of the Indian Section, Victoria and Albert Museum, London. The drawings consist of human beings, horsemen, animals, signs, etc. Colonel Gordon, who has studied the rock-shelter art of the Central Provinces, India, for many years, has come to the conclusion that no part of this art dates back to a period earlier than the first half of the first millennium B.C., and that paintings and engravings continued to be made well into medieval times. The Benakal Forest art for the most part seems to belong to the dolmen period, as there are stone cists in the vicinity, with which they are probably to be associated. This would date some of the drawings to the first centuries B.C.; but a great deal of the art is clearly much later in date, as engravings have been found of Hindu sectarian symbols, scratchings and bruisings of umbrellas, as well as some drawings of temples.

Beef-Cattle Industry of Australia

The Commonwealth Scientific and Industrial Research Organization in Australia has published the results of a survey into the beef-cattle industry of the country (Bull. No. 278). The survey was carried out by W. A. Beattie, of the Division of Animal Health and Production of the Organization, and lasted from 1946 until 1952; it was designed to provide a background for the future planning of research. During the survey Beattie visited and examined all the beef-cattle producing areas of Australia and received co-operation from graziers' associations and primary producers. The survey aimed at determining and defining the structure of the industry as it has evolved in a variety of climatic environments on a large island continent, about one-third of which lies within the tropics. Attention was given to the conditions in each of the natural regions, action that may be taken to enable cattle to survive or thrive in them, the breeds of cattle available, methods of animal husbandry, disease and pest control, stock routes and transport, land tenure, labour, and the social structure of the industry.

Soil Science in India

In his presidential address to the Section of Agricultural Sciences of the forty-third Indian Science Congress, Dr. S. P. Raychaudhuri reviewed recent work in soil science in India with special reference to classification and survey. The first requirements of a basic improvement in Indian agriculture are a fuller understanding of the soils and a scientifically based programme for their better management. Indian scientists are tackling the innumerable problems presented by their soils on a broad front, and appear to be paying particular attention to the chemistry of soil fertility. Recent experience has shown remarkable responses to chemical fertilizers, and this offers immediate prospects of greatly increased yields. The majority of Indian soils are deficient in nitrogen, and the production as well as consumption of sulphate of ammonia are increasing steadily. Phosphate, by itself, is of more doubtful value, but increases response to nitrogen. Potash is generally adequate in Indian soils. Deficiencies of trace elements are reputed to be widespread, but little systematic study has been made of them. Much attention is being paid to salinity and alkalinity of irrigated soils, and soil surveys of irrigation areas have been of great value in preventing costly mistakes. Little work has so far been done on soil physics and microbiology, but the study of bacterial nitrogen fixation offers a promising field which is now being explored.

Besides irrigation surveys, fertility, land-use and soil-conservation surveys have been made in various parts of India, and this work is being extended. A basic system of classification for Indian soils is still lacking, and much field-work will have to be done before such a system can be devised. An All-Indian regional soil survey has been planned, and soil classes will be determined on a soil and geomorphological basis, with complementary chemical and physical determinations in the laboratory. Four regional centres are proposed in alluvial, black, red and laterite areas. The Indian Agricultural Research Institute now provides a two-year training course in soil survey.

Year Book of the Physical Society, 1955

The miscellaneous items which were previously published in the December issues of the Physical Society's *Proceedings* are now being published by the Society separately, entitled "Year Book of the Physical Society". The first such "Year Book", that for 1955, has been published (pp. 92; 10*s*.) and contains the following items: the texts of the 1955 presidential address, the 1954 Rutherford Memorial Lecture, the 39th Guthrie Lecture and the 18th Thomas Young Oration; abstracts of the lectures delivered by the recipients of the 31st Duddell Medal and the 10th Charles Vernon Boys Prize; obituary notices of five Fellows including Albert Einstein and G. F. C. Searle; and the report of the Council of the Society for 1954. In his Rutherford Lecture, Prof. P. M. S. Blackett describes his impressions of Rutherford and in particular refers to Rutherford's attitude to research and to the technical methods by which Rutherford achieved his astonishing output of important discoveries. He then discusses the problem of the proper relationship between the training of students in experimental technique and in theoretical knowledge, the difference between the present practice in British and American universities, and finally advances the practical solution of giving the experimental research worker an intense theoretical education in that part of theoretical physics which is narrowly centred on his experimental investigation. The Guthrie Lecture, entitled "Magnetism in Retrospect and Prospect", which was delivered by Prof. E. C. Stoner, consists of a survey of the advance in knowledge and understanding of the magnetic properties of matter during the past thirty years. Some of the outstanding experimental and theoretical problems are indicated, together with suggestions as to the kinds of experimental investigations required to elucidate the particular difficulties associated with metals. The basic data of colour-matching are the subject of the Thomas Young Oration, delivered by W. S. Stiles, of the National Physical Laboratory, Teddington, and a new determination of the colour-matching functions is described.

The Physics of Gas Flow at Very High Speeds

The Summer Meeting of the Physical Society will be held this year in the University of Manchester during July 16–17, and will be concerned with the flow of air and other gases at speeds so high that changes in kinetic energy are comparable with the energy required to produce interesting physical changes, such as dissociation, ionization and substantial emission of radiation. The implications for the aerodynamics of man-made projectiles travelling at extreme speeds, and also of meteors, will be included in the discussion. The shock tube will be discussed at length, both as regards design and instrumentation for use with very strong shock waves, and in connexion with the results so far discovered by its use. Prof. M. J. Lighthill, Department of Mathematics, University of Manchester, is organizing the sessions. Among those taking part in this meeting are: Mr. J. G. Davies (Jodrell Bank Experimental Station); Dr. Wayland Griffith (Palmer Physical Laboratory, Princeton University); Dr. D. W. Holder and staff (High-speed Section, Aerodynamics Division, National Physical Laboratory); Prof. M. J. Lighthill (Manchester): Prof. N. F. Mott (Cambridge); H. K. Zienkiewicz (Manchester). Non-members of the Society will be able to attend the meeting; inquiries should be addressed to the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7, marked for the attention of Miss Miles.

Commonwealth Fund Grants for Medical Education in the United States

The Commonwealth Fund, New York, has recently given grants of 4,850,000 dollars to seven university medical schools in the United States for use in whatever ways the schools consider most effective to improve their programmes of medical education. These grants, which are in addition to the sums expended for specific medical education projects during the fiscal year 1955–56, have been drawn from the Fund's capital assets and current income, and they bring to a total of 12,600,000 dollars the amount of such gifts made by the Fund since November 1955 to help the medical schools in the United States. The schools receiving the new grants are: Albany Medical College of Union University, 500,000 dollars; George Washington University School of Medicine, 500,000 dollars; University of Pennsylvania School of Medicine, 500,000 dollars; Boston University School of Medicine, 600,000 dollars; University of Rochester School of Medicine and Dentistry, 750,000 dollars; Johns Hopkins University School of Medicine, 1,000,000 dollars; and Stanford University School of Medicine, 1,000,000 dollars. During recent years the primary interests of the Commonwealth Fund have been in the field of health, particularly in medical education, medical research and community health services.

Institute of Biology: London Branch

The London Branch of the Institute of Biology held its annual conversazione on May 10 at the South-West Essex Technical College, Walthamstow, by courtesy of the principal of the College, Dr. H. Lowery. Guests were received by Dr. Lowery and Dr. H. O. J. Collier, president of the London Branch. Many biological topics were represented, from seals to bacteria: anatomy, ecology, ethology, microbiology, parasitology, pharmacognosy, physiology and biochemistry, and genetics were all represented. An interesting section was grouped together under "Improvisation and Gadgetry"; this was a valuable idea. The research worker is so often helped if he or one of his colleagues is versed in the art of gadget-making. It is often not simply a matter of 'making do', but of constructing something to do a job when no suitable apparatus already exists. Films and slides on four different topics were exhibited. It is customary for a guest society to be invited to make an exhibit; this year it was the Royal Institution, which displayed various historic documents and objects. The Branch also permits each year one firm of suppliers of apparatus to provide an exhibit. The layout of the exhibits was admirable, the Great Hall of the College giving ample space for complete inspection.

Symposium in Geneva on High-Energy Physics

THE European Organization for Nuclear Research is holding an international symposium on "High-Energy Physics" during June 11–23 in the Institute of Physics of the University of Geneva. Some three hundred scientific workers from twenty countries will attend the symposium; they will include approximately one hundred and sixty from the twelve member States of the Organization, about sixty each from the United States and the U.S.S.R., and a number from Australia, Canada, Czechoslovakia, India, Japan and Spain. In addition, about a hundred members of the scientific staff of the Organization will be participating. During the first week the main discussions at the symposium will be on novel features in the design and techniques of high-energy particle accelerators; the first few days of the second week will be devoted to newly developed techniques for the detection and measurement of fast particles, such as bubble chambers and over-compression cloud chambers, and during the latter part of the week π-mesons and the anti-proton will be considered.

Announcements

THE Geological Society of London has awarded the R. H. Worth Prize for 1955 to Mr. James Wright, and the Prize for 1956 to Dr. C. T. Trechmann; these Prizes are from a fund established under the will of the late Richard Hansford Worth, of Plymouth, "to provide a prize or prizes for the encouragement of amateur geological research". The Daniel Pidgeon Fund for 1956 of the Society has been awarded to Dr. K. A. Joysey, of the Department of Zoology, University of Cambridge, who is studying the variation in living and fossil echinoid species in order to assess the stratigraphic and systematic significance of this variation.

THE following, among others, have been appointed to chairs in the newly established Medical School of the University of Western Australia, Perth: *Anatomy,* Dr. D. C. Sinclair, University demonstrator in human anatomy, Oxford; *Medicine,* Dr. E. G. Saint, director of the Clinical Research Unit in the Royal Perth Hospital, Western Australia, and formerly of the Department of Industrial Health, King's College, Newcastle upon Tyne; *Microbiology,* Dr. N. F. Stanley, director of the Institute of Epidemiology and Preventive Medicine, Prince Henry Hospital, Adelaide.

THE College of Technology, Bristol, in collaboration with the Regional Council for Further Education for the South West, has arranged a course during July 6–7 on "The Applications of Radioactive Isotopes in Industry and their Uses as Tracers". The course is designed for chemists, engineers and technologists from industry. The fee, exclusive of accommodation, is one guinea. Further information can be obtained from the Department of Chemistry and Biology, College of Technology, Bristol 1.

A SUMMER course on "Oilfield Reservoir Engineering" will be held in the University of Birmingham during July 2–28. The course, which will be residential, will comprise lectures by members of the Petroleum Production Department of the University and specialist lecturers from industry, including, in particular, the British Petroleum Co., Ltd. Further information can be obtained from H. Gilmour, Petroleum Production Department, University, Edgbaston, Birmingham 15.

THE Association of Applied Biologists will hold its summer meeting in Northern Ireland during July 19–21. After the reading of a number of papers on July 20 at The Queen's University of Belfast, the succeeding days will be devoted to tours of the Counties of Antrim, Londonderry, Down and Armagh. Further information can be obtained from the honorary local secretary, Dr. J. Colhoun, Department of Mycology and Plant Pathology, The Queen's University, Belfast.

A TWO-DAY summer meeting of the Royal Meteorological Society will be held in the University College of Wales, Aberystwyth, during July 26–28. On the first day there will be papers on ionization methods of measuring air density and a discussion on airflow, and on the next day papers on aspects of local climatology will be followed by a discussion on orographic effects in relation to rainfall. Further information can be obtained from the Assistant Secretary of the Society at 49 Cromwell Road, London, S.W.7.

A CONFERENCE on "Magnetism and Magnetic Materials", organized by the American Institute of Electrical Engineers in co-operation with the American Physical Society, the American Institute of Mining and Metallurgical Engineers, and the Institute of Radio Engineers, will be held in Boston during October 16–18. Those who wish to read papers should send in the titles by June 15, and abstracts by August 1, to T. O. Paine, Measurements Laboratory, General Electric Company, West Lynn, Mass., from whom further information can be obtained.

A SYMPOSIUM on "X-Ray Microscopy and Microradiography", sponsored by the International Union of Pure and Applied Physics, will be held in the Cavendish Laboratory, Cambridge, during August 16–21. The symposium is intended to be a gathering of those with some direct experience or interest, rather than a large public conference, and primary emphasis will be placed on the physical methods, in theory and practice. Sessions are planned on the reflexion, contact and projection methods, respectively; sessions will also be devoted to applications in biology, medicine, metallurgy and other fields, including industrial applications. Further information can be obtained from Dr. W. C. Nixon, Cavendish Laboratory, Cambridge.

THE eleventh annual conference and exhibition of the Instrument Society of America will be held in New York during September 17–21. The exhibition, which will be in the Exhibition Hall of the New York Coliseum, is for manufacturers and their representatives to display their range of instruments and control apparatus used in scientific, technological and engineering work; in particular, emphasis will be placed this year on the application of instruments to automation in industry. Further information can be obtained from the exhibition manager, Fred J. Tabery, Eleventh Annual Instrument-Automation Conference and Exhibit, 250 West 57th Street, New York City.

THE PRESENTATION OF SCIENCE TO THE PUBLIC

"WHY do scientists want to communicate science to the public, while lawyers do not show any such desire to communicate law ?" To answer this question, asked by Dr. H. J. T. Ellingham in the recent symposium on "The Presentation of Science to the Public", is to explain why it was organized. Unlike lawyers or doctors, scientists work in comparative isolation from other people, and so they are apt to feel, as Dr. Ellingham put it, a little misunderstood. Scientists are aware that the general public sometimes fears or dislikes science, which makes some of them keener to explain how their work may ultimately be valuable to everybody. Knowing, too, that theirs is a social activity, which depends in the end on public support, some scientists believe that they owe society an account of their doings. If they themselves do not help to give this account, then others less informed may give a misleading version. Finally, the popularization of science helps to recruit young people to a scientific career and to incline their elders to accept scientific findings.

For many years, therefore, scientists have felt a need to inform the public about science, and a few of those who responded to this feeling in the past, such as Thomas Henry Huxley, achieved a skill that can scarcely be bettered. New discoveries and inventions, new ways of presenting information and a new public require the problem to be tackled over again in every generation.

For such reasons the Institute of Biology (London Branch), the Royal Institute of Chemistry (London Section) and the Institute of Physics (London and Home Counties Branch) jointly organized a symposium on the subject, which was held on March 21 in the Senate House of the University of London under the chairmanship of Mr. A. L. Bacharach. The symposium was opened with papers by three experts in different media of presentation: Dr. Archie Clow (sound radio), Mr. A. W. Haslett (printed word) and Mr. James McCloy (television).

Dr. Clow distinguished two main methods of communicating science by sound radio—the talk and the "dramatized feature". The talk, with which he has been mainly concerned, presents the scientist together with the science, and the requirements for its success are four: something to say, a valid reason for telling the public, imaginative treatment, and ability of the scientist to perform. Since radio is paradoxically an intimate medium, the art of putting good conversational English into the script is fundamental. A radio talk differs from a printed article not only in style, but also because the listener cannot go back to consider again what he has not understood. The order of presentation of a radio script has to be very carefully planned: it should arrest the listener's attention with the first sentence, it should never allow him to lose the thread, and repetition is no sin.

Dr. Clow said that the knowledge of the listener should not be over-estimated. Of a group of 21-year old soldiers, the bulk knew that microbes cause disease, less than half that living organisms cause fermentation of beer, and about one in twenty that they turn milk sour.

Mr. Haslett discussed both readers and authors. Of readers, he said that they need interest, knowledge and general education. The question of who should write for these rather rare characters depends on the technical level of treatment in a channel of communication which begins with a letter in *Nature* and ends with a man in a public house. On highly technical levels the scientist, who knows more about the subject but less about how to explain it, should be the author; but at the other end of the scale, the professional science writer is essential. In between, both should collaborate.

Advising on how to write science, Mr. Haslett leaned heavily on Fellows of the Royal Society, individually and collectively. He passed on their recommendations to use short words and simple sentences, not to write for the half-dozen people in the world specially interested, not to be afraid of making a fool of oneself and to remember that no one really likes an equation. He also stressed the value of giving an honest account of how a discovery has been made, if by chance or through error, rather than tidying it up to look logical.

Mr. McCloy said that a television programme looks like film but is the child of radio. It differs from film in being a live act, in which the commentator visibly takes part. Science is a 'natural' for television, since experiments, demonstrations, models, charts, films, discussions and comment can all be built into one programme. As science programmes reach an audience of several millions, they have to be easily understood. It follows that a good science television broadcast is difficult to give and easy to receive.

No main speaker dealt with the role of museums; but this gap was filled by Dr. F. A. B. Ward, who pointed out in the discussion that museums have the advantages of operating in three dimensions, and of being able to present historic notebooks, apparatus and machines.

Discussion centred mainly on what may be called the problem of 'resistance', which has two sides: resistance of the public to understanding science, and resistance of the scientist to telling the public about it. As might be expected, the scientists joining in the discussion were more aware of resistance on the part of the public, while the professional presenters of science were at least equally concerned at the resistance of the scientists themselves.

The discussion was opened by one member of each participating Institute. All the openers considered how science may be presented in a way that people can easily take in. Speaking from long experience, Dr. Maurice Burton advocated stressing the personal note and telling a story. Dr. Kenneth Pankhurst preferred the word 'communication' to 'presentation', because the former implies a certain intimacy between the giver and taker of information. Sincerity and enthusiasm are essential, but they must be accompanied by skill in the medium used. Mr. Geoffrey Parr deplored inadequate illustration in popular science books; Beatrix Potter achieved the ideal relationship of words to pictures in "Peter Rabbit", and, as in "Peter Rabbit", illustrations should be coloured.

Mr. T. A. Margerison, on behalf of the Association of British Science Writers, welcomed the symposium, which he thought was the first of its type. He said there can be no question of the *élite* scientist spreading scientific enlightenment to the lay public, because the problem of spreading science among scientists is just as urgent as that of spreading it among the public at large.

Mr. Maurice Goldsmith discussed the resistance of scientists to appearing on television. In producing a weekly television magazine, he has found that a proportion of scientists hesitate to co-operate. Some are needlessly afraid of being used for commercial ends, others feel it beneath their dignity to appear on television or perhaps fear the disparagement of their colleagues, while some do not feel that anything can be achieved in the space of four minutes. He believes that scientists do not realize that 'cathode ray tube time' is quite different from any other form of time they know. It provides the opportunity for a new experiment in the popularization of science, enabling the scientist to put forward what he wants to say to an audience of five million.

The communication of science to scientists and to the public may be regarded as extensions of one another. It follows, as Mr. A. L. Bacharach[1] pointed out in a preceding symposium on "The Communication of Biological Knowledge", that the same underlying principles apply to the communication of science, whatever the audience. No mind, however good, can take in unfamiliar things without effort. The scientist, familiar with his own special field, should therefore present it to others (technically qualified or not) in such a way that the effort required is not beyond their capacities. Bad presentation on any level should be suspected as a cloak for muddled thinking or poor research. The present symposium, which showed that a representative sample of scientists recognizes such truths, may become a small landmark.

H. O. J. COLLIER

[1] Bacharach, A. L., *J. Inst. Biol.*, 3, 57 (1956).

LOW-TEMPERATURE CRYSTALLOGRAPHY

MEETING IN OXFORD

THE first joint conference of the X-Ray Analysis Group of the Institute of Physics and of the Low Temperature Group of the Physical Society was held at the Clarendon Laboratory, Oxford, during April 12–13 under the joint chairmanship of Dr. K. Mendelssohn and Mr. H. P. Rooksby. The subject of the conference was "Low-Temperature Crystallography", and the invited speakers dealt with both the technical aspects of X-ray work at temperatures down to 1° K. and also with the actual type of experiments where a low temperature is an advantage.

The first session was opened with an introductory paper by Sir Francis Simon (Clarendon Laboratory, Oxford). In this he emphasized that transitions which were not thought possible a few years ago do take place at low temperatures and that X-rays are one method of investigating the nature of these transitions. X-ray analysis can be used for giving information on the state of order of a system, this order being determined by the influence of the interaction forces between the components of a system. Order can exist only at low temperatures, and perfect order is only possible at the absolute zero. What we mean by a low temperature depends, of course, on the system we are considering; for diamond 1,000° K. is low, whereas for hydrogen 50° K. is high. X-rays can also give information on the form of the vibrational spectrum, and a combination of X-ray and thermal data should prove useful in entropy calculations based on the third law.

Dr. M. Blackman (Imperial College, London) dealt with the theoretical aspects of the effect of temperature on the reflexion of X-rays. He showed that from a generalized form of the Debye–Waller theory for a complex crystal, a characteristic temperature Θ_x can be calculated, and this can be compared with the characteristic temperature, Θ_{el}, derived from elasticity theory. The theoretical value of the ratio Θ_x/Θ_{el} for sodium chloride and potassium chloride did not agree with the ratio obtained from experimental results, and this discrepancy cannot, as yet, be resolved.

In a paper on a theoretical study of the variation of vibration amplitudes with temperature in some molecular crystals, Dr. D. W. J. Cruickshank (University of Leeds) discussed how the root-mean-square amplitudes of the translational and angular oscillations in benzene and anthracene have been determined by three-dimensional Fourier refinements with anisotropic parameters. From these amplitudes the various characteristic temperatures have been determined, and the temperature variation of the vibrational and rotational oscillations has been calculated. These show that, for studying fine details of electron density, it is much more advantageous to take measurements at 90° K. (or better still at $\sim$ 20° K.) than at room temperature, but that little extra is gained in this particular work by taking readings below 20° K.

Dame Kathleen Lonsdale (University College, London), in her paper on the determination of Debye factors by intensity measurements at low temperatures, showed that there are two independent ways of determining the Debye factors for crystal diffraction spectra: one is the original method of comparing the intensities at different temperatures with due regard to the existence of zero-point motion; the other uses the intensities at one temperature only, taking account of the positions and motions of the atoms as determined through a complete structure analysis. These methods have been compared from data on urea, and they have been shown to agree better than might have been expected, bearing in mind the possibility of change of atomic parameters with temperature.

Discussing low-temperature X-ray work on alkali metals and alloys, Prof. C. S. Barrett (University of Chicago) described an X-ray spectrometer in which metals can be cold-worked at temperatures down to 5° K. The X-ray studies show that, down to this temperature, lithium and sodium are the only alkali metals which partially transform on cooling. This transition is from the body-centred cubic to the hexagonal close-packed structure, the axial ratio in the hexagonal phase being very close to 1·633, the theoretical value for close packing. The transformation in lithium occurs at 70° K. On cold-working the lithium at low temperatures, there is a further transition, this time to the face-centred cubic structure. This does not appear to occur when sodium is cold-worked; but a similar transition does occur for solid solutions of magnesium in lithium.

Dr. W. B. Pearson (National Research Council, Ottawa) described X-ray cameras which have been built for use down to liquid-helium temperatures. These have been designed to have an accuracy of one part in 40,000, which is necessary for Debye–Scherrer photography if useful measurements of the change in lattice spacings with temperature are to be obtained. Other work to be done with these cameras includes the examination of structure changes in metals which are strained or subjected to high pressures at low temperatures.

The second session of the conference was opened with a paper by Prof. W. N. Lipscomb (University of Minnesota), who gave a general review of the techniques of low-temperature crystallography with particular reference to work on single crystals. After sketching briefly the history of single-crystal studies, he described the various methods of making single crystals for X-ray work. Many of these are gaseous or liquid at room temperature, and they require special methods for their production, the most common method being to crystallize the substance in a 'Pyrex' glass capillary. He also emphasized the need for keeping the production of frost down to a minimum, which can be done either by air-conditioning or by using a stream of dry air directed on to the apparatus. The consumption of liquid nitrogen, for cooling the specimen, can be quite considerable; for maintaining the specimen at −180° C. four litres per hour are required. Later speakers at the meeting, however, described cooling methods in which the consumption is much lower. Prof. Lipscomb's has been used for the completion of *hkl* data in B_5H_{11} and also for the investigation of transitions in ethylene chloride, hydrogen cyanide and nitrogen trioxide.

Dr. Aafje Vos (Laboratory of Inorganic and Physical Chemistry, Groningen) gave a review of recent Dutch X-ray work at low temperatures. This type of research has been done both at Amsterdam and at Groningen. In Amsterdam measurements on the electron-density projections of phthalic acid at −150° C. show an appreciable gain in resolution over those taken at room temperature. Low temperatures were also used in the investigation of the molecular compound of symmetric trinitrobenzene and benzene. At room temperature, pictures of the triclinic crystals showed a diffuse background with approximately hexagonal symmetry. This diffuse background disappeared completely at −150° C. The effect is probably due to independent thermal vibration of the individual molecules, and it seems most probable that the benzene molecules are responsible. In Groningen the crystal structure of 1,8-diphenyl-1,3,5,7-octatetraene has been examined at −100° C. in order to increase the accuracy of the determination of the bond-lengths. Standard deviations of about 0·003 A. and 0·04 A. were obtained for the co-ordinates of the carbon and hydrogen atoms, respectively. The use of low-temperature measurements has probably decreased the inaccuracy of the bond-lengths by a factor of two, and this is important if the experimental values are to be compared with theory. While in most of this work the specimens were cooled by a stream of cold air, another technique was described in which liquid nitrogen was dropped directly on to the specimen to cool it. In this apparatus the consumption of liquid nitrogen was 0·5 lit./hr.

Recent low-temperature crystallographic studies in France were described by Dr. A. J. Richard (Kodak-Pathé, Paris). This work was done at the Laboratoire Central des Services Chimiques de l'État. A Weissenberg camera was used in the temperature range − 160° to 20° C., the specimen being cooled by nitrogen gas obtained by boiling liquid nitrogen wit an electric heater. The temperature variation ove several hours was not more than five degrees, an during a period of one hour it was less than on degree. Structure studies were undertaken on nitri acid and its one- and three-molecule hydrate (V. Luzzati); one-, two-, three-, four-, five and seven-molecule hydrates of sodium hydroxid (P. W. Hemily); sulphuric acid and several compounds of the tertiary system nitrogen pentoxide–sulphur trioxide–water (R. Pascard); salicylic anhydride (Mme. P. Bourre); and acetaldehyd (A. J. Richard).

Another apparatus for maintaining specimens a low temperatures was described by Dr. J. H. Robertson (University of Leeds). In this the cold gas stream is again used for cooling, in order to give the minimum of interference with the X-rays, and by careful design the consumption of liquid nitrogen has been reduced to 1/7 lit./hr. The gas flow is very steady, the variation being only about 1 per cent over a period of 4½ hr. While the apparatus has not as yet been used with liquid hydrogen, it is hoped that it will be satisfactory in the temperature range down to 20° K.

Mr. M. H. Francombe (Research Laboratories, General Electric Co., Ltd., Wembley) gave a paper on the application of low-temperature powder photography to studies of magnetic and dielectric phenomena. A 19-cm. camera which incorporates a gas cooling system for the specimen was described and exhibited. The apparatus has been used for studying structural changes which occur in antiferromagnetic, ferrimagnetic and ferroelectric powders.

A paper by Dr. J. A. S. Smith (University of Leeds) showed how nuclear magnetic resonance measurements at low temperatures can give additional information in structural analysis. A general review of nuclear magnetic resonance methods was given, taking as an example work on benzene and ammonium chloride in which the behaviour below and above their nuclear magnetic resonance transitions was compared. From the variation of the line-width and relaxation-time in and above the transition region, the predominant molecular motions in the crystals could be investigated. In another series of experiments low temperatures were used to remove the narrowing effects of molecular motion on the line-width. This work has been done with sodium borohydride, hydrazinium oxalates and several hydrates. The results seem to cast further doubt on the existence of the ion H_4O^{++}.

Dr. C. H. Shaw (Ohio State University) read a paper on an X-ray determination of the structure of liquid helium. This work, which was done in collaboration with W. L. Gordon and J. G. Daunt, used proportional counter techniques for determining the intensity of the X-rays scattered by the liquid helium. Beryllium windows, 0·002 in. thick, were used to admit the X-rays through the vacuum jacket into the cryostat. The background count was reduced to 4 per minute. At scattering angles greater than 60°, no difference was found in the form of the diffraction patterns at 1·4 and 4·2° K. The low-angle results, however, which were taken at 1·4, 2·4 and 4·2° K., showed that there was a change in correlation number as the temperature was reduced, but that there seemed to be no definite change associated with the lambda point. X-ray measurements on tungsten showed that there was a maximum in the characteristic temperature, Θ, at 17° K. The existence of uch a maximum can also be derived from measurements of specific heat. In the discussion, Dr. M. lackman stated that on theoretical grounds this maximum is very difficult to explain.

In a paper on measurement of lattice parameters and thermal expansion at low temperatures, Prof. . O. Jones (Queen Mary College, London) described work done in collaboration with B. S. Figgins and . P. Riley. The apparatus was designed so that only the specimen was at the low temperature, and an accuracy of 1 in 10^5 in the measurement of the lattice parameter could be achieved. The temperature could be kept constant to 0·05 deg. at the lowest temperatures. So far, measurements of the lattice parameter (and hence of the thermal expansion) of aluminium have been carried out between 0° and 125° K. The results confirm earlier work of Bijl and Pullan, that at low temperatures there is a considerable deviation from Grüneisen's law. Measurements on solid argon are also in progress. In connexion with this work, Dr. E. R. Dobbs (Queen Mary College, London) gave a short contribution in which he described a simple back-reflexion camera for experiments on solidified gases down to 77° K. This has been used for work on solid krypton.

Mme. L. Couture (Centre National de la Recherche Scientifique, Bellevue) described work, done in collaboration with P. Jacquinot and I. Tsujikawa, on optical observations of transition in crystalline hydrates at low temperatures. The experiments showed that the absorption spectra of some substances (in particular, certain of the alums) changed at low temperatures, and these results were compared with corresponding changes which had been found in measurements of paramagnetic resonance. Complete agreement between paramagnetic and optical results was not achieved, but nevertheless the optical experiments confirmed that changes in crystalline structure do occur at low temperatures, especially in some of the chromium alums.

The conference showed that, while a large amount of X-ray work is already being done at temperatures down to 77° K., using liquid nitrogen as the coolant, not very many experiments have been done at lower temperatures, using liquid hydrogen or liquid helium as the coolant. There is still a very wide field of research open to anyone who has the necessary cryogenic facilities. In addition to the lectures already described, an evening discourse, entitled "Molecular Crystals", was given by Prof. J. D. Bernal (Birkbeck College, London).

In a meeting of the X-Ray Analysis Group which preceded the joint conference, a discussion was held on the collection and classification of crystallographic data for determinative and reference purposes. The discussion was opened with contributions by Dr. J. W. Hughes (University College, Cardiff) on the A.S.T.M. index, Prof. E. G. Cox (University of Leeds) on the single-crystal index, Dr. M. H. Hey (British Museum) on the Barker index of crystals, and Dr. L. E. Sutton (University of Oxford) on a bond-length index. Dr. W. B. Pearson (Ottawa) gave details of the index of metals and alloys which should soon be available. Several speakers in this discussion emphasized the need for research workers to send in their crystallographic and X-ray data to the compilers of the various indexes. Many of the data are obtained as an incidental part of some other research, and very often they are not published. Hence, they are overlooked when reference books are being written.

A full account of the conference will be given in the *British Journal of Applied Physics*. The next conference of the X-Ray Analysis Group will be held in London during November 16–17; two sessions will be devoted to biological structures, and one session to computational methods.

H. M. ROSENBERG

DIGITAL COMPUTER TECHNIQUES

A CONVENTION on "Digital Computer Techniques" was held in London at the Institution of Electrical Engineers during April 9–14, at which more than fourteen hundred persons attended, including 127 delegates from overseas countries. These figures emphasize the rapid growth of interest in this field, since at a similar convention, held three years ago, only two hundred in all were present. On the evening of April 9, after the convention had been opened by the president of the Institution, Sir George Nelson, an inaugural address was given by the president of the Royal Society, Sir Cyril Hinshelwood, and this was followed by an introductory lecture by Prof. F. C. Williams. During the next three days, fifty-eight papers were read. The papers had been divided into two groups: those of general interest, and those of interest to specialists. Normally, a general and a specialist session were held simultaneously, so that in this way both the non-expert and specialist were satisfactorily accommodated. On the last two days of the convention, visits to typical computer installations were made. These visits had been arranged with the co-operation of commercial companies, government establishments and universities; nearly nine hundred delegates availed themselves of these opportunities.

In his address, Sir Cyril Hinshelwood referred to the diverse lines of thought which have been successfully combined in the computing machine of to-day. Essential contributions have come from the theory of numbers, the relations between mathematics and logic, the discovery of various electric and magnetic phenomena, and the invention of the thermionic valve. He emphasized that the philosophy, in this case of machine design, preceded the actual construction and thus was not an afterthought about results, as it sometimes is. Having introduced the computing machine in this way, he then turned to view and speculate upon the interesting and exciting panorama which is beginning to unfold before us. On the scientific side there is now the prospect of solution of hitherto intractable problems; in the business world the mechanization of all kinds of clerical work and accountancy can be contemplated; and in industry the process of automatic control can be improved and carried a further step towards the final goal of complete 'automation'. The use of machines in this way must effect a displacement of man-power, and could amount to another industrial revolution. Sir Cyril Hinshelwood expressed the hope that any necessary redistribution of labour would be carried out without any serious results from the human and economic points of view. Finally, after a brief excursion into the seemingly age-old problems of 'Can machines think?' and the 'machine–brain analogy', he concluded by expressing his admiration of this work and his great confidence in its future.

In his lecture, Prof. Williams indicated the rapid development in the field of digital computers by considering the history of a typical computer installation, namely, that at the University of Manchester. Parallel developments have occurred elsewhere, but he selected this installation because of his familiarity with it. During the period 1946–56, two large-scale machines and one experimental transistor machine have been constructed. A commercial version of the first large-scale machine has been in continuous operation since 1951 and has now completed some 17,500 hours of useful computation. During this period, thirty-four different groups of users drawn from other universities, government establishments and industrial firms have operated the machine. Furthermore, 104 people have been trained to use the machine, and sixty-six scientific papers have been published using machine results. A commercial version of the second large-scale machine will be in operation at the University near the end of this year.

Prof. Williams went on to say that machines are attractive for many reasons: first, they can be universal so that they are capable of solving a large variety of problems; secondly, they are automatic, so that only a small amount of human intervention is needed; and finally, they are very fast, so that computation times are cut and, what is more important, many calculations previously impossible now become feasible. Machines are also relatively error-free; at the present time, on an average the machine makes one mistake in 4 million operations. What human being could compare! Moreover, though the hire of a machine appears expensive, in terms of cost per operation a machine is fifty times cheaper than a human computer would be. This latter comparison is only applicable if the machine is fully employed.

Looking a short distance into the future, Prof. Williams forecast machines which would be simpler to use, smaller in size, more economical in terms of power consumption, and also more reliable. However, the major steps, he stated, would be in the realization of the potentialities of these machines, and so a rapid expansion in the application of machines would result to the ultimate benefit of all. He concluded his lecture with the following remarks: "If at this juncture we are swollen headed with the sense of our achievements, or alternatively despair of further improvements, we have only to consider, for example, a rose seed. This very small particle contains all the data necessary for the manufacture of an unending and ever increasing supply of roses".

All the sessions on April 10 were of a mathematical nature and thus more of interest to the machine user. The topics of discussion in the specialist sessions were numerical analysis and logical design, five papers being presented. Computer applications were discussed in the general sessions, these being divided up into three sections: engineering and scientific calculation; business applications; and industrial control. Many papers were presented, the variety in the subject-matter illustrating immediately the universal nature of these machines. Topics ranged from testing the design of a proton synchrotron, to payroll calculations and the exploration of functional relationships in industrial processes. The main item of discussion during the day was a vital one, namely, that of machine reliability. Dr. I. J. Faulkner placed this particular problem in its right perspective, when he stated that progress towards a machine possessing a reliability of 100 per cent is very desirable, but no piece of equipment, whether electronic or not, yet possesses this feature. Further, until absolute perfection is guaranteed, systems dependent on a machine wi have to be designed to 'fail safe'. In the light of thes remarks, machines at the present time are adequatel reliable for a great deal of progress to be made Indeed, if the argument of waiting for more reliabl machines were adopted, nothing would be achieve for a very long time.

The general sessions on April 11 were devoted t machines existing or in the process of construction i Great Britain. Two large-scale computing machine are now commercially available. One is the 'Deuce' which possesses a high-speed store of approximatel 12,000 binary digits located in mercury delay-lines A magnetic drum-type store of capacity 260,00 digits is also provided which has electronic selectio of a block of sixteen heads. Further blocks of thes heads are selected by means of a novel mechanica system. Input and output facilities are provided b means of punched cards. In the second machine 'Mercury' magnetic core storage is used, and thi high-speed memory contains 40,000 binary digits Further storage of 650,000 binary digits is divide over four magnetic drums. Selection of the heads o these drums is entirely electronic. An interestin feature of this machine is its power to carry out 'floating point' arithmetic in a completely automati manner. Input and output facilities are at th present time by way of teletype tape. In addition t these two machines, numerous smaller-scale model are being constructed.

The two specialist sessions, one on rapid acces storage and the other on magnetic tape systems, als aroused great interest. At the first session Mr. N. H. Taylor, of the Massachusetts Institute of Technology, reviewed the history of the magnetic core store and gave an account of its present development in the United States. The climax was reached when he stated that a two-million digit store is well under construction at the Institute. In Britain the cost of the cores alone would be £80,000, which is greater than the complete cost of either of the machines already mentioned.

In the second session, two papers devoted to the development of tape systems moving the tape at speeds of the order of 100 in./sec. and with digit packing densities of approximately 100 digits/in. were presented. The tape is capable of moving in either direction and can accelerate up to full speed in the order of 15 m.sec. A further paper in this session discussed the design and operation of a head which is capable of reading digits off a tape even when this tape is stationary. At the present state of development, the head can identify digits with a packing density of 50 digits/in. The discussion revealed that many people realize the potentialities of this type of head.

At the first general session on the last day the design and construction of two point-contact transistor machines, one at Harwell and the other at the University of Manchester, were discussed. These operate at digit frequencies of about 100 kc./s. It is apparent that transistor development in Britain lags far behind that in the United States, since the latter already have transistor prototype machines functioning at a digit frequency of 5 Mc./s. At a subsequent specialist session, a lively debate took place on two papers utilizing techniques based on the combination of magnetic cores and junction transistors.

Other sessions on analogue/digital conversion and circuit techniques and components were held, but the main interest was aroused in a session discussing the computer in a non-arithmetic rôle. Here papers were presented on language translation, the playing of games and, finally, character recognition. A contribution was made by the U.S.S.R. delegates, who have been carrying out English to Russian translation on one of their machines since early in 1955. They assured their audience that the result was good Russian.

In conclusion, it can be stated that the convention brought together a large amount of detailed and expert technical knowledge in the various aspects of digital computers and their use. There is no doubt, too, that it proved valuable in some way to all who attended. The complete proceedings of the convention, containing the addresses, lectures, full text of all papers, and reports on the discussions, will be published in three issues as a supplement to Part *B* of the *Proceedings of the Institution of Electrical Engineers*.

DAVID B. G. EDWARDS

BRITISH AGRICULTURAL HISTORY SOCIETY

ANNUAL MEETING

SINCE it was founded in 1953, the British Agricultural History Society has held its annual meeting near Easter, and this year's meeting was at the Florence Nightingale Hall, University of Nottingham, on April 13. Officially, the annual general meeting is confined to one day—a business meeting in the morning followed by one or more papers read by members, and either more papers in the afternoon, or a visit to some point of interest. In addition, however, an after-dinner lecture was given in the evening of the previous day by Mr. John W. J. Higgs, curator of the Museum of Rural Life, Reading, and also honorary secretary of the Society. His lecture, which dealt with the problems involved in the identification and preservation of agricultural exhibits, was pleasantly informal and illustrated with lantern-slides. From the pictures it was clear that it is often difficult to discern the use of an object sent in, and even more so to date it. One such question arose out of the discovery on English farms of numbers of ox-shoes, or cues. It seems quite unlikely that bullocks on a farm would ever be shod, even if they were used for draught purposes, though they might be if used on roads. The explanation is probably that the animals were shoed before being brought from distant breeding-areas—Wales and Scotland, for example—and that it was not worth taking off any that remained on after the journey; eventually the shoes wore off and were dropped on the farm where the beasts were grazed. Many other similarly perplexing questions arise.

After the business meeting on April 13, the rest of the morning was occupied by two lectures, the first of which, given by Malcolm Gray, lecturer in economics in the University College of North Wales, Bangor, was on the "Consolidation of the Crofting System, 1750–1850". The story is extremely complex. Until 1815, population increased in the Western Highlands and Islands, and the number of crofts went up. Many were quite minute, only an acre or two. Attempts were made to meet the demand for land by rearranging the holdings, a kind of enclosure, but very different from the work done under Enclosure Acts in England. The kelp industry and the linen industry did a good deal to ease conditions, and the introduction of the potato was a boon. It provided more food from a given area than a grain crop. But it was attacked by disease, and the kelp industry lost ground in face of the competition of imported potash. These two factors, and a number of others, helped to make it difficult for the crofting system to survive. Dr. W. G. Hoskins, reader in economic history in the University of Oxford, gave the second lecture, which was on "Sheep Farming in Saxon England". There is only limited and scattered evidence on which to base such a lecture. A little is supplied by archæology, some by the study of place names, and some by a few documents. From these sources Dr. Hoskins has deduced the distribution of sheep in Anglo-Saxon England, and has estimated the total number as being about six million, or three or four sheep to each human being.

In the afternoon a visit was paid to the open fields at Laxton, now owned and preserved by the Government. Dr. J. D. Chambers, of the University of Nottingham, who is well known for his studies of the eighteenth century, acted as guide, and Mr. Rose, bailiff of the Manor, showed the fields.

THE PLACE OF UNIVERSITIES IN AUSTRALIA

THE Australian Vice-Chancellors' Committee has published in pamphlet form a symposium of papers on "The Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities", which were delivered during August 11–12, 1955, at a Commonwealth Inter-University Conference arranged in Australia by the Association of Universities of the British Commonwealth and the Australian Vice-Chancellors' Committee*. The first of these papers, by Prof. P. H. Partridge, on the Australian universities and Governments, gives a clear account of the closer dependence of Australian universities upon the State and Federal Governments, and this paper will assist those in Britain to understand some of the difficulties and dangers to which the Australian universities are exposed and also some episodes that may have puzzled those reading about them. Moreover, some of these dangers, such as that arising from the tendency in the thinking of Governments to subordinate research, advanced scholarship and post-graduate studies to the more elementary functions of making it possible for large numbers to gain degrees, could arise in Britain in appropriate circumstances; and Prof. Partridge notes other factors, such as the absence of any considerable proportion of university-educated men among Australian politicians, which have contributed to lack of understanding of the universities or respect for their autonomy in Australia. While he thinks the existing structure may be unhealthy and dangerous, he does not think that the independence of the Australian universities has been affected as much as might have been expected.

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* Australian Vice-Chancellors' Committee. A Symposium on the Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities. Pp. 66. (Canberra: Australian Vice-Chancellors' Committee, c/o Australian National Committee. London: Association of Universities of the British Commonwealth, n.d.)

Prof. Partridge, moreover, offers some wise counsel to the universities which has relevance even in the more favourable circumstances of Britain. He suggests that, in spite of obvious dangers and difficulties, the universities should, in partnership with the Commonwealth and State Governments, attempt to evolve national policies of expansion and policies which will provide for some measure of specialization in the different universities, particularly in research. It is not unreasonable, he argues, to expect that the universities should at least explore the possibility of using as rationally as possible the greater resources placed at their disposal by the State, and there is much to be gained from the point of view of academic standards by not dispersing available workers too thinly over a comparatively large number of institutions. To take the initiative in such ways would, he believes, strengthen the universities themselves and might also facilitate the change in thinking of the State Governments which he also thinks desirable for the use of Commonwealth funds and to meet national needs. What Prof. Partridge urges has some relevance to the expansion of technological education in Britain.

The paper by Prof. D. M. Myers on the Australian universities and industry is essentially a factual account of these relations during the past hundred years, which emphasizes the factors dominating the present scene, such as the dependence of the Australian economy on its primary products, the extreme concentration of the population and of secondary industries in several major centres, and the unusual position in industrial research occupied by government institutions such as the Commonwealth Scientific and Industrial Research Organization. Prof. Myers comments on the unfavourable effect on the universities of this uneven distribution of the population, with the consequent tendency to parochialism and absence of interchange of staff, and he believes that it will be a happy day, too, for Australian industry when the universities regain a proper balance in their activities and are dependent on direct grants through an appropriate body set up for the purpose rather than on the support of a government body established for definite practical objectives. Prof. Myers makes some practical suggestions for future relations between Australian universities and industry on these lines.

Prof. A. Boyce Gibson's paper on the Australian universities and public opinion makes some sound points which should be noted in Britain, though he thinks that, in general, Australian universities have more to learn about public relations from the United States than from Britain. He suggests that the universities should do more to communicate their own scale of values and that the best way to open up public opinion is to do things the use of which is apparent to people uninterested in inquiry and scholarship: in science, by increasing welfare; in arts, by raising the standards of discussion and entertainment.

Prof. R. M. Crawford, discussing postgraduate studies in the non-science faculties, which he suggests are freer than the scientific and technical faculties from the restricting effects of the demand for highly trained professional artisans and research workers, does not believe that research and teaching staffs should be separated, but that more guidance could be offered at the undergraduate stage and that the quality of research rests fundamentally on the quality of the undergraduate schools. He stresses the importance of travel and of minimizing professorial administration. Dealing with postgraduate studies in science and engineering, Prof. L. H. Martin also deprecates the tendency in Australia to favour complete segregation of research from teaching and, in particular, to subjugate research and its proper function to the university's responsibility for postgraduate training. In the absence of a background of tradition, the Australian university, he urges, must foster close association with the community which supports it, and here the technological departments have a special responsibility. Prof. Martin is concerned that the average quality of science students has deteriorated in the post-war years. First-class talent is becoming rare among science graduates. There is evidence in Melbourne that the number of Ph.D. candidates in science is likely to decrease, and in 1954 there was only one applicant for the most prized travelling scholarship in science offered within member countries of the British Commonwealth. He also believes that lack of finance, including inadequate salaries, is the fundamental cause of frustration in Australian universities.

UNIVERSITY EDUCATION IN HUNGARY

At the eighth university conference organized by the International Association of University Professors and Lecturers and held in Vienna during September 9–14, 1954, Prof. L. Tamas, of the University of Budapest, described the development of university education in Hungary since 1945.

In recent years there has been a vigorous expansion in university education. In the year 1937–38 there were 12,000 students in the universities and the *grandes écoles* (13 per 10,000 population); in the year 1953–54 there were more than 53,000 such students (56 per 10,000 population). There were 473 foreign students in Hungary, and, with the exception of Australia, all quarters of the world were represented. In 1938–39 Hungary had 16 universities and *grandes écoles* with 37 faculties; to-day there are 33 universities and *grandes écoles* with 56 faculties. In 1952 and 1953 the State budget had given almost 260 million forints to the construction of new universities and the expansion of the older institutions.

Prof. Tamas also spoke of student conditions. In former years, the children of workmen and peasants, who formed the greater part of the country's population, represented 3½–4 per cent of the total number of students; to-day they constitute more than one-half of the total student body. Women students, to whom all careers are now open, represented 13 per cent of students in 1937–38. To-day the proportion is 26½ per cent. A noticeable change has taken place in the subjects read. Previously, more than one-half of university students and one-third of the total number of students followed courses in the faculty of law, while those who undertook technical and scientific studies formed much the smallest group. To-day this proportion is reversed: 47 per cent of the total number of students are registered in technical and science faculties, while 3 per cent only follow law courses.

A great deal of State assistance is given to university students. More than three-quarters pay no fees, the remainder pay minimum terminal charges. There are no charges for laboratory-work or examinations.

More than 90 per cent of the students benefit regularly from bursary grants, 17,000 reside in student hostels, and 24,000 feed in student canteens. There is medical and social aid.

Prof. Tamas discussed curriculum reforms which have been introduced and brought closer in line with the country's economic and practical needs, and the extent of the advanced and research work undertaken in the Hungarian universities.

RED FOX IN THE UNITED STATES

AN evaluation of the red fox in the United States has been made by Thomas G. Scott, on behalf of the Illinois Natural History Survey*, which suggests that the fox has shown no sign of declining in numbers and that it has unusual capabilities for survival despite keen competition; the opening-up of forest lands and the reduction or elimination of wolves and coyotes seem to favour foxes. Some reports on rabies outbreaks in the eastern United States indicate that the fox is fully capable of reaching population-levels which are too high to serve its own interests.

The role of the red fox as a predator appears to be the most important of the various factors affecting the economic position of this animal. It tends to take the foods which are most readily available, and thus its diet varies immensely both with the season and the environment. The diet does not reflect precise, automatic adjustments to changes in population-levels of specific prey. For example, during the spring and summer, when prey such as rabbits, mice and birds are found in increasing numbers, the frequency of occurrence of these items in the fox's diet declines where acceptable fleshy fruits and insects are available. Thus it would be unwise to claim or expect an increase in numbers of prey species in response solely to the reduction or elimination of red foxes. A large-scale experiment with the reduction of a fox population as a means of increasing a pheasant population in New York State resulted in the conclusion that "despite reducing the fox population to a very low level, fox control on the Seneca County area did not increase pheasant abundance appreciably and certainly not to a degree commensurate with the cost". Though foxes unquestionably prey upon vulnerably situated poultry, and to a lesser extent on small pigs and lambs, it seems that poultry losses result largely from failure of owners to follow recommended poultry-husbandry practices.

Foxes are among the most important vectors of rabies in the United States, and herein probably lies their greatest nuisance. People living in an area where rabies has been reported experience great mental distress, and may even have to suffer the physical discomfort of Pasteur treatment if attacked. It is certain that losses occur among livestock infected through the bites of rabid foxes. When rabies breaks out in a locality of high fox population, the disease is likely to continue until the foxes in that general area are virtually exterminated; this may take from one to three years.

The most desirable method known for bringing rabies outbreaks among foxes under control has proved to be population reduction by means of organized trapping; but whether the several million dollars that has been paid out during the past twenty years on fox bounties has been money well spent is a question open to doubt. Experience in Pennsylvania indicates "that probably 50 per cent or more of the mammalian predators (red fox, gray fox, and weasel) would have been killed regardless of the bounty". The bounty system cannot be directed efficiently toward the reduction of specific, excessive fox populations because the administrative areas in which funds are approved for bounties seldom conform with the particular areas needing attention. The economic demand for red fox pelts is at present very low. The sport of fox-hunting contributes to the reduction of fox populations, and the survey, which is well illustrated, discusses the ethical and æsthetic values involved in this sport.

STIMULATION OF YIELD FROM RUBBER TREES

A GOOD deal of work has been done at the Rubber Research Institute of Malaya, both before the Second World War and, more recently, on the stimulation of yield in the rubber tree *Hevea brasiliensis* by applications of vegetable oils (for example, palm oil) and various synthetic substances, and several aspects of this are described by E. D. C. Baptist and P. de Jonge in the *Journal* of the Institute (14, 355; 1955). A brief historical review is given of methods used for stimulating the latex yield of rubber trees, and experiments are described in which vegetable oils applied to lightly scraped bark below the tapping-cut resulted in large increases in yield.

The results of these early experiments provided a clear picture of the reaction of the tree to yield stimulation and led to the development and commercial use of yield stimulants. Similar application of a number of synthetic growth substances in an oil vehicle has also resulted in increases in yield and in the thickness of renewed bark above the cut. Repeated applications of the treatments at six-monthly intervals over a period of three years have not resulted in an increased incidence of 'dry' trees; but the yield response is found to decrease with each successive treatment. Monthly treatment with yield stimulants of renewing bark just above the tapping-cut has also resulted in greatly increased yields and in an increase in bark thickness; the latter is confined to the non-latex-bearing tissues of the outer bark. A study has been made of the effects of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) on the rubber extraction area of the bark on tapping, the incidence of brown bast, rate and duration of latex flow, anatomical structure of the bark, and the properties of latex and dry rubber.

The response of the rubber tree to yield stimulants is shown to be influenced by the condition of the bark, the type of planting material, the tapping system, the composition and method of application of the mixture. An extension of the area of rubber extraction in the bark of trees in normal tapping as a result of treatment with yield stimulant has been demonstrated experimentally and is thought to account for the increased yields obtained and for the low incidence of brown bast after repeated treatment. The increase in bark thickness observed is caused by induced meristematic activity in the cortical and phloem regions, resulting in prolific development of undifferentiated parenchyma tissue, and not by activation of the vascular cambium. The rate and duration of latex flow are increased afte treatment with a yield stimulant, and there is slight decrease in the dry rubber content of the late which usually reaches its lowest value in the secon month following treatment.

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* Natural History Survey Division of the State of Illinois. Biological Notes No. 35: An Evaluation of the Red Fox. By Thomas G. Scott. Pp. 16. (Urbana, Ill: Department of Registration and Education, 1955.)

PROPHYLACTIC ACTIVITY OF SURAMIN COMPLEXES IN ANIMAL TRYPANOSOMIASIS

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THE first, and still the most effective, prophylactic drug for bovine trypanosomiasis is 'Antrycide Pro-Salt' (a mixture of antrycide dimethylsulphate and antrycide chloride)[1,2]. Experience has shown that the maximum reliable prophylaxis obtainable with this drug is approximately two months[1-3]. The administrative work, however, required to locate and inject nomadic cattle six times a year at two-monthly intervals is usually too great to be practicable.

Some preliminary results of an investigation designed to extend the existing period of prophylaxis, using trypanocidal drugs in common use, are described here.

The possibilities of using a suramin–pentamidine salt complex to extend the pentamidine prophylaxis of human trypanosomiasis were indicated by Guimaraes and Lourie[4]. On the basis of an observation made by Lourie during a sleeping sickness campaign in 1939–41[5], these authors showed that suramin could inhibit many of the pharmacological or toxic effects of pentamidine, primarily by the formation of an inactive salt complex. Experimental confirmation of extended pentamidine prophylaxis in rats by this method has been reported by Schneider (see ref. 8), and by Cosar, Ducrot, Gailliot and Baget[6]; Beaudiment and Zozol[7] and Beaudiment, Cauvin and Leproux[8] have further shown that suramin can reduce the toxicity of pentamidine in man.

It seemed probable that suramin might form similar salt complexes with drugs active in bovine trypanosomiasis, which are all strongly basic compounds like pentamidine. Suramin was, in fact, found to form insoluble precipitates *in vitro* with solutions of ethidium and dimidium bromides, the *bis*-cinnolinium compound '528'[9], antrycide dimethylsulphate, and a new German diamidine-type trypanocide 'Berenil' (di-(amidinophenyl)-triazene (-N-1: 3) diaceturate)[10].

As ethidium bromide is the most active member of this group, prophylactic experiments in rats and mice were begun, using combined treatment with suramin and ethidium bromide. At this time, Dr. W. E. Ormerod kindly made available to us the results of his experiments on the suramin detoxication of antrycide dimethylsulphate[11], following an analogy between the pharmacological effects of antrycide and curare; the toxicity of the latter was known to be reduced by prior administration of acid dyes such as congo red[12], which is related to suramin.

Although initial experiments showed that some degree of prophylactic activity was being conferred on ethidium bromide by suramin administration, the toxicity of the former drug was not markedly reduced by simultaneous or prior treatment with a separat injection of suramin under widely varied conditions The quantitative basis of complex formation wa therefore examined, since, theoretically, one molecul of suramin, with six sulphonic acid groups, coul combine maximally with six molecules of ethidium or dimidium bromide, or with three molecules o antrycide, '528', 'Berenil' or pentamidine. Gravimetric analysis showed that the combining proportions did in fact approximate closely to th theoretical, and suspensions of the precipitated complexes prepared by mixing aqueous neutral solution of the drugs according to these proportions wer afterwards given throughout as a single injection.

Results in rats given a single subcutaneous maximum tolerated dose of the suramin complex o ethidium, dimidium, antrycide, '528', and 'Berenil' showed that there was a maximum decrease in th toxicity of these drugs of approximately 10-, 5-, 14 8- and 3-fold, respectively. Prophylactic experiment in rats and mice repeatedly infected intraperitoneally with a virulent strain of *Trypanosoma congolense* showed that suramin-complex formation induced o increased prophylactic activity in all the drugs tested but to a varying degree. In the case of dimidium ethidium, and '528' the increase was only of th order of a week or two; with 'Berenil' the increase was approximately five to seven weeks, and with antrycide dimethylsulphate, more than fifteen weeks

Suramin complexes of three trypanocidal compounds have been tested in cattle for prophylactic activity; these were antrycide dimethylsulphate–suramin, ethidium bromide–suramin and 'Berenil'–suramin. Since the 'Berenil'–suramin complex showed little prophylactic activity even at a dosage o 40 mgm./kgm., it will not be discussed in this communication. (Dosages throughout refer to the amoun of the basic drug present in the complex, and *not* t the total amount of the complex.)

The trials were carried out at the Institute's laboratories at Vom, which is in a tsetse-free area The animals used were zebu cattle and each wa given a *single* injection of drug-complex or, in th case of controls, the drug alone. The animals wer then challenged repeatedly with cyclically transmitted trypanosomes. This challenge was delivered by *Glossina palpalis* reared in the laboratory, which had first been given multiple feeds on an ox or sheep heavily infected with *Trypanosoma vivax*; subsequen sample dissections showed that 90 per cent or mor of the flies in each batch were infected. Batches o 100–150 infected flies were fed on each experimental animal for three consecutive days, and this challeng was repeated every ten to fourteen days until break able 1. PROPHYLACTIC ACTIVITY OF SURAMIN COMPLEXES IN ZEBU CATTLE

Drug	Dose*	No. zebu used	Prophylaxis afforded (days)
Antrycide dimethylsulphate (control)	5 mgm./kgm.	3	39, 41, 52
Antrycide pro-salt (control)	5 mgm./kgm.	5	69, 72, 75, 80, 91
Antrycide dimethylsulphate – suramin complex	10 mgm /kgm.	5	95, 95, 115, 120, 129
	20 mgm /kgm.	5	135, 146, 149; 2 animals still not infected at 196 days
	40 mgm /kgm.	5	162, 163, 179; 2 animals still not infected at 196 days
Ethidium bromide (control)	5 mgm /kgm	4	57, 102, 122, 147
Ethidium bromide – suramin complex	5 mgm /kgm	2	216; one animal still not infected at 217 days
	10 mgm /kgm.	3	None infected to date (217 days)

* Dosage of complexes refer to amounts of antrycide dimethyl-lphate or ethidium present in complex form.

rough occurred. Four strains of *T. vivax* were sed in this manner. The zebus were also challenged ith wild *G. longipalpis* from Southern Nigeria which ere infected with both *T. vivax* and *T. congolense*.

The results of these trials are summarized in able 1. No toxic symptoms were noted at any osages of complexes given. There was the usual welling due to the depot of drug, but the surrounding rea did not become inflamed or oedematous. It will e seen that considerably more drug in complex form an be given safely than the known maximum safe oses of the drug alone. This is especially true for ntrycide dimethylsulphate, where the maximum olerated dose of the drug alone is 5 mgm./kgm., but n complex form the maximum tolerated dose is 0 mgm./kgm. Detoxication is less marked in the ase of the ethidium–suramin complex, where 10 mgm./kgm. appears to be the maximum tolerated dose. This is compensated for, however, by the marked prolongation of prophylactic activity of ethidium complex at low dosage. Reference to Table 1 shows that in the case of the antrycide dimethylsulphate complex the ability to give more drug safely results in a markedly increased prophylactic period; at the highest dose used (40 mgm./kgm.), at least five and a half months protection can be relied upon.

Although the number of animals used for the ethidium-complex trial is small, there is every indication that this complex is the most promising. This is of interest since the prophylactic trials in small animals gave little indication of its activity in cattle. Seven months protection has been afforded by as little as 5 mgm./kgm. of complex, and at 10 mgm./kgm. no break-through has yet taken place after 217 days. A larger trial with the ethidium-complex is planned. A full account of these trials will be published elsewhere.

We are indebted to Dr. T. A. M. Nash, director of this Institute, for his continued interest and encouragement of this work. [March 28

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DIAMOND AS A PINPOINT RADIATION COUNTER*

By W. F. COTTY

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SINCE van Heerden (1945) reported that silver chloride, at low temperature, would detect -particles, several other crystals have been found hich possess this property. In this work I am oncerned with only one of them, namely, diamond, room-temperature counter discovered by Woolridge, Ahearn and Burton[1]. A crystal with this dvantage makes the design of a practical crystal ounter much simpler, and my work has been hiefly concerned with investigating the possibilities the diamond may have of eventually being developed nto a useful pinpoint counter.

Besides its ability to count efficiently, the diamond as physical and chemical properties which make it n attractive material for use in a practical counter. f the counter were intended primarily for medical se, these properties would have added significance, specially the density of the crystal. Physically, its density is such that diamond has a stopping power early three thousand times greater than that of air, nd electronically, the density (and the γ-ray absorption) of carbon is of the same order as that of human tissue. Thus a high-speed particle would penetrate both diamond and tissue to about the same degree. Consequently, if the diamond counter were to be used to measure the dose-rate on patients receiving deep therapy or similar treatment, one would expect to get more accurate measurements than could be obtained with more conventional instruments. Furthermore, because of its chemical composition, diamond can be autoclaved and sterilized satisfactorily for use internally.

The advantages of the diamond as a counting crystal have been recorded elsewhere[2]. In contrast to its many desirable features looms the bugbear of polarization, due to the space charge which builds up inside a counting crystal and opposes the externally applied field, thus causing considerable reduction in the counting efficiency of the crystal. It is caused by the current carriers being captured by the trapping sites in the crystal. Since every diamond reacts differently, it was just possible that diamonds did exist which were electronically perfect enough not to be seriously affected by polarization. I therefore sorted through approximately a hundred thousand diamonds to test this possibility, and I am convinced that such diamonds occur in Nature. These diamonds make really efficient counters and will maintain a reasonably steady counting-rate for periods of several hours, perhaps indefinitely. For this test I used a 1-mc. γ-source (cobalt-60) placed at a distance of 1 cm. from the diamond. Such diamonds have been used for the past five years, and I classify them as structure-sensitive diamonds peculiar to certain diamond fields. Using small octahedra of 1 mm. side, Champion (unpublished work) has shown that the non-polarizing regions of a counting diamond fall into class 2 of his identification table for diamonds. My specimens, on the other hand, have varied widely in size and shape, and for sorting purposes I have had to rely on the ultra-violet fluorescence method for selecting counters.

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* Substance of a thesis which was awarded the Insignia Award of he City and Guilds of London Institute in 1955

Ahearn has shown that under the influence of rays from a radioactive source a counting diamond, working in an electric field, will generate small pulses of current. Under these conditions, an electron and a positive hole will be created every time a high-speed particle communicates sufficient energy to a carbon atom. This is analogous to ionization in a gas. In a diamond, relatively free of electron traps, the electrons and the positive holes move in opposite directions with substantially the same velocity and, by placing the diamond in a suitably designed electronic circuit, the movement of the current carriers can be measured.

In the early laboratory experiments the diamond was placed as close to the grid of the pre-amplifying valve as possible, since the signal voltage is inversely proportional to the capacity of the circuit. For practical purposes, however, it is necessary to move the diamond some distance away from the pre-amplifier. This entails two alterations to the conventional circuit: (i) slight modifications to the electronic circuits, and (ii) a properly designed diamond holder. After some preliminary experiments, I found that the diamond may be conveniently mounted at the end of a thin, hollow metal tube or a flexible coaxial cable to form a probe. The length of the probe is limited by the amount capacity permitted in the circuit, but probes up to foot in length have been made and function sati factorily. In one instance the external diameter the probe was less than 3 mm. and, in this case, th volume of the diamond was probably no more tha two or three cubic millimetres. For best results th diamond should be cut to fit snugly into the end the tube. My method of mounting the diamond such a tiny holder is to have a hole drilled in th diamond just large enough to accommodate a ve thin wire. This wire acts as an anode and runs dow the middle of the tube. It is insulated from th outer metal holder, which is at earth potential. Th potential difference between the inner electro and the holder creates the energizing field for th diamond.

The pulses generated by the diamond under bombardment are of the order of microvolts and have be amplified considerably before they will opera conventional recording devices. A linear amplifier employed for this purpose. One of the limitations this type of amplifier is the noise which is generate by the pre-amplifying valve and its associated circuit This noise sets a threshold limit to the sensitivity the diamond counter at approximately 25 μV. Th in turn determines the lowest energy which can recorded by a diamond counter under present conditions; but for α- and β-sources usually used in th laboratory the diamond counter is as efficient counter as the Geiger counter[3].

To date, work on the diamond counter has bee confined to a limited number of research worke whose preliminary investigations have demonstrate some of its advantages and disadvantages. Th indications are, however, that it has possibilities ultimately being developed into a useful pinpoin counter suitable for specialized—probably medical—applications. The potentialities of the diamond i this field therefore merit fuller investigation.

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ANTARCTIC ATMOSPHERIC CIRCULATION

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IN 1951[1] I put forward the view that general attempts to interpret Antarctic atmospheric circulation in terms of a permanent low-level anticyclone surmounted by a permanent upper cyclone could not be reconciled with the sequences of daily synoptic weather maps of the southern hemisphere, which were then becoming available for the first time. In particular, the concept of permanency was untenable, as in the case of atmospheric circulation systems in other parts of the world.

The problems raised by (1) continuing nourishment (at least, in some degree) of the Antarctic ice-cap and (2) occasional observations of cyclonic winds and weather on the coast and by expedition parties in the interior of Antarctica could only be resolved in terms of a succession of changing weather situations. Evidence now exists that these situations embrace *inter alia* both (warm) anticyclones and (cold) depressions in which the respective circulation systems reach to great heights without change character[2,3].

It will be generally accepted that katabatic down slope surface winds are predominant at most point of the fringe of the ice-cap and, to a less exten probably on the higher parts of the inland ice. has also become clear that most of the active depres sions which skirt, or encroach upon, Antarctica hav closed cyclonic circulations extending at least up t the higher parts of the ice-cap, which are liable t be swept by gales and experience the frontal cloud and weather.

In collaboration with Instr. Commdr. G. Britton, R.N., I have lately confirmed and amplifie these conclusions by making statistical studies (*a*) the distribution of centres of depressions an anticyclones in high southern latitudes on the dail weather charts[4] analysed during 1947–49 by Britto and Morgan at the Royal Naval Investigations

Weather Centre at Simonstown, South Africa, and b) the percentage frequency of occurrence of urface westerly winds in all sectors of the coast of Antarctica and near the ice-edge at sea south of 0° S. Some of these results have already been published[5].

The geographical distribution of anticyclone centres ver the southern polar regions, derived from the Simonstown daily synoptic analyses of the southern emisphere, on 134 days when such deduction was possible during January–April and November 1947 nd March–April 1948, showed the main concentration of anticyclones displaced from the georaphical pole in the direction of the broadest part f Antarctica, perhaps as far north as lat. 85° S. in long. 40–50° E. This position is very close to the true centre of the ice-covered polar region, but may reflect an unconscious bias on the part of those analysing the daily charts to indicate the anticyclone as near to the South Pole as could be made to fit the vidence. It is also in reasonable agreement with the main cluster of centres of highest monthly mean pressure about lat. 82° S., long. 60° E. in the three years 1951–53 given by the Southern Hemisphere Daily Weather Analysis Project of the South African Weather Bureau, Pretoria[6]. There is perhaps some ground for preferring to believe the more eccentric position.

Careful assessment of all these data and re-examination of the weather logs of the main expedition ourneys of the past into the interior of Antarctica have made possible a reasonable estimate of the frequency of generally cyclonic weather situations over Antarctica (largely resulting from the encroachment of large travelling depressions from other atitudes) and has yielded unmistakable evidence of ndividual deep depressions as they passed inland over the ice.

The frequency of cyclonic situations in the interior, with westerly winds at the coast, may be given as about 5–15 per cent for different parts of the continent, though there are great variations from year to year. In some particular months (for example, March 1947) the percentage may have been 50 per cent or even higher. East Antarctica between lat. 0° and 90° E. is probably most nearly immune. Surprisingly, cyclonic situations and low pressures are more frequent in winter than in summer (with a possible reservation in the case of the Graham Land–Weddell Sea sector, where pressures tend to be relatively high both in December–January (summer) and in May–July (early winter)).

The majority situations (85–95 per cent) are quite various, though there is usually either a shallow surface anticyclone or a region of relatively high surface pressure and slack circulation somewhere over Antarctica, especially "East Antarctica" (where the continent is broadest), between the surrounding depressions. The central anticyclonic region, even when it is most clearly defined, sometimes takes up a position far out from the Pole in one sector or another for fairly long periods, and may at times be centred over the ice of either the Weddell or Ross Seas: disturbed conditions then usually prevail in the opposite sector.

Several cases are on record in which very deep depressions (mean sea-level pressures 927–945 mb. at the nearest coastal bases) passed inland south of the Adélie Land coast (lat. 67° S., long. 140–145° E.) and Ross Barrier (lat. 78° S., long. 160–180° W.), in all cases between late June and early October. At least two of these depressions passed south of Admiral Byrd's 1934 advanced base (Bolling Station) in lat. 80° S. on the Ross Barrier.

The occasional southerly gales experienced even in summer by all parties on the polar plateau between the Ross Sea and the South Pole would be consistent with depressions passing on a track near lat. 80° S. from the Ross to the Weddell or Bellingshausen Seas—the shortest track across West Antarctica. These gales blew up the general gradient of the ice plateau (that is, against the katabatic effect) between 88° S. and the Pole.

Independent summaries dealing with antarctic meteorology[3,7] suggest that there is now a good consensus of opinion among workers in various countries in support of my main thesis regarding impermanence of the antarctic anticyclones and great variability of the general weather situation, especially in winter.

The geographical distribution of the antarctic anticyclones, which is now becoming clear, has a corollary of some possible practical importance: the frequency of the gales which sweep the polar plateau should fall off from the Pole in the sector of East Antarctica, so that the "fairest weather route to the pole" (the phrase is Britton's) may be expected to lie across that part of the continent between about the 0° and 90° E. meridians. This appears to be the preferred region for anticyclones and is relatively infrequently encroached upon by depressions. Moreover, in longitudes between 20° W. and 20° E., east of the Weddell Sea, the general circulation around these anticyclones (which are the heavily predominant situation in summer, that is, December–January), should tend to oppose and offset the general katabatic drainage of cold air off the ice-cap, which blows in the face of expedition parties on the ground making for the polar plateau. This suggests that, on the whole, there should be relatively least trouble with headwinds, blizzards and snow in longitudes between about 20° W. and 45° E., whatever the geographical difficulties of the route might be. At the same time, expeditions must always reckon with the characteristic type of variability (most pronounced between March and October) of the Antarctic atmospheric circulation, which is liable to long spells, lasting in extreme cases up to two to three months, of unusual circulation patterns when any part of the interior may be liable to experience cyclonic weather.

The same work on the meteorology of the far south led to certain hypotheses about major geographical features—a great trough and a great ridge—in the broadest, unexplored region of the Antarctic continent in eastern longitudes. One of these hypotheses has recently been confirmed by observation (*The Times*, March 7, 1953).

I am indebted to the Director of the Meteorological Office for permission to publish this account.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Isolation of Two Myoglobins from Horse-heart Extracts and the Determination of the Molecular Weight of the Main Component

The method developed by Boardman and Partridge[1] for the separation of hæmoglobins on columns of the ion-exchange resin, 'Amberlite *IRC*-50' (*XE*-64), has been applied to the purification of horse carbon monoxide myoglobin, with the result that two carbon monoxide myoglobins were isolated from extracts of horse heart. The component carbon monoxide myoglobin (*B*) was present to the extent of about 10 per cent of the main myoglobin fraction, carbon monoxide myoglobin (*A*). Each fraction was shown to be homogeneous in the ultracentrifuge, and when examined in a Hilger 'Uvispek' spectrophotometer each gave an absorption spectrum typical of carbon monoxide myoglobin. The molecular weight of the main component was determined from measurements of osmotic pressure[2] and a detailed amino-acid analysis was carried out by the procedure of Moore and Stein[3].

A water extract from a perfused horse heart was saturated with carbon monoxide, and an ammonium sulphate fractionation of the proteins was carried out at 0° C. Most of the colourless muscle proteins and residual carboxy hæmoglobin were precipitated at 80 per cent saturation, and the carbon monoxide myoglobins were precipitated by raising the concentration of ammonium sulphate in the filtrate to 94 per cent saturation. The carbon monoxide myoglobins were dissolved with the minimum amount of distilled water and then dialysed against a citrate buffer, *p*H 5·70; sodium ion concentration, 0·34 gm. ions/l. An aliquot (20 ml.) of the myoglobin solution was subjected to chromatography on a column of 'Amberlite *IRC*-50', 16·5 cm. × 5·0 cm., with the citrate buffer as eluting liquid. The effluent from the column was collected in 3-ml. fractions and analysed photometrically at 278μ and 542μ. The result is shown in Fig. 1. The first band of protein to emerge from the column contained colourless proteins which had not been removed by the ammonium sulphate fractionation. This was followed by a band of hæmoprotein carbon monoxide myoglobin (*B*), which was almost completely separated from the main band of hæmoprotein carbon monoxide myoglobin (*A*). The main-fraction carbon monoxide myoglobin (*A*) behaved as a single substance when applied to a fresh column of the same resin and could be eluted from it quantitatively.

Table 1

Conc. of protein (gm./100 ml.)	Osmotic pressure (mm. mercury at 0° C.)	M/φ*	Molecular wt. (M)
0·43	3·99	18,326	18,551
0·51	4·72	18,548	18,822
0 64	5·93	18,228	18,563
1·01	9·54	18,029	18,559
1·46	14 20	17,464	18,211
1 51	14·72	17,415	18,188
		Average	18,482

* φ is a factor taken from measurements on hæmoglobin (ref. 4). External liquid, 0·03 M Na_2HPO_4 + 0 01 M NaH_2PO_4. *p*H 7·4 at 0° C.

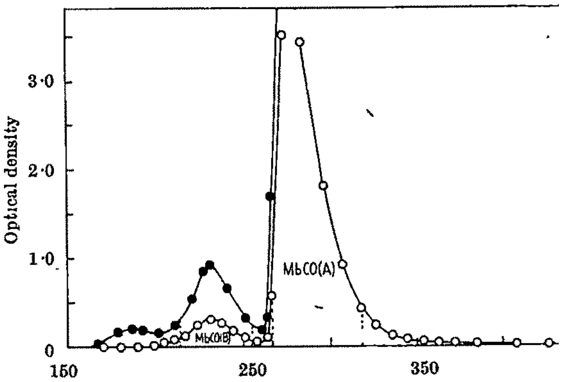

Fig 1. Chromatogram of a preparation of horse carbon monoxid myoglobin on a column of 'Amberlite *IRC*-50', 16 5 cm. × 5 0 cm Buffer citrate, *p*H 5 70, sodium ion concentration 0·34 gm. ions/l Rate of flow: 5–10 ml./hr. Temp. 2° C. Amount on column about 300 mgm. protein. ○, Optical density at 542μ; ●, optica density at 275μ

The dotted lines in Fig. 1 indicate the fractio collected as carbon monoxide myoglobin (*A*) ar carbon monoxide myoglobin (*B*). The absorpti spectra of the two proteins were identical in t visible and Soret regions; but the latter showed higher absorption at 275μ, indicating a higher tyrosi or tryptophan content. Examination in the 'Spinc ultracentrifuge showed that both preparations we homogeneous and they had similar sedimentati constants.

The molecular weight of the main-fraction carb monoxide myoglobin (*A*) was determined fro measurements of osmotic pressure, using the tolue osmometers of Adair[4]. Membranes which held abo 1·5 ml. protein solution were used, special care bei taken to make thin membranes which did not adso myoglobin. Concentrations of protein were calculat from refractometric measurements; but in certa cases these were checked by making cyanmetmy globin and measuring its absorption at 542μ. T extinction coefficient of a solution containing 1 mgm ml. of cyanmetmyoglobin (*E* 0·1 per cent) was fou to be 0·613.

The results of the osmotic pressure measureme are shown in Table 1. The figure obtained for t mean molecular weight of the main component w 18,400, which is considerably higher than the 16,8 obtained by Roche and Vieil[5] from osmotic pressu measurements and 17,200 obtained in ultracentrifu studies[6].

Table 2. Amino-acid Composition of Carbon Monoxide Myoglo (*A*) (Total Nitrogen 17·0 per cent)

Amino-acid	Wt. amino-acid in 100 gm. protein	No. residues/molecule	
		Present work	Tristram (ref.
Glycine	6 68	15	13
Alanine	7·90	15	15
Valine	4·68	7	6
Leucine	13·33	17	22
*iso*Leucine	6·56	9	
Phenylalanine	7·04	7	5
Tyrosine	2·33	2	2
Threonine	4·73	7	7
Serine	3·09	5	6
Methionine	1 75	2	2
Proline	3·12	5	5
Aspartic acid	7 81	10	10
Glutamic acid	16·70	19	19
Arginine	2·14	2	2
Lysine	15·29	18	18
Histidine	9 00	10	9
Tryptophan	—	(2)	2
Total	112 15	152	143

Moreover, the number of amino-acid residues per molecule calculated from the present amino-acid nalysis (Table 2) is greater than the number calulated by Tristram[7]. The present figures were btained from 24-hr. and 96-hr. hydrolysates (6 N ydrochloric acid under reflux) and corrections were made for the decomposition of certain amino-acids. When compared with Tristram's figures, it is seen hat there is an increase in the number of residues f leucine – *iso*leucine (4), phenylalanine (2), glycine 2), valine (1) and histidine (1) and a decrease of ne residue of serine.

A full account of these experiments will be published ater.

While this work was in progress, Theorell and keson[8] recorded an electrophoretic diagram for myoglobin showing three components. The main omponent, Mb 1, had an equivalent weight of 8,800, calculated from iron analyses, nearly equal o the molecular weight of our fraction MbCO*A*.

We thank Dr. D. A. Titchen for perfusion of horse earts. The amino-acid analysis was carried out by Ir. D. F. Elsden. This work, which forms part of he programme of the Food Investigation Organization of the Department of Scientific and Industrial Research, was carried out during the tenure by one f us (N. K. B.) of an I.C.I. fellowship.

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An Extrarenal Effect of Pitressin

It is generally believed that the action of pitressin, nd more specifically, antidiuretic hormone, is ntirely referable to its effects on the kidney. Although n extrarenal site of action has been suggested, the vidence has not been convincing[1]. Our recent tudies in the rat suggested that pitressin might have n extrarenal action in this mammal[2]. This would gree with the findings in other vertebrate classes[3].

The problem was studied in the rat using inulin, s modified from the method of Ledingham[4], to measure extracellular fluid volume. The renal edicles were first ligated. One hour later, a measured mount of inulin was injected into the right femoral ein and two hours allowed for equilibration. At his time (0 min.), using light ether anæsthesia, a ·5-ml. sample of blood was obtained from the left emoral artery and analysed for inulin and sodium. his was followed immediately by the injection of I.U. of pitressin (Parke, Davis) in 0·5 ml. of saline ntraperitoneally in a group of ten animals. A control roup of ten received the saline only. A second lood sample was obtained 40 min. later from the ame artery. The procedure was repeated in fresh roups to cover intervals of 60, 90 and 120 min. after njection of pitressin.

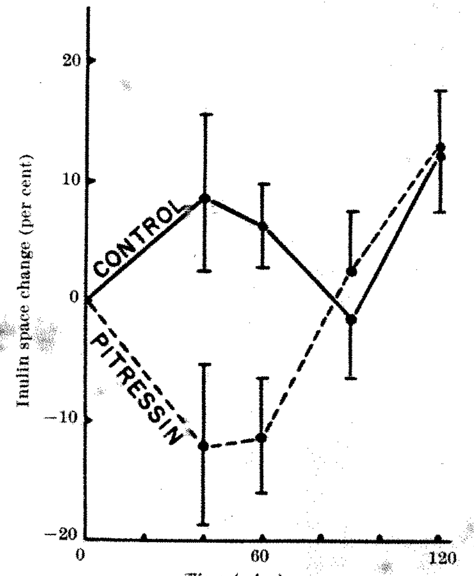

Fig. 1. Effect of 1 I.U. of pitressin intraperitoneally on inulin space in nephrectomized rats. Time of injection of pitressin is taken as 0, inulin having been injected 2 hr. previously to allow for equilibration

As shown in Fig. 1, pitressin caused a significant decrease in inulin space which can only signify a movement of water into the intracellular compartment. This was apparently accompanied isosmotically by sodium, since the plasma concentration of this ion remained unchanged throughout despite the decline in inulin space. In Table 1 the change in inulin space in two separate experiments is shown for the period of 60 min. after injection of pitressin.

Table 1. Effect of 1 I.U. of Pitressin on Inulin Space in Nephrectomized Rats

The first space determination, at 0 min., was carried out 2 hr. after inulin injection and was followed immediately by the injection of pitressin in the treated animals and saline in the control animals

	0 min.	60 min.	Change (per cent)	
	Experiment 1			
Control average	26·64 ml.	27·86 ml.	+6·46	
Standard error	±1·93	±1·67	±3·51	
				$p < 0·01$
Pitressin average	26·63	23·59	−11·05	
Standard error	±1·37	±1·71	±5·02	
	Experiment 2			
Control average	23·66 ml.	22·33 ml.	−5·53	
Standard error	±0·75	±0·93	±2·70	
				$p < 0·02$
Pitressin average	23·21	19·48	−15·95	
Standard error	±0·98	±1·12	±3·51	

The details of this shift as studied using smaller doses of pitressin intravenously, together with the effects of sodium and potassium, will be reported separately.

We are grateful to the Ciba Company, Ltd. (Montreal), for support of this project.

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Secretory Potentials and Secretion in the Sublingual Gland of the Cat

INTRACELLULAR recording from sublingual gland cells in cats has revealed that the resting potential over the outer membrane is about 30 mV. (internal negativity). On repetitive stimulation of the chorda nerve, the potential difference increases to 50–60 mV., and this potential change is called a secretory potential[1].

When the tip of the electrode is inserted further through the gland cell, the tip penetrates the inner gland-cell membrane, and the resting potential of the lumen is found to be a few millivolts positive to the external medium. On activation, the initial potential change in the lumen is identical with the potential change in the interior of the gland cell. Thus the initial potential change is entirely over the outer cell membrane of the gland. With continued stimulation of the chorda nerve, a potential change usually, but not always, appears also over the inner membrane, its sign showing that the lumen becomes more positive to the interior of the gland cell.

For investigation of the mechanism of establishment of the secretory potential over the outer membrane, the secretory potential was investigated at different levels of membrane potential. For this purpose double-barrelled electrodes were used. After insertion through the outer membrane of the gland cell, the potential was measured with one channel and current flowed through the other. Fig. 1 shows that the secretory potential appears almost unchanged within a large range of membrane potential. Thus the secretory potential has no equilibrium potential. Hence it cannot be due mainly to a change in permeability but must be due to active transport. It is assumed that this transport is in the same direction as the secretory work, and to account for the sign of the potential it must be a transport of anions from the external medium to the interior of the gland cel over the outer membrane.

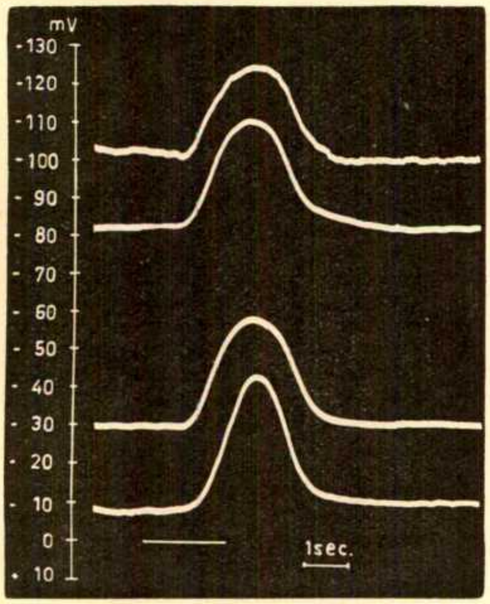

Fig. 1. Intracellular recording from sublingual gland cell with one channel of a double-barrelled electrode. Duration of repetitive stimulation of the chorda nerve at 25/sec. shown by white line. Record with a resting potential of 30 mV. was obtained without current flow through the other channel, and the remaining records with a current flow to change the 'resting' potential as seen in the figure (potential due to common coupling resistance subtracted)

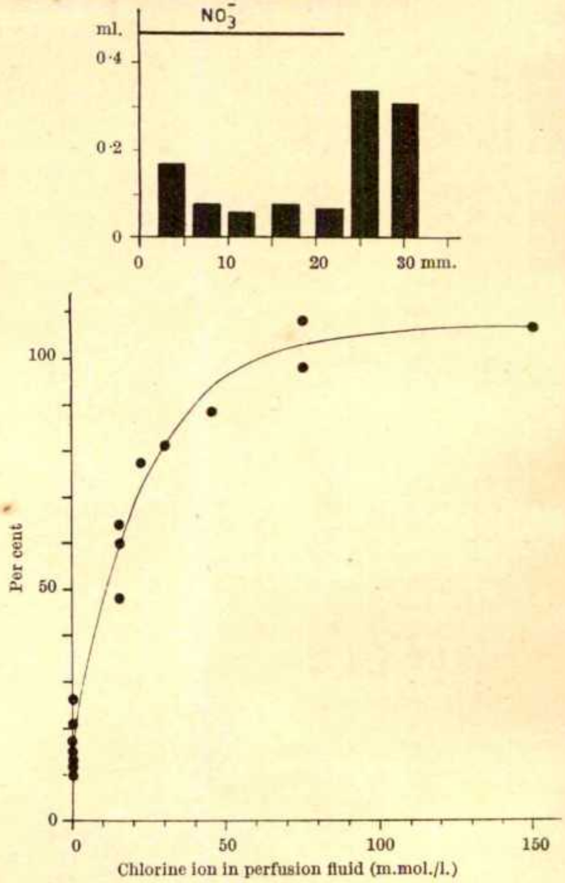

Fig. 2. In the upper plot each black column represents the amount of saliva obtained during 3 min. after injection of 1 μgm. acetylcholine. Horizontal black line shows duration of perfusion with chloride-free nitrate-saline; after 23 min., replacement with saline containing 150 m.mol./l. chloride. The graph shows the amount of secretion in response to 1 μgm. acetylcholine with partial substitution of chloride by nitrate in perfusion fluid. Ordinates, amount of secretion as percentage of that obtained in the same gland after change to a perfusion fluid containing 150 m.mol./l. chloride

This active transport of anions could account for secretion of salt and water; cations could follow due to electrical forces and water osmotically, and for passage through the inner membrane of the gland cell into the lumen of the tubulus the raised intracellular hydrostatic pressure might suffice. The sublingual gland saliva contains 160 m.mol./lit. chloride ion, and these ions are those that are transported if the secretory potential be the electrical sign of a transport responsible for secretion of salt and water. An active transport of chloride ions has been found in frog skin stimulated by adrenaline[2] and also in the frog gastric mucosa[3].

Further experiments have been made with glands perfused with oxygenated saline (at room temperature) containing physiological concentrations of sodium, potassium and calcium ions and with chloride as the only anion. On activation, such a gland gives a normal amount of secretion and the secretory potential over the outer membrane appears as in the blood-perfused gland.

On replacement of chloride ion in the perfusion fluid with nitrate ion the amount of secretion obtained on injection of 1 μgm. acetylcholine falls to 10–30 per nt (Fig. 2). The graph in Fig. 2 shows the amount secretion in response to 1 μgm. acetylcholine with rtial substitution of chloride by nitrate in the rfusion fluid. The amount is given as a percentage the amount of saliva obtained in the same gland er return to a perfusion fluid with full chloride ntent. It appears that with 10 per cent chloride e gland secretes 50–60 per cent of the normal nount, and with 50 per cent chloride the secretory sponse is virtually the same as with 100 per cent loride. These experiments show that nitrate ions e not toxic to the secretory process; the limiting ctor for secretion at low chloride concentration is ost probably depletion of chloride ions in the ternal medium of the gland cells (the amount of cretion in response to 1 μgm. acetylcholine at 100 per nt chloride ions is about one-fourth of the weight the gland).

In experiments with microelectrodes on the trate-perfused gland, a small potential change with e same sign as the normal secretory potential was countered over the outer membrane on activation. is therefore possible that this membrane has a nited capacity to transport nitrate ions, which ansport may account for the secretion remaining the nitrate-perfused gland.

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Dec. 31.

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Changes in the Dimensions of the Nuclei of Neurones with Activity

HYDEN[1] has summarized the evidence relating anges in cytoplasmic and nuclear constituents of e neurone to growth and activity of the cell. We ve found an increase in Feulgen staining in the urone nuclei of both the granular and molecular yers of the mouse cerebellum, following convulsions roduced by 'Picrotoxin' and 'Metrazol', as well as ter a fall[2]. The deoxyribonucleic acid content, measured by the specific absorptiometric technique[3], however, remained unchanged following a 'Picrotoxin' convulsion. These two findings suggested that an explanation of the apparent increase in Feulgen staining might be found in a contraction of the nuclei.

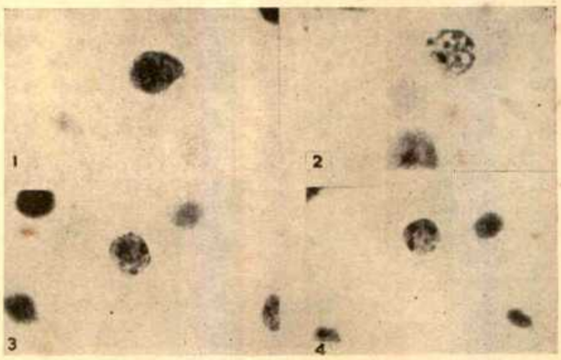

Fig. 1. Nuclei from the molecular layer of mouse cerebellum. (1) Resting mouse. (2) After running to exhaustion, 200 ft. in 10 min. (3) Convulsed with 'Picrotoxin', C.D.50. (4) Following a fall, 3 × 10 ft.

A change in dimensions of the nuclei was confirmed by direct measurement of the area of each nucleus. Freeze-dried samples of cerebellar tissue taken from the medial lobe by the method of Chance and Yaxley[4], after fixation in ethanol and embedding in paraffin wax, were cut transversely to the axis of the brain 15μ thick (since the average diameter of the nuclei of resting mice was 6·3μ) and stained with Harris's hæmatoxylin. Measurements were made only on whole nuclei at the periphery of the sample, where freeze-drying artefacts were absent. The area of a number of nuclei in five different parts of each section was measured; these measurements were repeated on sections from different mice receiving the same treatment (Table 1). The area of each nucleus was assessed in arbitrary units comprising the squares (to the nearest half-square) included in a camera lucida projection of the nucleus on to standard graph paper. These were then calibrated in μ^2.

This technique has been used for examining the changes in the dimensions of the nuclei of neurones of the molecular layer following the activities summarized in Table 1.

Table 1

Experimental details					Dimensions of nucleus viewed in transverse sections	
Activity of mouse	Severity of treatment	Time relations of treatment and sampling	No. of mice	Total No. of nuclei measured	Area (μ^2)	
					Mean	S.D.
1. Resting	—	—	5	116	26·95	6·74
2. Anæsthetized	'Seconal' A.D. 100 : 51 mgm./kgm. subcutaneous	Sampled while anæsthetized 15 min. after injection of 'Seconal'	5	120	22·74	5·66
3. Convulsed	'Metrazol' C.D. 50 : 20 mgm./kgm. intravenous	Sampled within 5 sec- of end of continuous clonic convulsion lasting not more than 30 sec. in each mouse	2	48	17·28	3·70
4. Convulsed	'Picrotoxin' C.D. 50 : 5 mgm./kgm. intravenous	Sampled within 5 sec. of end of intermittent convulsions lasting 5, 6 and 10 min.	2	49	17·52	11·58
5. Falling convulsion*	3 × 10 ft. fall	3 falls completed within 30 sec. Sampled within 5 sec. of last fall	5	125	10·91	3·35
6. Running	100 ft. in 5 min.	Sampled within 5 sec. of end of run	3	57	35·04	9·04
	To exhaustion. 200 ft. in 10 min.	Sampled within 5 sec. of end of run	3	70	37·33	12·48
7. Swimming	To exhaustion. 5, 10 and 12 min.	Sampled within 5 sec. of end of swim.	3	59	39·51	12·59

* See refs. 2 and 4.

Each treatment produced changes in the area of the nuclei, with confidence limits below 1 per cent, compared with nuclei from the resting mice. It is clear, therefore, that the different types of behaviour were reflected in changes in the dimensions of the nucleus, as assessed by the measurement of the area in transverse section. Although these changes probably reflect a change in volume, this is not certain in the absence of complementary measurements of the nuclei in sections cut longitudinally to the axis of the brain.

The standard deviation for each treatment group shows wide variation between treatments. It should be noted that whenever the activity includes periods of exhaustion ('Picrotoxin' induces intermittent seizures separated by periods of exhaustion), the variation is high. This could reflect the influence of recovery processes proceeding at different rates in each mouse, the different parts of the brain, or the separate nuclei. An analysis of variance revealed that only in the instance of swimming to exhaustion was there a significant difference between mice as well as a significant contribution to variance from parts of the brain (areas) and from area/mouse interaction. Significant differences between areas occurred in treatments 3 and 7, and area/mouse interactions were significant in 3 and 6.

The full details and analysis of results will be published elsewhere.

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Action of Ascorbic Acid on Corticotropin

Holzbauer and Walter[1] have recently reported that the adrenal ascorbic acid – depleting properties of corticotropin are destroyed by treatment with ascorbic acid at room temperature for 18–20 hr. The corticotropin preparation used by these workers had a potency of 3 I.U./mgm. In view of the potential importance of their observation, we have repeated their experiment using highly purified corticotropin. The preparation used was a sample of corticotropin A_1 (for nomenclature, see Dixon and Stack-Dunne[2]), made in this laboratory by ion-exchange chromatography of an oxycellulose concentrate of pig corticotropin. This preparation had a potency of 110 I.U./mgm. when assayed by the adrenal ascorbic acid – depletion method of Sayers, Sayers and Woodbury[3].

A solution of corticotropin A_1 containing 0·4 I.U./ml. in Ringer solution, was divided into two portions. One portion was kept as control while ascorbic acid was added to the other portion to give a final concentration of 0·084 mgm./ml. Both solutions were kept for 18 hr. at 25°. These conditions and concentrations are identical with those of Holzbauer and Walter[1]. Both solutions were diluted for bioassay by the adrenal ascorbic acid – depletion method. The solution treated with ascorbic acid assayed 147 per cent of the control (p = 0·95, 76–282 p cent).

Our results are thus in contradiction to those Holzbauer and Walter. The increase in poten found is of doubtful significance, but could be e plained by the protective action of ascorbic ac against autoxidation of the hormone[4].

The difference in the observations is most probab explained by the low potency of the preparation us by Holzbauer and Walter. The ascorbic acid ma act by activation of proteolytic enzymes present the impure preparation. The presence of su enzymes in crude pituitary extracts has already be demonstrated[5].

It must be concluded, therefore, that ascorbic ac has no effect on purified preparations of corticotropi

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Prof. Morris's results are in good agreement wit the observation of Holzbauer and Rigler[1] that th time necessary for the inactivation by ascorbic aci of the melanophore-expanding activity of pituitar extracts increased with increasing purity of th preparation. In these experiments, however, 88 pe cent of the melanophore activity disappeared i 28 hr. even when the activity of the preparation wa 150 I.U. of corticotropin per mgm. It is regrettabl that a highly active preparation was not availabl to us when the experiments with K. Walter wer carried out.

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Reactions between Amino-Acids, Organic Acids and Sugars in Freeze-dried Apricots

Haas and Stadtman[1] separated an apricot concentrate (30 per cent solids) into cationic, anioni and neutral fractions and showed that brownin occurred when any two fractions were combined an stored at 57° C. The reactions of individual cations anions and neutral compounds in freeze-dried aprico *purée* stored at 25° C. and 70 per cent relative humidity (79 per cent solids) have now been studied After sixteen months, this material was a mid-brow colour. It contained 1-deoxy-1-(N-amino-acid) fructoses[2] and traces of 2-deoxy-2-(N-amino-acid) glucoses[3], together with sucrose, glucose and (traces of) fructose half-esters of malic and citric acids. These compounds replaced almost quantitatively the apparent losses of free amino-acids and malic and citric ids. After allowing for these reactions, there was loss of 11 m.moles of glucose and 8 m.moles fructose per 100 gm. fruit solids. It appears that, this relatively early stage of browning, the coloured ompounds were formed from sugars without the corporation of any significant amount of amino-id or organic acid residues. If the 1-deoxy-1-N-amino-acid)-fructoses were intermediates in brown-g, subsequent reactions must have included the lease of the amino-acid[4]. The behaviour of glucose-phosphate[5] suggests that the malic and citric id esters may also be important intermediates in rowning.

Equivalent quantities of apricot purée and browned eeze-dried *purée* were extracted with 80 per cent hanol. The soluble cations and anions were sep-ated by displacement chromatography on columns f sulphonated polystyrene[6] and 'Dowex-1-*X*4' in the cetate form[7]. The compounds were identified by eir order of emergence from the columns and by eir behaviour on paper chromatograms. Appro-riate fractions were combined for quantitative nalysis. The soluble neutral components were xamined and estimated by paper chromatography.

The amino-acids (as m.moles/100 gm. fruit solids) resent before and after browning were: asparagine 7·3, 1·3), aspartic acid (1·8, 1·0), proline (0·5, 0·5), lutamic acid, serine, alanine, γ-amino-butyric acid, hreonine, valine, glutamine, glycine, phenylalanine, ucine, pipecolic acid, and traces of tyrosine, histi-line, arginine and unknowns (1·8, 1·1). There was lso some ammonia (4·6, 4·1, estimated in the alcoholic xtract). After browning, at least twelve compounds *F*1–*F*11 and *X*1) emerged from the columns before spartic acid (total, 7·1 m.moles by weight, calculated s 1-deoxy-1-asparagino-fructose). In addition, at east six compounds (*Y*1–*Y*6) emerged between the mino-acids and ammonia (total, < 0·5 m.mole). Tests in solution and on paper indicated that *F*1–*F*11 were 1-deoxy-1-(N-amino-acid)-fructoses. The main omponent (*F*4) gave asparagine when heated with ·1 *N* acetic acid. Others gave aspartic acid, serine, hreonine, alanine and valine. *X*1 appeared to be 2-deoxy-2-asparagino-glucose, *Y*1–*Y*3 were 1-deoxy-amino-fructoses and *Y*4–*Y*6 were 2-deoxy-2-amino-glucoses.

The acids present (as m.moles/100 gm. fruit solids) before and after browning were: malic (50·5, 42), itric (9·8, 8·4), and small quantities of quinic, hosphoric, succinic and unknown acids. After rowning, some new acids emerged from the columns before and with quinic acid; hydrolytic experiments howed that they were sucrose, glucose and fructose alf-esters of malic acid (total, 6·5 m.moles). Similar sters of citric acid emerged just before malic acid total, 1·5 m.moles).

The neutral components found were sucrose (before rowning 100 m.moles; after, 67), glucose (79, 86), fructose (60, 80), xylose (1, < 0·5), a ketose oligo-saccharide, inositol, and sorbitol. Some sucrose 4 m.moles) was combined as esters, and it was assumed that 29 m.moles were hydrolysed to glucose and fructose. Approximately 1 m.mole of fructose and 11 m.moles of glucose were found combined in esters and amino-acid derivatives, leaving 8 m.moles of fructose and 11 m.moles of glucose not accounted for and presumably involved in the production of brown pigments.

Similar results have been obtained with freeze-dried peach *purée* stored under the same conditions for fifteen months.

This work, which will be reported fully elsewhere, was carried out as part of the research programme of the Division of Food Preservation and Transport of the Commonwealth Scientific and Industrial Research Organization, Australia.

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The *Diego* Blood Factor in Chinese and Japanese

THE *Diego* blood factor was originally reported by Levine, Koch, McGee and Hill[1] in 1954, as a 'private' blood factor. A year later, studying the incidence of the *Diego* factor on Venezuelan subjects, we found[2] that it is relatively common in two stocks: 50 positive cases out of 170 Caribe Indians and 8 out of 152 Arawaco Indians. It was also present, although in low incidence, in people from Caracas and Barcelona (Venezuela) where Indian admixture was already known.

The serological independence of this factor from other blood factors was demonstrated by Levine, Robinson, Layrisse, Arends and Dominguez Sisco[3]. Its incidence has been studied by Junqueira *et al.*[4] in Carajás and Kaingangues Indians from Brazil, showing respectively 36 and 48 per cent of positives. Piaroa and Guahibo Indians living in Territorio Amazonas (Venezuela), who are anthropologically independent from all Indians mentioned above, also carry this antigen[5]. The Piaroas showed 3 *Diego* positive (12·5 per cent) out of 24 samples, and the Guahibos, 11 out of 76 (14·47 per cent).

Consistently negative results have been obtained in a thousand Caucasoids of the United States[3], two hundred random Dutch (van Loghem, personal communication), a hundred and fifty Spaniards and two hundred Italians (tested by us).

Since the Indians of the American continent are considered to be anthropologically related to the Mongoloid people of the Old World, we decided to investigate the incidence of the *Diego* factor in other available representative Mongoloids living in Venezuela. We now report our findings in Chinese subjects.

One hundred unrelated male Chinese from Canton (China), living in Venezuela, were selected for this study. Their physical features were typically Chinese and there was no admixture with the Venezuelan natives. The blood samples were tested against anti-Di^a serum by the indirect Coombs test as previously reported[2]. *Rh* factors (*C*, *c*, *D*, *E*), A_1A_2BO, *MN* and *Duffy* blood groups were tested by standard methods. Table 1 shows the results.

The frequencies of A_1A_2BO, *MN* and *Duffy* found in this study are very close to those already reported[6].

Table 1. FREQUENCY OF A_1A_2BO, *MN*, *Rh*, *Duffy* AND *Diego* IN 100 CHINESE FROM CANTON

A_1A_2BO system									*MN* system					*Duffy* system			
Phenotypes (per cent)					Genes (per cent)				Phenotypes (per cent)			Genes (per cent)		Phenotypes (per cent)		Genes (per cent)	
A_1	A_2	B	A_1B	O	P_1	P_2	q	r	M	MN	N	M	N	$Fy(a+)$	$Fy(a-)$	Fy^a	F
28	4	25	2	41	16·55	2·45	14·65	66·30	21	59	20	50·5	49·5	100	0·0	100	0·

RH system										*Diego* factor			
Phenotypes (per cent)						Chromosomes (per cent)				Phenotypes (per cent)		Genes (per cen	
CCDE	*CCDee*	*CCddee*	*CcDE*	*CcDee*	*ccDE*	*CDE*	*CDe*	*Cde*	*cDE*	$Di(a+)$	$Di(a-)$	Di^a	Di
8	45	1	17	25	4	5·55	66·82	1·00	26·62	5	95	2·54	97·

As regards the *Rh* system, all but one were $Rh_0(D)$ positive. The *CDe* and *cDE* chromosomes have the incidence found by other investigators in Chinese[7]; the *CDE* chromosome was rather high (5·82 per cent) and the only Rh_0 negative found was a sample of phenotype *CCddee*.

The outstanding feature of this study was the detection of five *Diego*-positive Chinese (5 per cent). This finding indicates that the *Diego* factor is not restricted to South America. It indicates also that it could be present in all countries where Chinese have entered as part of the population.

The persistent absence of the *Diego* factor in all Caucasoids studied up to date and its presence in six South American Indian stocks and in Chinese suggest that this antigen is Mongoloid rather than Indian. It would not be surprising to find it in other Mongoloid branches.

The finding of the second sample of *Diego* antibody in a Polish couple, apparently unrelated to South American Indians, could not be explained before[3]. However, in the light of our findings in Mongoloids (Chinese and South American Indians), the presence of this antigen in a Polish family may be interpreted as indicative of Mongoloid admixture.

These facts indicate that besides its clinical importance (two cases of hæmolytic disease already known), the *Diego* blood antigen has a potential anthropological significance.

Dr. Albin Opalinski and Miss Abilia Rojas gave us technical assistance.

Subsequent to the submission of this manuscript for publication, we have studied sixty-five unrelated Japanese, finding eight *Diego* positives (12·30 per cent)[8].

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The Blood Group Antigen *Diego* in North American Indians and in Japanese

THE blood group antigen *Diego* has been reporte to be present with not inconsiderable frequency i Indians of South America[1], but absent in 1,00 Caucasoids in the United States[2]. The secon example of anti-*Diego* was identified by Levine an Robinson (unpublished observation) in a specime submitted by Witebsky and Rosamilia. Using th latter serum, we have found the antigen *Diego* to b present in 16 of 148 unrelated Chippewa Indians i northern Minnesota, and 6 of 77 unrelated Japanes in Winnipeg. This suggests that *Diego* may be a Asiatic character. The family in which Witebsk and Rosamilia found anti-*Diego* was Polish, and w know from the frequency of the gene *B* that there i probably a somewhat greater admixture of Asiati blood in Poland than there is farther west in Europe The antigen *Diego* promises to be of great anthropological interest.

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The Carotid Body of the Pilot Whale, *Globicephala melaena*

HEYMANS[1] has shown that mammalian blood pressure and respiration-rate are largely regulated by chemoreceptive cells which are innervated by the glossopharyngeal nerve. These are situated near the bifurcation of the common carotid artery (carotid body) and at the base of the great arteries (aortic body).

So far, no conclusions have been reached as to the ontogenetic relationship between receptor cells and their innervation. Some consider this system consists of two separate units[2]—mesodermal receptor cells which are eventually innervated—while others suggest a purely nervous organization in which receptor cells represent modified ganglion cells[3].

ısitivity to blood composition, as found in the otid body, would then be a function of nervous ;ue alone.

This latter view may find support in the present rk on the carotid body of the pilot whale. It was ısible to obtain fresh material from pilot whales ınded in Orkney during March 1955.

'he structure of the carotid body was found to 'er from those so far investigated in the intimate ıtionship between receptor cells and ganglion cells. ә presence of small numbers of scattered ganglion s, especially on the periphery of the carotid body, well known[4]. They usually occur singly and are all in size. By contrast, in the pilot whale, large umulations of compact masses of ganglionic tissue incorporated into the carotid body, amounting to sters of ten to twenty cells per 10μ section. These ıglion cells are identical in appearance with those nd in peripheral autonomic ganglia and they w the same variation in size and range of staining ction. The difference, however, lies in the fact t in many instances sinusoids, typical of chemoeptive tissues, are seen to ramify between the ıglion cells. In such cases the sinusoids are surnded by a few chemoreceptive cells, or by a body a large ganglion cell on one side, while chemoeptors lie close to the ganglion cell and the sinusoid. :h a modified ganglionic tissue is also frequently nd embedded in the branch of the glossopharyngeal ve as it approaches and penetrates the carotid ly. Indeed, those tissues occur more frequently ngside and in the vicinity of the nerve supply to carotid body than farther away from it, and as in s case the supplying nerve passes straight through carotid body, they often command a fairly central ;ition.

The carotid body of the pilot whale consists of ıumerable large and small lobes separated by con:tive tissue so as to form a rather diffuse organ. considerable variation is found in the structure of se lobes, which may contain chemoreceptive tissue, ıglionic tissue or a combination of the two in rying proportions. Often ganglion cells, bundles myelinated and unmyelinated fibres and chemoeptors are united into comparatively small glomeruli by well-developed connective tissue capsules (Fig. 1).

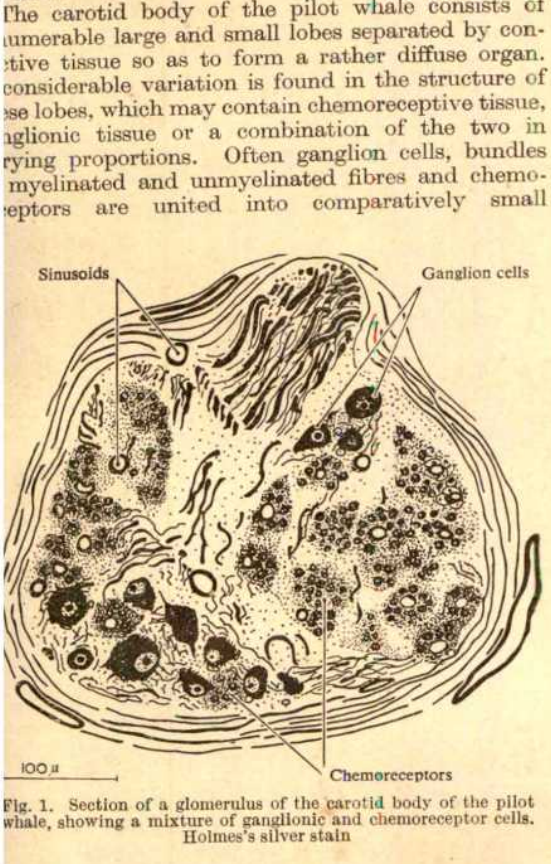

Fig. 1. Section of a glomerulus of the carotid body of the pilot whale, showing a mixture of ganglionic and chemoreceptor cells. Holmes's silver stain

It was found that the modifications of the carotid body of the pilot whale—one of the Odontoceti—are not shared by the Mystacoceti such as the finner whale, *Balaenoptera physalus*.

Detailed reports on both types of carotid body will be published elsewhere.

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Separation of Epidermis from Dermis by Filtrates of *Trichophyton mentagrophytes*

Although fungi of the *Trichophyton* group have been shown to be capable of digesting keratin[1], little attention has been given to the possibility of their liberating toxic substances. As early as 1896, Macfadyen[2] showed that cultures of *T. tonsurans* liquefied gelatin by means of a diffusible enzyme, but this appears to have been overlooked in subsequent consideration of the pathology of dermatophytes. As part of an investigation into the pathogenicity of dermatophytes, studies have been made of the effects of filtrates of *T. mentagrophytes* upon skin. The fungus has been cultured upon a simple fluid medium which will also support the respiration of skin and exercise no toxic effects when portions of skin are 'cultured' in it for a period of five hours. The culture medium consisted of 12·9 ml. Krebs–Ringer phosphate, 1 ml. 10 per cent glucose, 1 ml. 2 per cent glycine, 1 ml. 1 per cent ammonium chloride and 0·05 ml. of a mixture of zinc sulphate, manganese sulphate and ferrous sulphate, each 1 mgm./ml. The constituent fluids were sterilized separately and mixed when cold. This amount of medium formed a shallow layer in a 20-fl. oz. screw-capped bottle laid flat.

A heavy inoculum of aerial mycelium from beer-wort agar cultures of *T. mentagrophytes* was added and incubated at 28° C. After fourteen days, the growth formed a mat over the surface of the fluid. Some slimy mycelial growth also occurred below the surface. The medium was then decanted and a fresh supply added. This was repeated at two fortnightly intervals. After this time the growth appeared to degenerate somewhat. The decanted fluid was sterilized by Seitz filtration and then stored at 0° C.

Tests for proteolytic activity were made by examining the effects of the filtrate upon dyed hide-powder ('Azocoll') and congo-red-fibrin. The former tests were made semi-quantitative by measuring the release of dye colorimetrically. In addition, the ability of the filtrate to liquefy gelatin and to hydrolyse salivary mucin was tested, the latter being carried out by the method of Sammons[3].

As commercial trypsin has been shown to cause separation of epidermis from dermis[4], portions of guinea pig ear skin were incubated with the filtrate in a similar manner.

In all tests two types of 'controls' were included—of uninoculated fungus medium and of boiled filtrate.

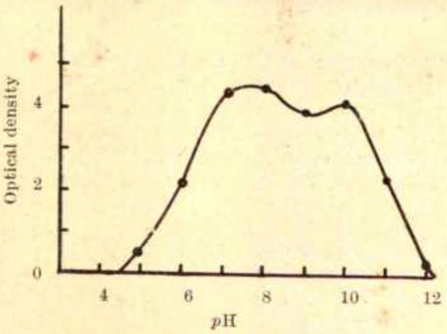

Fig. 1. The dye release from 'Azocoll' by filtrates of *T. mentagrophytes* in relation to *p*H

Release of dye from 'Azocoll' hide-powder was rapid—the undiluted filtrate showing activity within half an hour. Estimations of the release of dye over a range *p*H 4–12 indicate a wide range of activity from *p*H 6 to *p*H 11 (Fig. 1). There appeared, however, to be two maxima—about *p*H 7 and about *p*H 10. In repeat experiments the exact location of the peaks was not precise ; but the reduced activity between the maxima was always present. The experimental method, however, is not precise enough to define accurately the exact maxima.

The release of dye from congo-fibrin was considerably slower, at least four hours incubation being necessary. The range of *p*H over which activity appeared was similarly *p*H 6–11.

Sammons's test, which depends upon the ability of mucin to cause clumping of a suspension of barium sulphate, and the impairment of this property after enzymic digestion, also gave a positive result. Digestion of salivary mucus took place after about two hours.

Gelatin liquefaction occurred after incubation overnight, and similarly decolorization of denatured hæmoglobin was shown by allowing the enzyme to diffuse through a hæmoglobin-agar plate incubated at 37° overnight.

Finally, it was shown that incubation of thin slices of guinea pig ear skin with the filtrate so affected the epidermal–dermal bonds that the epidermis could be separated from the dermis by fine forceps. About two hours incubation was necessary, and this represents the time required for a solution of commercial trypsin 12·5 mgm./ml. to induce this loosening of the tissues.

Serum inhibited the skin-splitting effects of the filtrate and it also inhibited the hydrolysis of 'Azocoll' and hæmoglobin.

A filtrate from a culture of *T. rubrum* has also been examined and was found to have similar properties.

These results indicate that filtrates of *T. mentagrophytes* contain an enzyme or enzymes which are proteolytic. The wide *p*H range of activity and the two optima for the release of dye from 'Azocoll' suggest that more than one enzyme may be present.

The separation of epidermis from dermis by commercial trypsin has been stated to be due to the presence of an elastase[5]. We have found, however (unpublished observations), that a crystalline trypsin, although less effective, will also cause skin-splitting. The mucinase isolated by Sammons[3] will also split skin, and consequently this skin-splitting property gives indication of the nature of the protease prese

However, the knowledge that *T. mentagrophy* produces an enzyme which can cause separation epidermis from dermis throws some light on pathology of fungus infections. It is reasonable believe that, as the fungus grows in the more sup ficial layers of the epidermis, the proteolytic enzy diffuses from it and loosens the epidermal atta ments. Thus in areas exposed to friction, vesic will readily appear.

The proteolytic enzyme may be responsible for itching associated with epidermophytosis. Arth and Shelley[6] have shown that the injection of p teases into the skin is accompanied by itching.

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Occurrence of Triple and Quadruple Cones in the Retina of the Minnow (*Phoxinus laevis*)

Triple cones have previously only been observ in the retinæ of a frog, *Rana temporaria*[1], and of gecko, *Aristelliger praesignis*[2], and in both the animals they are rare and atypical. I have examin many retinæ of trout, *Salmo trutta*, of all ages, a I have found a considerable number of triple con which, from their distribution in the cone patter appear to be anomalous double cones. In the minno however, triple cones are abundant and predomina in most regions of the retina, and quadruple con are numerous enough to suggest that they may ha a significant function.

These multiple cones are seen most clearly tangential sections of the retina (Fig. 1). In sever

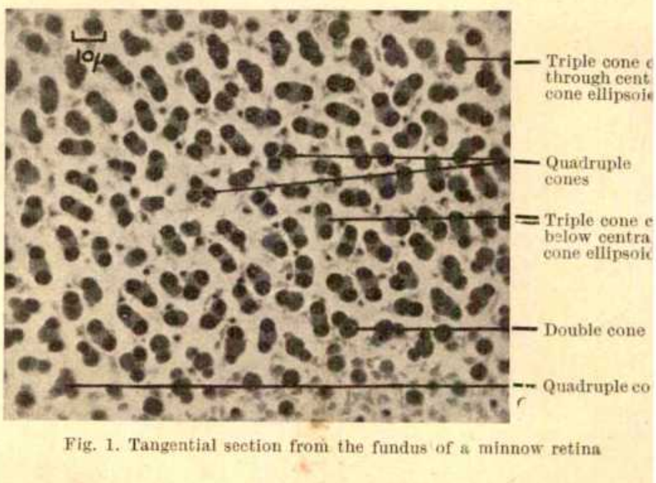

Fig. 1. Tangential section from the fundus of a minnow retina

tions the quadruple cones are proportionately re numerous than in Fig. 1. The three parts of a ut triple cone are of equal size ; but a minnow le cone consists of a large central cone with two aller cones arranged linearly on opposite sides of and a quadruple cone has three smaller cones ced symmetrically around the central cone. Each t of a multiple cone resembles a typical teleost gle cone in structure, having a small outer segment, rger inner segment with an ellipsoid, and a nucleus l foot-piece. In the minnow, the ellipsoid of the tral cone is level with the outer segments of the aller lateral cones, so that in a tangential section the ellipsoids of one multiple cone are not visible.

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Jan. 20.

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Site of Hibernation of a Tachinid Larva within its Host

DURING investigations on the physiological relations tween the pine looper, *Bupalus piniarius* L. (Lep. ometridae), and its parasite *Carcelia obesa* Zett. ipt. Tachinidae), some interesting facts were dis- vered, which so far as we know have not hitherto en described.

The egg of *Carcelia obesa*, which is deposited on e young caterpillar, contains a well-developed aggot which forces its way into the host within a w hours. Reaching the hæmocœl, the maggot eeps towards the head of the caterpillar and pene- ates into a mandibular muscle. (According to omp[1] the larvæ attach themselves first to the wall the fore-intestine.) The muscle reacts by the forma- n of a protruding hypertrophy, in which the resting aggot stays during the larval life of its host. *upalus* passes the winter in a state of pupal dia- use. When in the autumn the caterpillar pupates, d the mandibular muscles go into histolysis, the aggot (still in its first stage) is again released into e hæmocœl. However, when dissecting parasitized pæ in November and December, one finds the aggot mostly in a cavity between the abdomen and e wings, and consequently outside the body of the ture moth. This cavity not only contains exuvial id, but also a quantity of air which communicates th the first pair of abdominal stigmata, lying side the sclerotized pupal cuticle under the wing se. More than once we have taken the maggot the act of holding its caudal stigmata in contact th the air bubble.

Whether the maggot reaches the cavity actively, whether it is ejected by the host, is still being vestigated. The maggot resumes its development soon as diapause in its host is broken and adult velopment initiated.

Clearly the subalare air-mass of the host pupa is great importance to the hibernating parasite. The estion arises, What is its significance for the host elf ?

We have found air bubbles in the subalare cavity all pupæ of Lepidoptera so far examined : *Pieris assicae* L., *Sphinx ligustri* L., *Automeris io* Fabr., *ilosamia walkeri* Felder., and *Phalera bucephala* L. Only in *Pieris* and *Bupalus* did the air occupy the greater part of the cavity. In *Pieris* its volume may even exceed that of the abdomen. At first we thought this might be the clue to the intermittent release of considerable quantities of carbon dioxide during diapause by lepidopterous pupæ, as demonstrated by Punt[2], Schneidermann and Williams[3,4] and Buck[5]. However, the quantity of 'subalare air' was found to be relatively small in *Philosamia walkeri*, in which Schneidermann and Williams[4] have apparently found discontinuous respiration.

Most probably the air compensates for the loss of body water during the long period of hibernation, and thus provides a possibility of shrinking, which in the *pupa obtecta* is not otherwise provided for.

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Observations on Pool and Capillary Feeding in *Aedes aegypti* (L.)

Gordon and Lumsden[1], in a classical paper, first directed attention to the fact that mosquitoes take up blood either directly from a capillary or from a pool formed in the tissues by the leakage of blood from a capillary previously lacerated by the mosquito's proboscis. The former method was termed 'capillary feeding' and the latter 'pool feeding'. It was also noted that, when a mosquito fed from a capillary, engorgement took about three minutes as compared with as long as ten minutes when the blood was taken by pool feeding. Attention was also directed to the significance of the two methods of feeding in relation to the taking up and deposition of pathogens by mosquitoes. These experiments were performed on the frog's web, using *Aedes aegypti* (L.), and were criticized[2] on the grounds that the mechanism of feeding might be very different in mammalian tissues. Recently, Griffiths and Gordon[3] developed a new technique for making observations on mosquitoes while they fed on the mouse's ear. Using this technique it was possible to show, by direct observation on living mammalian tissue, that no essential difference existed between the method used by mosquitoes while feeding on batrachian and mammalian tissues.

In view of the medical significance of these two types of feeding, it was considered of interest to determine the differences in the times taken by *A. aegypti* to engorge when feeding on man. It was hoped that such observations would indicate the frequency of the two types of feeding when man was host to the mosquito.

During the course of studies on the reactions of medical students to the bites of *Aedes aegypti* (L.)[4], records were kept of the time taken by each mosquito to fill to repletion (T_r). All observations were made at room temperature, which varied from 22° to 24° C. during the course of the observations. The mosquitoes all came from the same colony and had not had a

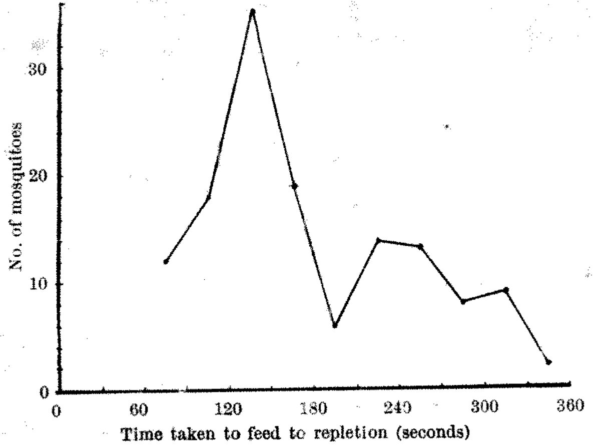

Fig. 1

previous blood meal. In all, 140 observations were made on seventy-five medical students, each observation being made on a separate mosquito. The time interval T_r was taken from the insertion of the proboscis to its final withdrawal after the mosquito had fed to repletion. Preliminary probings which ended by the proboscis being completely withdrawn and the mosquito failing to obtain blood were not included. Probing which did not result in the withdrawal of the proboscis but which was a preliminary to engorgement was included in the time T_r. The mean for T_r was 189 ± 77 sec. The results obtained are shown in Fig. 1.

The markedly bimodal distribution pattern of T_r shows that two groups occur in the population sampled. In the absence of other obvious differences between the mosquitoes used, it is reasonable to suggest that the two groups are capillary and pool feeders respectively. If we then assume that a mosquito feeding from a capillary takes 180–210 sec. as a maximum feeding time and that the pool feeders take at least 180 sec. to feed to repletion, we may then include the six specimens in the class 180–210 sec. with both groups. The mean time to repletion for capillary feeders then becomes 131 ± 33 sec. and for pool feeders 267 ± 50 sec. These means are highly significantly different when Students' T test is applied (P is less than 0·001). It will be noted that capillary feeding occurs more frequently than pool feeding, the latter method of feeding being used by about 40 per cent of *A. aegypti* feeding on man.

These results confirm Gordon and Lumsden's findings[1] and, although the direct observation in man of the two types of feeding is virtually impossible, show that there is strong evidence that the two types do occur. These observations were made while I was employed by the Unit of Veterinary and Medical Entomology, Science Service, Ottawa, Canada.

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Effects of Gamma-(2 : 4-Dichlorophenoxy) butyric Acid on Sporelings of Bracken

AMONG their recent studies of the chemistry a mode of action of plant growth-substances, Wain a his co-workers[1] have demonstrated that a β-oxidati system exists in certain plants, whereby usua inert formulations of certain ω-phenoxyalkyl ca oxylic acids may be broken down in the plant the active acetic derivative. Since this is an enzyma reaction, there seems no reason why such oxidati should not take place in all classes of plants ; l the examples so far described belong to the Ang sperms. It is therefore of interest to note tl positive growth reactions have been shown by you plants of the common bracken fern (*Pteridi aquilinum*) when treated with γ-(2 : 4-dichlo phenoxy)butyric acid (2 : 4-D.B.).

During recent tests of the effects produced certain chemicals on 1-yr. bracken plants grow under garden conditions, three test plants were ea sprayed with 10·5 c.c. of a water solution of γ-(2 : dichlorophenoxy)butyric acid at a concentration 500 p.p.m. These plants (and others which were us as untreated controls) were chosen for uniformity frond growth, and each (in addition to a cent group of very small juvenile fronds, most of wh were short-lived) had sixteen to eighteen fronds 33–38 cm. height. Spraying was carried out August 9, and eight days after treatment two of t three treated plants showed epinastic curvatu on the stalks of the youngest, elongating fronds. Fo weeks after treatment, the plants were growi vigorously ; but many of the fronds showed epinas curvatures of the frond rachis and marked reducti in pinnule size. These fronds had a more rigid appea ance than those of the control plants, and the reduc pinnæ gave the experimental plants a delicate feathe appearance. Fronds developing later tended to ha more normal form ; but, for the rest of the seasc fronds on the treated plants showed a rather st erect habit.

At harvesting, seven weeks after treatment, three experimental plants showed vigorous fro growth, the number of fronds being greater than tl of the control plants. One of the treated plants w dug up, leaving the other two for future observatic The rhizome of this plant showed positive (growt regulating) reactions, the chief morphological featu being : (*a*) restriction of internodal developmer which resulted in the extension of the rhizome bei much less than that of untreated plants ; (*b*) mark contortions and dormancy of the majority of t rhizome apices ; and (*c*) increased root formati particularly around the dormant stem tips. As the case of frond growth, these morphological featur were less marked on the younger, later develope branches of the rhizome.

Such morphological features are all strictly in li with growth effects shown by young bracken plan when treated with the recognized active growt regulator, 2 : 4-dichlorophenoxyacetic acid (2 : 4-D In themselves, they do not prove the breakdown the butyric compound, and further analysis is need to show this. But the morphological reactions we marked enough to suggest that the butyric cor pound was degraded inside the plant to the mo active acetic homologue ; and that an oxidatic mechanism may operate in the tissues of the bracke sporophyte, at any rate in the early stages of develo ment.

Acknowledgment is made to the Agricultural search Council for its support of this work, and Messrs. May and Baker, who supplied samples of 2 : 4-dichlorophenoxy)butyric acid for testing.

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Effect of the Anion on R_F Values of Quaternary Ammonium Salts

THE effect of anions on the R_F value of cations is most cases ignored, since little interaction has ever en found to exist. Pollard *et al.*[1] refer to the fferent R_F's of various cupric salts and also demonrate that lead, sodium and potassium move parately from their respective anions. Lederer[2] ates that butanol saturated with 0·5 N ammonium droxide keeps halide salts completely in the ionic rm and that they move as ions. Others[3] have noted fferent R_F's with several salts of acetylcholine.

While studying the *in vitro* metabolism of the nglionic blocking agent, 'Ecolid' chloride (4,5,6,7-trachloro-2-(2-dimethylaminoethyl)-*iso*indoline diethochloride)[4], we noticed that after precipitation tissue proteins with trichloracetic acid, paper romatograms of the acid solution yielded one spot ith R_F value 0·67, whereas 'Ecolid' chloride itself ve R_F 0·18. If, however, 'Ecolid' was precipitated ith reinecke salt and the reineckate chromatoaphed after treatment of the material at the origin ith silver nitrate to split the salt[5], a spot with R_F 0·23 sulted. A possible explanation for these phenomena that salts of 'Ecolid' migrate in undissociated form. herefore, the trichloracetic acid filtrate would give spot of 'Ecolid' trichloracetate whereas silver nitrate eatment of the reineckate would yield a spot of colid' nitrate.

To test this hypothesis, a solution of 'Ecolid' loride was passed through an anion exchange resin, ermutit S-2', and the 'Ecolid' hydroxide thus tained was added to various salt solutions. Aliquots these solutions were then subjected to ascending per chromatography along with the 'Ecolid' droxide using two solvents. Solvent A consisted n-butanol saturated with 0·1 N ammonium ydroxide, whereas solvent B consisted of 20 per nt ammonium hydroxide in 95 per cent ethanol. all cases identification of 'Ecolid' was by spray-g the chromatogram with a modified Dragendorff lution[5].

It is apparent from Table 1 that the nature of the nion markedly affects the R_F of the 'Ecolid' cation. he iodide and trichloracetate salts of 'Ecolid' are latively insoluble and crystals of each have been btained which are homogeneous by paper chromatoraphy. The iodide displays the same R_F as one repared by another route.

Shepherd and West[6] describe the appearance of a cond adrenaline-like spot in trichloracetic acid ltrates, which seems to be a complex of trichlorcetic acid and adrenaline. They suggest compound rmation between the weak phenolic group of drenaline and trichloracetic acid as the cause. imple salt formation between adrenaline cation and ichloracetic acid anion, similar to that observed with trichloracetic acid and 'Ecolid', could easily explain the effect observed by Shepherd and West.

Table 1

Anion	R_F of 'Ecolid™' in solvents A*	B*
Hydroxide	0·15–0·16	0·10–0·13
Fluoride	0·18	0·18–0·19
Chloride	0·18	0·45–0·5
Bromide	0·24	0·52–0·54
Iodide	0·25–0·29	0·62
Carbonate	0·58	0·25–0·27
Nitrate	0·23–0·24	0·51–0·52
Acetate	0·56	0·51
Phosphate	0·61–0·63	0·74
Sulphate	0·64–0·65	—
Trichloracetate	0·65–0·69	0·77

* See text for composition.

The effect of anions on the R_F of cations, in this case a bisquaternary ion, emphasizes that care must be taken in the interpretation of chromatograms from natural fluids or tissue extracts. The danger of loss of material due to the formation of relatively insoluble salts was underlined by our observation of a sparingly soluble 'Ecolid' trichloracetate in trichloracetic acid filtrate preparations. Therefore, standard solutions should not be prepared with simple solvents but with the fluid or tissue extract under consideration.

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Arcs in Vacuum

DURING an investigation of the behaviour of electric arcs in vacuum, measurements have been made of arc voltages with various cathode materials, and photographs have been taken of cathode spot tracks on one particular material. Certain of these measurements may be relevant to phenomena occurring at the opening of low-current contacts in air.

To enable an arc to burn in a high vacuum, one electrode at least must vaporize. In all the tests made, the cathode provided the vapour from high current-density cathode spots.

Although the arcing voltages were exceedingly ragged, the average arcing voltage depended on the cathode material, as did the current necessary to maintain a stable arc. A solid cadmium cathode, for example, allowed a 2-amp. arc to burn steadily, whereas an arc with a tungsten cathode was unstable even at 50 amp. Oscillograph records showed no sign of a change of average arc voltage as an initially clean steel anode became coated with vapour from the cathode, and when cadmium was used as the cathode, heating the anode to a temperature above the boiling point of cadmium did not affect the average arcing voltage.

The anode was a flat steel disk about 2 in. in diameter, and pieces about ½ in. in diameter were used for cathodes, except in the cases of gold and nickel, when wires were used. The arcs, which were

Table 1

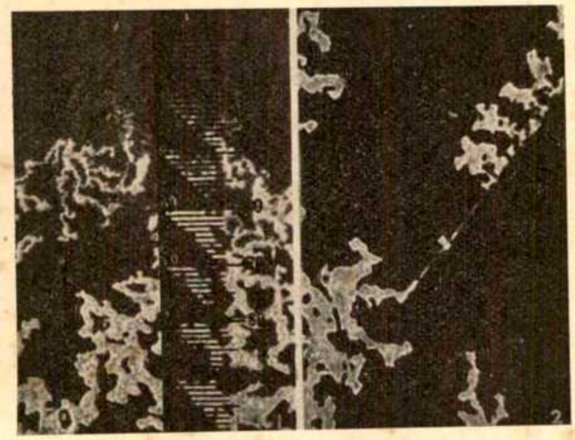
Cathode material	Arc voltage (volts)
Cadmium	10
Magnesium	12
Gold	12·5
Nickel	15·5
Silver	16·5
Aluminium	19·5
Carbon	20
Copper	21
Steel	33
Tungsten	>50

initiated by separating the electrodes, were drawn to lengths of between 1 and 10 mm.

The voltage gradient of the arc was less than 0·05 V./cm. in every case, and the arc voltage was very nearly independent of the arc current. Some arcing voltages are shown in Table 1.

After arcing had taken place, the cathodes all showed microscopic melting, with the exception of carbon, which had small pits burned into it.

If, instead of using a solid piece of metal for a cathode, a very thin film of metal evaporated on to glass is used, very clear cathode tracks can be obtained. Cathode tracks made by a 1-amp. arc about 2 cm. long on a film of cadmium about 0·02μ thick are shown in Figs. 1 and 2. In this case the arc was initiated by a spark from a third electrode. The narrowest track appeared to be about 0·4μ wide, which is about the same size as those caused by very short arcs on contacts, photographed by Germer and Boyle[1]. It seems likely that the wider tracks are made by the overlapping of narrower tracks, the cathode spots running around the edges of the tracks, and evaporating larger areas. That these cathode spots can be guided by fine scratches, like those shown by Germer and Boyle, is shown in Fig. 2. There is also evidence that the spot tracks become narrower where the metal film is thinner.



Photomicrographs (× 1,200) of cathode tracks on film of cadmium about 0·02μ thick. Current approximately 1 amp. (2) shows effect of very fine scratches guiding cathode spots

A detailed account of this investigation will be published elsewhere in due course. This communication is published by permission of the Director of the Electrical Research Association.

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Formation of the High-Pressure Arc Column in Hydrogen

WE have noted[1] that by increasing the current a hydrogen high-pressure glow discharge betwe copper electrodes, we cause the discharge column concentrate gradually until a critical current value reached, when a sudden marked constriction occu resulting in a bright red column[2]. It was noted al that with clean electrodes, the characteristic glc discharge properties at the cathode are n affected by the column changes. We have now o served that similar effects may be obtained usi tungsten electrodes.

Our recent experiments give the variation of sor of the main properties of the column through t transition region, and typical results are shown Fig. 1. At low currents the column diameter increas slowly with current ; but between 1·0 and 1·5 am the column contracts gradually until at about 1 amp. a discontinuous constriction occurs, produci a sudden fall in the voltage gradient and a lar increase in the current density. The electrical a optical properties of the column are now almo identical with those of the normal hydrogen a Measurements of excitation temperatures of Balm series reveal that a minimum temperature is reach at the value of the constriction current, and th further increase in current produces increased te peratures and a convergence of the separate excitati curves. The results suggest that at low currents t excitation temperatures describe an electron ener

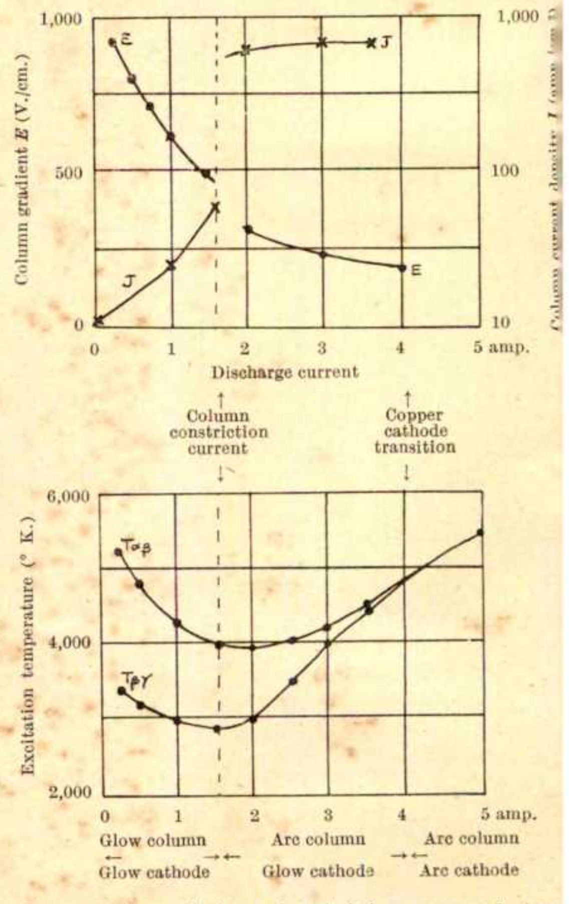

Fig. 1. Hydrogen discharge characteristics: pressure, 1 atmosphere; copper or tungsten electrodes; gap, 5–10 mm.

stribution, and that with increase of current the as temperature rises from a low value and approaches e electron temperature.

With both tungsten and copper electrodes further crease in current results in a discharge with normal rc cathode and column regions, with, however, o further discontinuous column changes. Thus may be concluded that the true hydrogen arc olumn is first formed when the sudden constriction ccurs. The experiments show also that the values r minimum excitation temperature are independent f pressure, gap-length and electrode material and lways occur at the constriction current. It seems kely, therefore, that the suggestions of King[3] are alid, namely, that the column constriction is ependent upon dissociation and thermal considera-ions. This view is further supported by our experi-ents, which show that with water-cooled copper lectrodes the constriction occurs at higher current alues if the gap distance is decreased, but that the everse effect is obtained with hot tungsten electrodes.

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Aggregation of Spherical Particles

FESSLER[1] has recently directed attention to the xistence of pearl-string artefacts in random arrays f spherical glass particles, and suggests that the ccurrence of such arrangements in electron micro-raphs should be accepted with caution in the bsence of additional evidence. This communication lescribes a system in which this phenomenon has een observed using the electron microscope; but at he same time light-scattering measurements have lso confirmed the presence of associates of this hape.

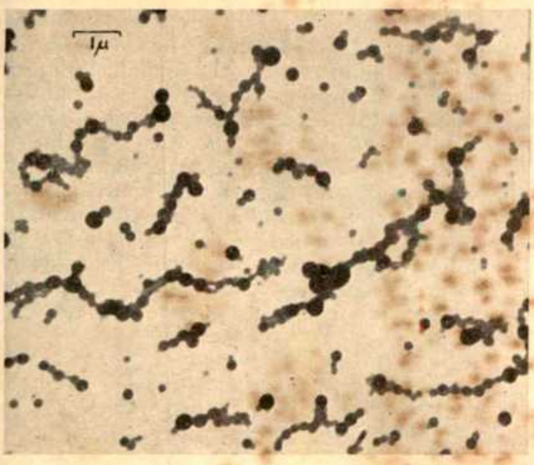

Fig. 1. Electron micrograph of precipitated polystyrene, showing small spherical particles and aggregates. × 11,000

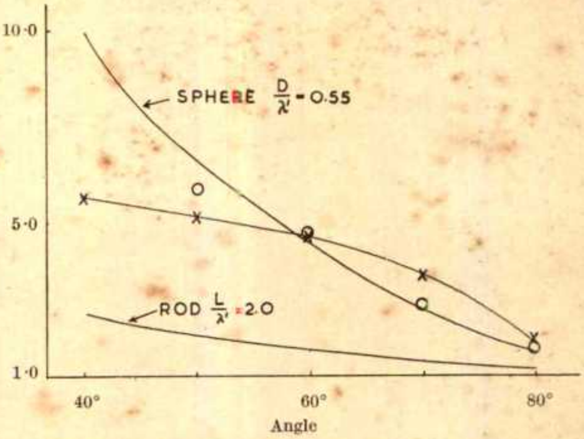

Fig. 2. Plot of dissymmetry against angle, showing the theoretical and experimental results. ○, Initial (5 per cent); ×, final (85 per cent) stages of precipitation

In the turbidimetric method of analysis of polymer solutions, non-solvent is slowly added to the solution, the turbidity being measured as the decrease in transmission of a parallel beam of light passed through the system. The method is useful for estimating the distribution of molecular weight, and also in detecting the presence of 'block' and 'graft' type polymers in the presence of their associated homo-polymers. The polymer is progressively precipitated, and if all this material is present in the form of spherical particles which are small compared with the wave-length of light used, then the decrease in transmission will give an exact measure of the quantity of each molecular species present in the system.

In an analysis of this type, a 0·004 gm./100 ml. solution of a sample prepared in the laboratory of polystyrene of molecular weight 400,000 was used. 30 ml. of this solution together with 12 ml. of methanol was placed in the turbidimeter cell at 25° C. and precipitation brought about by adding more methanol at the slow rate of 0·01 ml./min. with continuous slow stirring.

Electron micrographs of the precipitated material taken at the 50 per cent precipitation point (Fig. 1) show the existence of pearl-string associates. These are very large compared with the individual spheres also present.

Light-scattering measurements were also made on samples taken from the titration cell, the transference being carried out very carefully, in order to exclude contamination by extraneous particulate matter. Intensity measurements were made over the angular range, 40°–140° at 10° intervals, on samples of the initial (5 per cent) and final (85 per cent) stages of the precipitation.

Fig. 2 shows the dissymmetry of angular scattering at several angles. The dissymmetry is defined as the ratio of the intensity of scattering at the forward angle θ, to that at 180° − θ. Also in this figure are the expected distributions for spherical and rod-like particles of the size indicated, and calculated using the following relationships[2]:

$$P_{(\theta)} = \frac{3}{x^3}\,[\,(\sin x - x\cos x)\,]^2$$

$$P_{(\theta)} = \frac{1}{x}\int_0^{2x}\frac{\sin x}{x}\,\mathrm{d}x - \left(\frac{\sin x}{x}\right)^2$$

where λ' is wave-length of light in liquid, θ is angle of scattering ($\theta = 0$ for transmitted light), $x = \frac{2\pi D^*}{\lambda'} \sin \frac{\theta}{2}$, D^* being the characteristic dimension, D is diameter of the sphere and L is length of the rod.

In the early stages of the precipitation, the experimental points fall on the theoretical line associated with the spherical model. In the later stages the plot shows many of the characteristics of scattering expected of rod-like particles. This would be expected if the sample was a mixture of small spheres and linear aggregates of spherical particles. Work is proceeding in order to elucidate the problem further.

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Chemistry Department,
University,
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March 19.

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[1] Fessler, J. H., *Nature*, **117**, 439 (1956).
[2] Debye, P., *J. Phys. and Coll. Chem.*, **51**, 18 (1947).

Latin-Square Designs with Individual Gradients in One Direction

THE efficacy of the Latin-square design[1] in eliminating two-dimensional variation from treatment comparisons, particularly in field experiments, has long been established. Kendall[2] states that horizontal and vertical gradients at least are removed from the comparisons, implying, of course, that the three degrees of freedom for columns in a 4 × 4 Latin square, for example, can be regarded as eliminating linear, quadratic and cubic components in one direction. The mathematical model for the analysis can be regarded equivalently as representing the background of the experimental material against which the experiment is conducted as a curved sheet, the curvatures in vertical planes parallel to the columns (rows) being equal for plots in one row (column). In some situations, however, the changes in the experimental material may be such that different curvatures are more realistic, and on the assumption that the more closely the imposed model represents the underlying phenomena, the greater the achievable accuracy, such alternatives merit consideration.

As usual, a completely general expression of the background material introduces difficulties because of the relation between the number of parameters estimated and the number of degrees of freedom for error, so that some compromise guided by *a priori* knowledge is required, and only the simplest cases have so far been studied.

In one case, for which applications can immediately be envisaged (see below), it is assumed that columns (say) are discrete and that variation within them may be represented in terms of individual linear regressions. The mathematical model used therefore is:

$$y_{ij} = \mu + \varkappa_j + \beta_j a_{ij} + \theta_i + e_{ij}$$

where y_{ij} is the observed value for the experimental unit of the ith treatment in the jth column; μ is the general mean; $\varkappa_j$ and β_j are the location and slope parameters for the linear variation in the jth column; a_{ij} is the discrete row constant for the ith treatment in the jth row measured from a zero mea at the centre of the rows, and it is convenient to tak

$$\sum_{i=1}^{n} a^2_{ij} = \sum_{j=1}^{n} a^2_{ij} = n\,;$$

θ_i is the ith treatment parameter.

As usual, it is assumed that the unexplaine variate e_{ij} is distributed normally and homoscedastically with variance σ^2 about a zero mean.

Unbiased estimates of treatment comparisons ca readily be obtained, and the variance – covarianc matrix for an $n \times n$ Latin square is

$$-\,n\,[\mathbf{AA}' - n^2]^{-1}$$

where $[\mathbf{A}]$ is the matrix $[a_{ij}]$.

The linearly declining portions of the lactatio curves of dairy cattle and goats form the background for numerous experiments, in some of which treatmen after-effects are absent or sufficiently small to perm the application of the preceding analysis. Th corresponding analysis of variance on the left i Table 1 is compared with the conventional analysi of a randomization imposed on the lactation curve of four Guernsey cows.

Table 1. ANALYSES OF VARIANCE OF MILK YIELDS (LB./WEEK)

Gradient	d.f.	m.s.	Conventional	d.f.	m.s.
Cows	3	8,525·4518	Cows	3	8,525·451
Regressions ignoring treatments	4	553·3383	Weeks	3	398·701
Treatments adjusted for regressions	3	35·5477	Treatments	3	86·097
Unexplained variation	5	39·5352	Unexplained variation	6	177·212

The treatment estimates for the two methods are

	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\theta}_3$	$\hat{\theta}_4$
Gradient analysis	−4·97	1·07	0·83	3·0
Conventional analysis	0·55	−2·02	−4·70	6·1

The variance – covariance matrix for the design usec is:

$$\frac{1}{8}\begin{bmatrix} 3 & 0 & -1 & 0 \\ 0 & 3 & 0 & -1 \\ -1 & 0 & 3 & 0 \\ 0 & -1 & 0 & 3 \end{bmatrix}$$

so that the variance estimate for differences betwee two treatments is either 39·54 or 29·65; compariso with the corresponding estimate, 88·61, obtaine from the conventional analysis shows that in thi case a substantial increase in the amount of information has been achieved. The greatest increases i information may be expected when large difference exist between the individual regression coefficients a situation more likely to occur in animal than i crop experiments, and the gradient analysis may b especially useful when animals from a small her cannot easily be matched for stage of lactation.

A detailed paper, on the methods discussed her and on the general case allowing for higher-orde individual regression terms, is in preparation.

C. P. COX

Section of Statistics,
National Institute for Research in Dairying,
University of Reading.
Feb. 10.

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[1] Yates, F., *Emp. J. Exp. Agric.*, **1**, 235 (1933).
[2] Kendall, M. G., "The Advanced Theory of Statistics", **2** (Griffin, 1946)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, June 12

ight-Fleming Institute of Microbiology (at St. Mary's ital Medical School, London, W.2), at 5 p.m.—Prof. R. Hare . Transmission of Infections of the Respiratory Tract".* (Almroth ght Lecture.)

ological Society of London (at the Zoological Gardens, nt's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 13

stitute of Metals (in the Weir Hall of the Institution of Naval itects, 10 Upper Belgrave Street, London, S.W.1), at 6.30 p m.— R. Smoluchowski (Carnegie Institute of Technology): "Some nt Studies of Irradiation Effects in Metals and Other Solids".

Thursday, June 14

uncil for the Preservation of Rural England (at the l Institute of British Architects, 66 Portland Place, London, , at 2 30 p.m.—Annual General Meeting.

yal Society (at Burlington House, Piccadilly, London, W.1), 30 p.m.—Dr I. de Burgh Daly, F.R.S.. "The Institute of Animal iology, Babraham, Cambridge".

ne and Tooth Society (at the Institute of Orthopædics, 234 t Portland Street, London, W.1), at 5 p.m.—Annual General ing; followed by "Casual Communications".

ndon Mathematical Society (at the Royal Astronomical ety, Burlington House, Piccadilly, London, W.1), at 5 p.m.— . Marshall Hall: "Finite Projective Planes".

iversity of London (in the Physiology Theatre, University ge, Gower Street, London, W.C.1), at 5.15 p m.—Prof. Roy P. r (U.S.A.): "Active Transport in Cells of Mammalian Renal les Studied *in vitro*".*

Thursday, June 14—Friday, June 15

ciety for the Study of Fertility (on Thursday at the Meeting se of the Zoological Society of London, Regent's Park, London, .1, and on Friday at the National Institute for Medical Research, Hill, London), at 10 a m. daily—Conference.

Friday, June 15

yal Institution (at 21 Albemarle Street, London, W.1), at n.—Sir Gavin de Beer, F.R.S. "Archæopteryx".

APPOINTMENTS VACANT

plications are invited for the following appointments on or re the dates mentioned:

sistant (scientist with experience in initiating projects and dinating the work of research teams under a pre-determined ramme) to the Director of Research—The Director of Re- h, British Food Manufacturing Industries Research Association, dalls Road, Leatherhead, Surrey, marking envelope "Confidential" e 13)

emist (with a first- or good second-class honours degree or valent qualification, at least three years experience, and preferably owledge of liquid fuels and lubricants) in the Central Laboratory, wick—Recruitment and Training Officer (F/EV.. 587), London sport, 55 Broadway, London, S W.1 (June 14).

sistant, Grade B, in the Physics Department; and an stant, Grade B, to teach Biology in the Natural Science De- ment—The Principal, Derby and District College of Technology, nanton Road, Derby (June 16).

search Fellow in Chemistry to carry out original work on a chemical topic in the Londonderry Laboratory for Radio- nistry; and a Research Student in Radiochemistry, to under- original research leading to a higher degree—The Secretary, University, 38 North Bailey, Durham (June 16).

esearch Assistant in Mathematical Statistics; and a earch Assistant in Numerical Analysis—The Registrar, The versity, Liverpool (June 18).

ssistant Lecturer or Lecturer in Zoology—The Secretary Registrar, The University, Southampton (June 20)

ecturer in Applied Mathematics—The Secretary, The Univer- , 38 North Bailey, Durham (June 20).

ecturer in Pure Mathematics—The Secretary, The Queen's versity, Belfast (June 20)

esearch Fellow (graduate, with experience in natural products aistry) in Chemistry, at the University College of the Gold Coast he Secretary, Inter-University Council for Higher Education rseas, 29 Woburn Square, London, W.C.1 (June 22)

nglish Electric Company Research Fellow in Aeronautics he Secretary of University Court, The University, Glasgow. ne 23).

xperimental Officer (agricultural graduate or person with parable qualifications) at the Dunholme Field Station, Lincoln, ssist in experiments on sugar beet—The Secretary, Rothamsted erimental Station, Harpenden, Herts (June 23).

entific Officer (with a knowledge of advanced chemistry and graduate training in plant physiology) in the Department of nt Breeding, to study developmental physiology of fruit trees, particular reference to growth and flowering hormones—The etary, John Innes Horticultural Institution, Bayfordbury, Hert- , Herts (June 23).

Research Assistant in Psychology—The Secretary, The University, 38 North Bailey, Durham (June 25)

Research Fellow (graduate with teaching and/or research experience) in Education—The Registrar, The University, Bristol (June 25).

Assistant in Parasitology—The Assistant Secretary, The University, Edinburgh (June 30).

Lecturer in Physical Geography; and a Lecturer in Economic Geography, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C 1 (June 30).

Lecturer (with special qualifications in physical and/or inorganic chemistry) in Chemistry in St. Salvator's College—The Joint Clerk to the University Court, College Gate, St. Andrews (June 30).

Lecturers (3) in Microbiology—The Registrar, The University, Birmingham (June 30).

Senior Lecturer or Lecturer (with a degree or equivalent qualification in veterinary medicine) in Animal Health, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 3).

Research Officer or Senior Research Officer (with a university honours degree in science with chemistry as a major subject, postgraduate research experience, and preferably experience in paint technology) in the Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Highett (near Melbourne), Victoria, Australia, to co-operate with another research officer who will be making a study of the chemical and physical characteristics of fibrous plaster—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 390/238 (July 7).

Lecturer in Electrical Engineering; Lecturer in Civil Engineering, and a Lecturer in Mechanical Engineering—The Assistant Secretary, The University, Edinburgh (July 9)

Lecturer in Statistics—The Registrar, The University, Hull (July 11).

Lecturer in Mathematics at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

Lecturer (with an honours degree and experience in research or in clinical work) in Psychology, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

Fellow (with an honours degree of a British university) in Physics—The Warden, Merton College, Oxford (July 23)

Assistant Keeper in the Department of Geology; and an Assistant Keeper in the Department of Archæology—The Secretary, National Museum of Wales, Cardiff (July 28).

Lecturer in Mathematics at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

Lecturer in the Department of Psychology, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (New Zealand, July 31)

Lecturer (university graduate in civil engineering and preferably some professional experience, and a specialized knowledge in the theory of structures) in Civil Engineering, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31)

Lecturers or Senior Lecturers (2) in the Faculty of Rural Science, one in Physiology and one in Biochemistry, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (Australia, July 31).

Assistant (with good academic qualifications and experience in the organization of work programmes at a large industrial laboratory) to the Divisional Chief Scientist, West Midlands Division—Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

Biochemist (recent graduate) in the Department of Clinical Research, to assist in a research programme relating to certain biochemical aspects of mental illness—The Physician Superintendent, Crichton Royal Mental Hospital, Dumfries.

Conservation Officers (under 30, with a degree in agriculture, agricultural engineering, conservation or pure science; or obtain such a degree in June–July) in the Department of Conservation and Extension, Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which will consist of advisory work among farmers on all aspects of agricultural production as well as the conservation and utilization of the soil—Federal Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2.

Demonstrator or Assistant Lecturer in Botany in the Department of Biological Sciences—The Registrar, Wye College, near Ashford, Kent.

Demonstrators in (*a*) Agricultural Botany (preferably with an interest in plant physiology); (*b*) Microbiology (with an interest in dairying or soil microbiology); (*c*) Agricultural Chemistry (with qualifications in agricultural chemistry); and (*d*) Agricultural Zoology (with qualifications in agricultural zoology or zoology)—The Registrar, The University Nottingham.

Experimental Officer (male, with a degree in engineering or physics or H.N.C. in electrical or mechanical engineering, or equivalent qualifications, and experience in instrumentation, especially servo mechanisms or computing, and preferably a knowledge of guided weapon control techniques), at the Royal Military College of Science, Shrivenham, Berkshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. D.38/6A.

Geneticist, Scientific Officer grade (with some research experience and an interest in quantitative genetics), to work with mice on problems related to animal breeding—The Director, Institute of Animal Genetics, West Mains Road, Edinburgh 9.

Laboratory Technician (Zoology) (with some knowledge of biological techniques and/or experience in the use of laboratory apparatus)—The Registrar (ZT), Queen Mary College (University of London), Mile End Road, London, E 1.

Lecturer (preferably honours graduate with industrial experience) in Inorganic Chemistry—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham, Kent.

Lecturer (with a good degree, and preferably industrial experience) in Metallurgy—The Secretary, Royal Technical College, Glasgow.

Non-Medical Biochemist, Basic grade (with a university degree in biochemistry or A.R.I.C.), to work under the Consultant Biochemist—The Hospital Secretary, Paddington General Hospital and Group Laboratory, Harrow Road, London, W.9.

Research Assistant (female, with a degree in chemistry or physics, and an interest in the physical chemistry of biological systems)—The Secretary, The Research Institute (Animal Virus Diseases), Pirbright, Surrey.

Research Assistant (Ph.D. standard), for work on the physical absorption of vapours on ionic crystals—Dr. F. C Tompkins, F.R.S., Imperial College of Science and Technology, London, S.W.7.

Research Lecturer or Assistant Lecturer in Statistics—The Registrar, The University, Nottingham.

Research Students to work on problems relating to atmospherics—Meteorology Section, Cavendish Laboratory, Cambridge.

Scientific Officer (with a first- or second-class honours degree) for laboratory work on physical and engineering problems associated with the use of new techniques in crop conservation—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

Senior Lecturer or Lecturer (with a special interest in inorganic chemistry) in Chemistry, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Senior Technical Assistant for development work in the Bacteriological Laboratory—Prof. Todd, Royal Technical College, Glasgow.

Student Technician (male or female) in the Pathological Laboratory—The Secretary, Wembley Hospital, Wembley, Middlesex.

Superintendent Physicist (with high qualifications in physics and a wide experience of explosive shock phenomena, and preferably some experience in the study of transient electrical phenomena), to lead a team in the study of shock excitation of materials to high temperatures—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. No. 1141/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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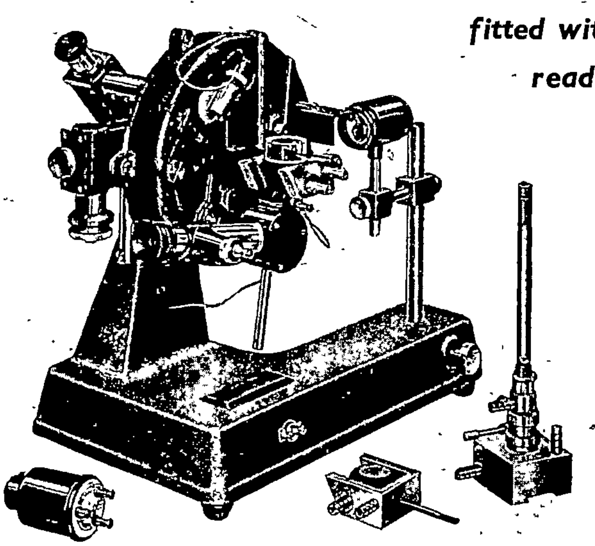

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THE BALANCE OF ARTS AND SCIENCES IN EDUCATION

PEAKING at the North-western Management Conference at Southport on March 19 of the need industry for students of the humanities, Mr. R. O. Thomas urged that, to meet the advances science and technology, and changes in the tech- que of control and communication which electronics bringing about, we need men who are responsive ideas over a wide front and who are capable and ady to accept responsibility with courage and cision. Without such men who can appreciate entific method and the nature of scientific ideas well as the humanities, efficient organization and ministration are scarcely possible to-day ; nor are likely to deploy to the best advantage our present nited numbers of scientists, technologists and tech- cians, let alone achieve the larger number that Great itain requires. Whether, like Mr. Thomas, we are imarily concerned with the training of managers, , like Dr. D. S. Anderson, addressing the Northern unties Technical Examinations Council, our con- rn is chiefly with the expansion of the technical lleges and colleges of technology, or whether our ncern is with the shortage of scientists or the nction of the universities in this age of nuclear wer and the electronic computer, we are brought ce to face with the question of general education d the need for a balance between science and the manities, both in the training of the scientist and chnologist and in that of the administrator and an of affairs.

This is indeed the central problem which has to be ced in planning the expansion of university and chnological education as well as of technical ucation, and no allocation of resources of materials d finance which ignores it will suffice. We have to ake up our minds what we mean by general lucation in this context—how and where it should given—and not merely formulate adequate pro- sals but also take effective measures to give effect them. It is idle to hope that the situation will nprove of itself. It is more likely to deteriorate. ven from the point of view of science alone, Dr. obert Oppenheimer, speaking to the American stitute of Physics on February 2, expressed the iew that the pioneer conceptions which led through instein to the splitting of the atom are now in- lequate to yield an orderly description of the ysical world. Dr. Oppenheimer is not confident at the man or woman who can rescue us from the ch disorder of our new knowledge will speedily ppear ; but he believes that he or she is likely to be young natural scientist. It is even more probable at he or she will be someone able not merely to terpret the nuclear scientist to fellow natural ientists, but equally to set that new knowledge in e context of biological science and of the humanities.

It is important, therefore, that full support should e given to what is already being done in Britain to ncourage movement or transfer from the arts side science, both on the part of those just leaving school and also within the university. The fifty scholarships endowed by Imperial Chemical Industries, Ltd., for those leaving school who wish to transfer from the humanities and enter the universities to train as scientists is a welcome step ; but it is an example which needs to be followed by the universities themselves, as well as by the Ministry of Education and the local authorities. For a time it will only touch the fringe of one problem ; but it could demonstrate the value of such a transfer, and the cumulative effect may be invaluable. It is no substitute, however, for the fundamental thought about the content of courses and balance of studies, the hard work that may be involved in replanning complicated time-tables and the fundamental questions as to the respective purpose or functions of university, college of technology and technical college.

That challenge is, however, already being met. Sir Eric Ashby and Prof. K. Denbigh have recently directed attention to the place of the humanities in technology and suggested that technology can, in fact, be taught as an essential element in a liberal education and one which makes for social coherence. Pointing out that human interests and sympathies are even more to be desired in the technologist than in scientific workers in the laboratory, Prof. Denbigh has stressed the real need to-day for technologists who are good at their speciality but who have an equal interest in management, and emphasized that because of his human responsibilities and contacts the technologist needs imagination and something of the outlook of the humanist. He puts the intellectual value of technology rather with that of economics, psychology or medicine, and suggests that, rightly presented, it should appeal to the boy or girl whose school work is in the humanities. Still more recently, Prof. C. W. Dannatt, in his presidential address to the Institution of Mining and Metallurgy on May 17, in discussing the educational value of technological studies, claimed that they provide the discipline and training essential to culture ; but he indicated also the problems that require attention if they are to develop that full educational value.

The demonstrable value of the humanities, properly taught, to the future administrator should make us take care that the administrator of to-day, in acquiring the understanding of science and technology that he needs, preserves that element ; but equally the scientist intended for managerial responsibilities should be given full opportunity of acquiring it. Here, as Prof. Denbigh points out, there is room for more constructive thought about the assimilation of technology into the social structure. Training for leadership bears closely on leadership in a technological society, and the problems of technological change and the adaptation of society to innovation.

If, however, any considerable changes are to be made in the content and balance of university and technical college courses, there must be widespread public understanding of the reason for those changes. The Government has indeed recognized in the White Paper on Technical Education that, without the support and understanding of parents, we can scarcely expect to obtain the considerable increase in the number of students of technology that is required. This is no less true of any increase in the number of scientists, and the growing dependence of the universities on public support makes it essential in regard to changes of policy. The academic freedom and autonomy of a university can only be preserved if their importance is clearly understood by those from whom ultimately its resources are mainly drawn.

This is one reason for welcoming the further number of *The Twentieth Century* devoted to the universities, which appeared in February. Although this issue was concerned solely with the so-called civic universities, it is well calculated to further the public understanding and the respect for learning and pursuit of truth by the governing elements in Britain which are the ultimate guarantee of academic freedom in any society. Moreover, the symposium is far from being a survey and comparison of the provincial universities: their weaknesses as well as their achievements are assessed, and many points are indicated on which searching inquiry as well as constructive thinking should be proceeding if the universities are to make their fitting contribution to the expansion of technological education or in meeting the needs of the increased number of those leaving school which will be seeking admission in the next ten years.

Principal P. S. Noble, for example, who is confident that, despite increasing dependence on government support, academic freedom is not seriously endangered because the mutual understanding and respect between the universities and governing circles is likely to continue, points out that economic conditions will none the less determine whether we can continue to expand facilities and maintain standards. Nor can we yet assume without question that there is a considerable untapped reservoir of talent, or that there is not already in the universities of Britain at the public charge a considerable number of students who for lack of ability or other reasons are unfitted for university education. Indeed, Prof. J. Simmons is frankly dubious on this point. He does not believe that the standard of ability is declining; but he considers that students enter universities less well prepared than in the past, less widely read and often inadequately grounded in such fundamentals as the use of the English language. This, Prof. Simmons remarks, wherever the responsibility lies, tends to lower the standards of university teaching; and he sees another and more insidious threat to academic standards in the tendency of some students to regard as of right—not as a privilege to be earned—the assistance which some three-quarters of university students in Britain now receive in one way or another from public funds. Such an attitude may well prevent the student from deriving the full advantage of a university education, and quite apart from its inhibiting effect on the effort he puts into his studies, it may well blind the stude as to the real purpose of a university education.

That at least is something which needs to be mc clearly and generally understood, not merely by t student but also and more especially by those cc cerned with the planning of university expansic and not least when that expansion is being cc sidered in relation to some particular need such technology. This symposium throws little light that purpose. Prof. Simmons reminds us that t advancement of learning is the central task of universities, and he is clearly concerned that ove anxiety to raise the standards of teaching may le the civic universities to press their teachers so ha as to hinder the continuation of the notable co tribution to learning which, collectively, they ha made.

Prof. Simmons's uneasiness is reflected in Arnc Kettle's impressions of Leeds. He, too, comments the comparative illiteracy which often characteriz first-year students in their inability to write cohere sentences, to read with pleasure a good book an their ignorance of history. An appreciable proporti of successful scholarship candidates, he maintair are intellectually ruined by the process of crammir and pseudo-specialization which the present schola ship system induces in the grammar schools. B his statement that, in the only provincial universi he knows well, probably most of the students a completely lacking in intellectual interest is not ju depressing; it is as much an indictment of tl teaching as an indication that students are unfitte for a university course. Mr. Kettle's impressions a undoubtedly disturbing. He doubts whether tl provincial universities of Britain are yet in any real valuable sense civic or regional universities, and l has some comments on the tendency to stress t technological and vocational aspects of universi education which are highly pertinent to the prese discussion on the expansion of technical educatio We can only impart to our students the broa mindedness that is so desirable by teaching any ar every subject from a fully humane and non-dogmat point of view with sufficient emphasis on its origin purposes and implications.

Nor is Mr. Kettle the only contributor who fea that the provincial universities are at present gre purveyors of the mediocre. The symposium as whole suggests that there is a good deal of disqui as to conditions and standards, of which note shou be taken before setting the pattern for furth expansion over the next decade. There are indicatio of particular problems such as the proper relatic between the arts and the sciences, to which mo thought will clearly have to be given by the arts si as well as by the scientists. Alasdair MacIntyr writing on the modern universities and the Englis tradition, suggests that the inadequacy of the pr vincial universities arises from the lack of any cle conception of what the significance or purpose university life is. This ultimately derives from tl loss of the moral tradition which guided Englis provincial life for many decades and in which tl provincial universities were founded.

But it is not simply to the need for more con- uctive but fundamental thinking about the purpose university life that this symposium points. ually, as Mr. Kettle observes, we need an overall ucational perspective in the school and university stems of Britain. Far more important than con- rn with the alleged decline in academic standards the attack on the vast problem of improving e educational system as a whole, and Mr. Kettle inks that university people would be wise to use ore of their influence in trying to further that tack.

That is the only way in which Britain can deploy the best advantage the limited resources in man- wer, finance, equipment and building which it can vote to education. Unless those resources are anned as a whole, particular shortages like that science teachers will continue to exert an effect t of all proportion to their real magnitude and to fy any speedy adjustment except at high cost. rticularly should the expansion of technical and chnological education be planned in relation to one other, as well as in relation to the need for trained an-power and in relation to university education a whole, and to the conditions and needs of condary education in the grammar schools, the chnical schools and the modern schools.

This, however, is the weakest spot in the Govern- ent's proposals. Thus far the Government has nsistently refused to approach the question as a hole, and has persisted in dealing with each problem ecemeal and in isolation. This is the burden of r. John Wellens's paper on technical education and e shortage of scientists, technologists and tech- cians (see *Nature*, May 26, p. 967). He insists that e have not even yet the knowledge on which to tisfy ourselves that even the measures so far pro- sed are likely to be effective, and in particular he iticizes the White Paper for evading the re- xamination of the place of the technical school in e educational system of the country. Moreover, ke Sir Francis Simon and others, including Mr. . K. Brown, in his presidential address on May 20 the Association of Teachers in Technical Institu- ons, he urges the importance of establishing a body ke the University Grants Committee, competent not erely to ascertain the facts but also to secure the ncerted policy and action that the national interest mands, and too authoritative and informed to erlook dangers attending the scheme of the ational Council for Technological Awards for a ploma of technology.

Whether the Parliamentary and Scientific Com- ittee or any other body will be able to put effective essure on the Government remains to be seen; it the promised debate on the White Paper on chnical education offers an opportunity which ould be used to the full to explain what is involved a national policy and the points on which further formation is required as a matter of urgency. Mr. ellens's paper provides one good starting-point; ut there are many others. Moreover, while the niversities are formulating their own plans for the xpansion of their technological departments, Prof. J. L. Montrose's presidential address on May 25 to the Association of University Teachers shows that university teachers themselves are alive to the qualities required to ensure that technology or any other subject is carried out at a university-level, and that some fresh thinking is already proceeding both as to the purpose of a university and the functions of a department of technology and the content of its studies. Likewise, the trend of the discussions at the Conference of the Universities of Great Britain and Northern Ireland last December, both on the passage from the school sixth form to the university and on the age-group bulge and its possible effects on university policy, indicates that, in the universities and also in the schools, an attempt is being made to think out a common policy and to consider it against the educational needs of Britain as a whole rather than the interests or traditions of particular universities or schools.

The widespread debate that is thus already proceeding should help to form a public opinion alive to what is involved, and prepared to make the sacrifices that a concerted educational policy on the necessary scale will demand. There must, however, be no relaxation of effort on the part of professional associations of technologists, university teachers and of educationists generally to make sure that those issues are clearly understood, and that defects in the Government's proposals are firmly indicated and explained without ambiguity. But above all there must be an increasing disposition not merely to look at university and technological and technical education as part of a national educational policy, but rather to subordinate sectional and local interests to national needs.

ESSAYS ON SCIENCE

What is Science?

Edited by James R. Newman. Pp. viii+493. (New York: Simon and Schuster, Inc., 1955.) 4.95 dollars.

THIS is a symposium of twelve chapters each specially written for the book. The editor, already known as the co-author of "Mathematics and the Imagination" and other works, has done his work well and writes engagingly about his intentions. His claims concerning the book are honest, have been fulfilled and are worth quoting: "Though written for persons without special training, the pieces in this book are not always easy. Neither is modern science. A decent respect for the reader requires that he be told when a subject admits of no further simplification; the contributors have not pretended to explain what cannot be explained. Nevertheless, every effort has been made to speak plainly, to refrain from jargon and nebulous profundities, to enlighten rather than astound. Although some areas are too difficult for any deep explorations, the nature of the problem, the aims of its investigations and the instruments they use have been made clear". If some of the book is not easy reading, any expenditure of effort on the part of the reader will be rewarding: the issues have not been avoided in an over-facile attempt to popularize science in terms of exciting superficialities.

The book is published in the United States; but more than half of the authors are British. The sections are as follows: science and human life (Bertrand Russell); mathematics and logic (the late Sir Edmund Whittaker); astronomy and cosmology (Hermann Bondi); physics (Edward V. Condon); chemistry (John Read); biochemistry (Ernest Baldwin); biology (the late Warner Clyde Allee); evolution and genetics (Julian Huxley); psychology (Edwin G. Boring); anthropology (Clyde Kluckholn); psychoanalysis (Erich Fromm); and science as foresight (Jacob Bronowski).

Bertrand Russell sets the stage for the subsequent contributors in his essay on the social relations of science. "It is to progress in the human sciences that we must look to undo the evils which have resulted from a knowledge of the physical world hastily and superficially acquired by populations unconscious of the changes in themselves that the new knowledge has made imperative. The road to a happier world than any known in the past lies open before us if atavistic destructive passions can be kept in leash while the necessary adaptations are made."

The late Sir Edmund Whittaker follows with a chapter on the nature of mathematics from the philosophical and logical point of view. This is timely and useful in view of the fact that so much mathematics is devoted to the niceties of internal arrangement.

Prof. Bondi discourses on the modern cosmologies and deals with the internal constitutions of the stars in terms of terrestrial physics. This is followed by an account of the problems of modern physics, with special reference to fundamental particles and waves, by Dr. Condon. Prof. Read's treatment of chemistry is historical, and he is followed by Prof. Baldwin, who surveys the field of modern biochemistry with special reference to human physiology.

The late Warner Clyde Allee has a short chapter on the nature of a living matter, as a prelude to an understanding of the human organism; and Dr. Huxley gives a short historical account of a century's work in evolution and genetics considered in the light of present-day human problems. "Through the new knowledge, the evolutionary process was able for the first time to become conscious of itself. The next decisive step in evolution will accordingly be the fuller development of that self-consciousness. In particular, it will be the conscious clarification of the future in the light of the long evolutionary past and of the study of human potentialities. Once this has been done, greater realization of possibilities rather than higher productivity; fulfilment rather than efficiency will become the over-riding aim."

The chapters on psychology, psychoanalysis and anthropology contain historical accounts of their subjects from the practical point of view, and show their significance in relation to modern needs.

Of particular interest is Dr. Bronowski's last chapter of fifty pages on "Science as Foresight". "Machines, like animals, have evolved in two directions: the one toward muscle and strength, and the other toward brain and foresight. We can use knowledge to help us control our relations to our environment because it gives us foresight. That is, experience encourages us to believe that the future follows the past in a repeatable pattern; and knowledge helps us to isolate and to forecast this pattern." Thus, Dr. Bronowski deals with the new electronic calculators and follows with a simple description of those which have a mechanism for adaptation a learning. Such machines, which change not o their answers but also their approach to a probl as a result of their own findings, form an interesti analogue to the human brain. Dr. Bronowski de in a lucid manner, by using analogues and diagra with the circuits of electronic calculating machin binary notation and the programming of machin From here he touches on topics in the fields cybernetics, the exploring machine, game-playi machines, information theory, information a entropy. The last part of the chapter is devoted the logic of science and the nature of scient knowledge. He anticipates the development of machine which will have a more subtle, hum characteristic—that of being able to base foresig on insight. "The processes of nature can be pictur as messages written in a code whose unit-symb are unknown to us. All that we can do, at any st of our factual knowledge, is to prefer that code whi makes what we know most orderly. That is, choose those concepts which organize the messag of nature most coherently, by maximizing th content of information or meaning. This is the t for the inductions by which we try to generalize fr our particular experience and to gain a basis foresight."

There is an up-to-date bibliography with notes each book, given under the headings of the chapte

W. L. SUMNER

VIRTUOUS QUARRELS

Custom and Conflict in Africa

By Prof. Max Gluckman. Pp. ix+173. (Oxfor Basil Blackwell, 1955.) 12*s*. 6*d*.

THIS book contains the text of six lectures Prof. Max Gluckman that were broadcast the B.B.C. during the spring of 1955. Ea lecture is concerned with one of the standard topi habitually discussed by academic social anthrop logists, namely, feud, chieftainship, family structu witchcraft, ritual and race relations. The present tion is admirably clear. As a handbook for unde graduate anthropologists alarmed at the prospect approaching examinations, it can be heartily recor mended.

For the more sophisticated the interest of the boo is of a different kind. All six lectures are hooked a common theme which, in parody, might be repr sented thus: (*a*) people who quarrel are people wl have common interests; (*b*) people who live togeth as members of the same political corporation ha many common interests; (*c*) therefore, people wl live together as members of the same politic corporation will have many quarrels. Thus state the syllogism is no more than a logically fallacio platitude, and yet it is essentially the same as tl Durkheimian thesis that groups which express soci solidarity at one level of opposition will be internal segmented by faction at another. Prof. Gluckma has given the argument a novel twist by turning tl third leg of the syllogism back to front so as to read (*c*) therefore, people will have many quarrels in ord that they may live together as members of the sam political corporation.

Thus garbled, the argument might seem eve sillier than before, and yet in Prof. Gluckman's hand it becomes a most illuminating paradox. He show

r example, that the conventions which governed
e operation of the Anglo-Saxon vengeance group
ere rules which must lead to peace rather than
archic war. Similarly, he demonstrates that in
any different African societies there is a wide range
situations in which the hatred generated by
ructures of authority is quite explicit. Rebellion
gainst legitimate office-holders is almost institu-
onalized. Paradoxical perhaps, and yet clearly the
blic expression of hatred is also a public assertion
f the high value of that which is hated. The Barotse,
e are told, "state explicitly that it is the lot of
aders to be hated, because they are the Law itself".

With regard to the family, Prof. Gluckman argues
at, where relationship is effectively maintained
mong a wide circle of kinsmen, then husband and
ife must of necessity be somewhat estranged. Even
alice is claimed to have a positive value; witch-
aft accusations, by projecting the responsibility for
vil on to the scapegoat witch, permit the ordinary
an to retain his faith in the moral virtue of brotherly
ve even when his own daily actions are anything
ut kindly.

In all these cases there is the common theme that
is an essential feature of the working of any social
ystem that the 'friends' of one context should be
e 'enemies' of another. It is the divided loyalties
f the individual resulting from this contradiction
hich makes peaceful co-operation humanly possible.
his, it is maintained, is true even in the context of
e colour bar of South African native reserves. It
all very ingenious; such an analysis has many
pplications much nearer home than South Africa.
useful and well-selected reading list has been
dded to the text of the original spoken lectures.

E. R. LEACH

ICTIONARY OF TELEVISION AND RADAR TERMS

lsevier's Dictionary of Television, Radar and Antennas in Six Languages

nglish/American; French; Spanish; Italian;
utch and German. Compiled and arranged on an
nglish Alphabetical Base by W. E. Clason. Pp.
ii+760. (Amsterdam: Elsevier Publishing Com-
ny; London: Cleaver-Hume Press, Ltd., 1955.)
0s.

THIS is a most welcome addition to the reference
books dealing with the recent applications of
dio to radar and television techniques. Most
orkers in these fields find that, sooner or later, they
ave to discuss progress with their contemporaries
other countries or to read accounts of scientific
d technical progress in other languages. The
dvances made during the past decade have been so
volutionary that most existing technical dic-
onaries are in many respects obsolete. Moreover,
science becomes more and more international;
ere is a growing need for multilingual dictionaries.
was with the view of meeting this need that the
blishers planned a series of polyglot technical
ctionaries, of which this one is the first, dealing
ith television and radar and the aerials used with
th these applications. In planning this dictionary,
e author and publisher have been guided by certain
inciples proposed by Unesco. The object of these
inciples is to ensure that each dictionary produced
cording to them shall fit into place in a pattern which, it is hoped, may progressively extend over all inter-related fields of science and technology and cover all necessary languages.

The arrangement and lay-out of this volume have clearly been the subject of much serious thought and experiment. At each double-page opening the reader is presented with, on one side, the English term or phrase in bold-face type, and a brief but adequate definition of this term; while on the other page are given the equivalent terms in each of five other languages—French, Spanish, Italian, Dutch and German—the gender of the term being indicated in each case. Each definition is numbered at the extreme left and right, respectively, of the double page. The basic language being English/American (according to the publishers), these definitions are arranged in alphabetical order. But the book is completed by five alphabetical indexes for the other languages mentioned, giving the numerical reference to the English term. Where the usage of the 'English' term differs in Britain and in the United States, this is made quite clear, and the appropriate cross-indexing is included. It is interesting to note that a number of the terms are followed by the italic letters *sl*, meaning slang or code-names, which are or have been in common use among those engaged in the development and application of radar in Great Britain and the United States. Some, but not all, of these have been found to have equivalent terms in other languages.

The bibliography appended to the volume shows that full use has been made of the glossaries and technical dictionaries published in various countries, including those of the British Standards Institution, the American Standards Association and the International Civil Aviation Organization.

The publication of this work is very opportune at the present time in view of the growing importance of the exploitation of radio aids to aerial and marine navigation, and the need to facilitate the international exchange of programmes in the further advance of television. The production of the book is excellent; it is of a handy size, in a semi-flexible binding, and provided with a convenient thumb-index to the different languages. It should be readily available for immediate reference by every scientist and engineer engaged in the fields of television, radar and the associated antenna systems.

R. L. SMITH-ROSE

SPECTROSCOPY AT CENTIMETRE WAVE-LENGTHS

Microwave Spectroscopy

By Prof. C. H. Townes and A. L. Schawlow. (International Series in Pure and Applied Physics.) Pp. xviii+698. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 90*s*. 6*d*.

Spectroscopy at Radio and Microwave Frequencies

By Dr. D. J. E. Ingram. Pp. xii+332. (London: Butterworths Scientific Publications, 1955.) 45*s*.

MICROWAVE spectroscopy may in some respects be regarded simply as an extension of both radio-frequency measurements and of infra-red spectroscopy to the spectral region lying between 3×10^9 c./s. and 3×10^{11} c./s. (that is, to wave-lengths between 10 cm. and 1 mm.). The techniques of measurement may be derived from each of these limits or be entirely characteristic of the centimetre wave-length range itself. Thus the bolometer is more usually recognized as a detector for infra-red radiation, whereas the barrier layer rectifier is a circuit element often used at radio frequencies. Both of these may be used for micro-wave measurements; but in addition there are the reflexion klystron and magnetron as sources of power, the waveguides and cavity resonators as transmission networks which are features peculiar to the microwave techniques and warrant a separate discussion.

The results obtained from the microwave measurements also have some similarity to those derived from the radio-frequency and infra-red regions of the spectrum, but yet have additional and important contributions to present. Gaseous spectra in the infra-red are usually concerned with transitions between the molecular vibrational energy-states, and the rotational motion gives rise to a fine structure while nuclear effects are rarely resolved. In the centimetre region, however, the absorption spectra arise directly from rotational transitions, and a structure from the electric quadrupole moment of the nucleus is readily observed. The Stark effect also now gives rise to large perturbations of the energy-states and provides not only a useful method for detecting the spectra and identifying the transitions, but also enables the molecular electric dipole moment to be determined accurately. The Zeeman effect is less frequently used for the investigation of gaseous spectra, since few molecules are paramagnetic in the ground-state; but the extension of microwave spectroscopy to the absorption spectra from the solid state has been confined almost entirely to the investigation of transitions between the ground-state energy-levels of paramagnetic sites in crystal lattices. These measurements have provided detailed information about the ground-state wave functions of transition-group ions, they have allowed the determination of a number of nuclear spins, and they are powerful techniques for the investigation of the different types of chemical bonding and the structure of lattice defects.

The first measurements at centimetre wave-lengths were carried out in 1934 by Cleeton and Williams; but there was little subsequent work in this field of research until 1946, by which time the development of radar had provided sufficient instruments and experienced operators. During the past ten years, however, there has been such enormous activity that a review of the principles, the techniques and the results is now both desirable and necessary. To discuss adequately the whole field of microwave spectroscopy would be a formidable task, and the title of the book by Prof. C. H. Townes and Dr. A. L. Schawlow disguises the fact that these authors have very wisely limited themselves to a considered treatment of the microwave measurements on gases. It is a well-written book which treats the subject-matter with authority and maintains the reader's interest. The early chapters give a thorough discussion of the theory of microwave molecular spectra, while the later sections are concerned with the various microwave spectroscopes and contain a great deal of useful information about the measuring techniques. There is also an extensive bibliography with about a thousand references.

The book by Dr. D. J. E. Ingram is of quite a different type. The author has endeavoured not only to cover the whole field of microwave spectroscopy in all its aspects but also to include the radio-frequency measurements on molecular beams ar nuclear resonance. The treatment of individu topics is therefore necessarily very brief, and th reader may soon lose interest. One is left with t impression that too much has been concentrat within the compass of one volume, an impressi which is furthered both by the print and the diagram which also seem to be compressed. However, D Ingram's book does include a great deal of inform tion, and the reader seeking a more detailed discussi of any particular topic will find a carefully present series of references. It is a book, therefore, which a survey rather than an authoritative text and ma be found useful by many of those who are wonderi whether and how to start out into the field of micr wave spectroscopy.

D. M. S. BAGGULEY

POLYNESIAN TALES IN POETRY

Voices on the Wind

Polynesian Myths and Chants. By Kathari Luomala. Pp. iv+191. (Honolulu: Bernice Bishop Museum, 1955.) n.p.

ALL peoples have their folk-lore and fairy tale often transmitted in the form of poetry. The study is of great importance since past events as we as the outlook on life of the people themselv become enshrined in the tales. The story of Jas and the Golden Fleece probably results from a actual prospecting expedition to the head of th Black Sea. We can be very grateful, then, t Katharine Luomala for this volume, which recites number of Polynesian tales. A Maori mother tel her mischievous son that he is a "Maui-of-a-thousan tricks". The lad is flattered, since what boy in th South Pacific can ever hope to match a single pran of the demi-god, the hero of innumerable adventure But who was 'Maui'?

The Fakahina Island (formerly Niuhi) folk live an atoll around which blow violent winds tending force canoes out to sea. Here is a poem about it b some unknown Fakahina composer:

> This is Niuhi, land of gales.
> Sail the canoe outside—it is driven to sea.
> Sail the canoe inside—it is driven to sea.
> Mark, will you, the form of the land of Niuhi,
> Like a roll of Hala leaves,
> When sinks,
> When wanes,
> The Northeast wind.
> (Fails my breath!)
> O speed the fame of Niuhi
> to the world!

The account of the occupation of New Zealand too long to quote here, but is equally fascinatin Naturally, some of the tales owe their origin t outside influences—often impossible nowadays t trace. Thus the story of the hero who builds a gre boat just before a vast flood must have been intr duced into the folklore. Few people have grown u in entire isolation; somehow or other, ideas develope in one area found their way around the world eve in ancient times. But it is only when we hav studies like those under review that we can obtain picture of the ideas of a people and sometimes hin of past events in their history. The poems ar charmingly rendered into English and the blac and-white illustrations are delightful.

M. C. BURKITT

Electricity : Direct and Alternating Current

By Prof. Charles S. Siskind. Second edition. Pp. xii + 538. (London : McGraw-Hill Publishing Company, Ltd., 1955.) 43*s*.

THIS is an elementary text-book. As the author states in his preface, it "is intended for use in technical institutes, junior colleges, and short courses for non-electrical engineering students in universities . . ."

The first four chapters deal with direct current. Chapter 1 is concerned with basic ideas of conduction and the effects of electric current ; the second and third chapters deal with resistance calculations for conductors, and d.c. circuits, respectively ; the following chapter discusses basic theorems and laws, for example, those of Kirchhoff, and the superposition and maximum power transfer theorems. These are illustrated in terms of direct current ; but there is no mention of their application to the a.c. circuits, which appear in Chapter 5. As magnetism and electromagnetism are deferred until Chapter 6, this means that inductance is introduced before electromagnetism is touched upon. Then, unlike most British text-books, the chapter on electromagnetism has no mention of inductance. The remaining four chapters deal with d.c. measuring instruments, electromagnetic induction, generators, and motors.

The book on the whole is written quite clearly and is excellently produced. It would be suitable for National Certificate students. The advantage, however, of having such an American book (good of its kind as it is) in Britain does seem doubtful. The case against it is that it is expensive, there are British text-books available which cover the same material, and, of more consequence, the illustrations of usage and the units are those employed in American practice. As an example, flux density is quoted in kilolines per square inch, a quantity not commonly employed in British teaching.

W. FRASER

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 3, Part A : Aromatic Compounds. Pp. xxiv + 685. (Amsterdam : Elsevier Publishing Company ; London : Cleaver-Hume Press, Ltd., 1954.) 115*s*.

WITH the appearance of the first part of the third volume, this well-known compendium reaches that solid bed-rock of organic chemistry—the aromatic compounds. Although this is, of course, a well-trodden subject, recent work—for example, on 'benzyne' and the non-benzenoid aromatic compounds —shows that the field is by no means spent.

The volume begins with a series of articles by authorities which seek to survey the familiar facts in terms of modern concepts. Prof. C. K. Ingold contributes two such essays dealing with the benzene nucleus and orientation in electrophilic aromatic substitution ; the result is an object lesson in clarity and brevity. Prof. D. H. Hey and Dr. G. H. Williams perform the same function for nucleophilic and homolytic substitution, and Dr. N. Campbell ends this preliminary survey with a discussion of the formation and fission of the benzene nucleus.

The rest of the volume is devoted to a factual survey of the benzene series and simple derivatives thereof. This considerable task has been largely handled by Dr. W. J. Hickinbottom, with smaller contributions from Drs. J. Chatt and Z. E. Jolles. The presentation follows the pattern laid down in the previous volumes, although the enormous amount of material available has needed more drastic selection. More complex mononuclear derivatives and polycyclic and pseudo-aromatic structures are to be dealt with in Vol. 3, Part *B*.

R. A. RAPHAEL

Organic Chemistry

By Dr. I. L. Finar. Second edition. Pp. xv + 732. (London : Longmans, Green and Co., Ltd., 1954.) 40*s*. net.

THIS text, which is suitable for students reading for a university honours degree, was first published in 1951. It rapidly became popular, and a new edition was soon required. This popularity was possibly largely due to the author's plan of not adding the electronic theory as a tail-piece, but blending it in with the descriptive material, a plan which helps the student to make classifications and see inter-relationships and one that is conducive to an understanding of the subject. Conforming to the international rules of nomenclature, adopted in Britain by the Chemical Society in 1950, Dr. I. L. Finar has now written prefixes denoting substituents in alphabetical order. The new system was announced too late for inclusion in the first edition.

Among the other changes are enlarged sections on molecular orbitals, reaction mechanisms, stereochemistry, heterocyclic compounds and dye-stuffs. Thus the introductory section on molecular orbitals now occupies six pages. Dr. Finar, dispensing with mathematics, offers a simplified explanation of the concept and expounds its significance for the understanding of bonding problems. Thereafter, for instructional purposes, he uses it in conjunction with the valency-bond theory. These additions undoubtedly improve what was already a good book.

G. F.

The Moon

A Complete Description of the Surface of the Moon, containing the 300-inch Wilkins Lunar Map. By Dr. H. Percy Wilkins and Patrick Moore. Pp. 388 + 14 plates. (London : Faber and Faber, Ltd., 1955.) 63*s*. net.

THIS discussion of the physical features of the Moon's surface includes a chart in twenty-five sections on a scale of 32 inches to the Moon's diameter. It is reduced from the larger one by Dr. H. P. Wilkins published in 1952. Each section is accompanied by a description of the principal formations represented therein, the rectangular co-ordinates, elevations, and dimensions being given in most cases. The chart is based on visual and photographic observations, and the surface is shown in great detail. A number of large-scale drawings and reproductions of some excellent photographs supplement the chart. Considerable attention is given in special maps to features near the limb, which are difficult to study even under favourable conditions of libration and illumination.

The introduction summarizes the history of selenography and reviews the classification of the various types of formations. Several pages are devoted to an examination of suspected changes in the lunar surface that have been reported from time to time. A useful account of the techniques employed in lunar photography is given in an appendix by E. A. Whitaker.

The volume will provide for beginners an attractive introduction to the study of the Moon's surface ; for practised workers in the field it will serve as a useful supplement to earlier publications.

PEACEFUL USES OF ATOMIC ENERGY

By Dr. T. E. ALLIBONE, F.R.S.

THE papers submitted to the Geneva Conference last August were prepared at great speed, printed in many cases by offset lithography, and were illustrated with diagrams of indifferent quality. The United Nations is now publishing the full proceedings in a series of sixteen volumes in which the papers are grouped into main subjects, together with the discussion at the end of each session of the Conference. Vol. 3, on "Power Reactors", was the first to appear, followed by Vol. 2 on "Research Reactors" and Vol. 14 on "Isotopes"*. The volumes are printed on a high-quality paper on which all diagrams and photographs appear with excellent definition, and editing has been of such a high standard that in the detailed reading and study of a dozen of the papers I have failed to find a mistake. The discussion is recorded verbatim—which I think is a pity. In Britain we accept severe pruning of the printed record of a discussion in the interests of brevity; the recorded discussion in these columns could have been cut by 75 per cent without any loss of scientific context. However, the time allowed at Geneva for discussion was so short that it was the least important feature of the Conference.

Vol. 3, "Power Reactors", is for the engineer and applied physicist possibly the most interesting and important of all the proceedings. Here we have American, Russian and British accounts of the post-war design and construction of power reactors, and to many attending the Conference these accounts contained much that was new. There are also important authoritative plans for the future particularly emanating from the United States, while ideas from Holland contain great originality. To those who ask which country is ahead in reactor development, the answer can be given that all three of the Great Powers have 'firsts' to their credit: the American breeder reactor first produced 100 kW. of electrical power in 1951, and the submarine reactor produced an undisclosed amount of power in 1953; the Russian graphite water-cooled enriched reactor first produced 5,000 kW. of power in 1954; while the British 'first' will be the first 50,000 kW. generation of power from a natural uranium gas-cooled reactor—possibly this summer. In magnitude of effort based on population, Britain and America are almost on a par: Great Britain has two major developments, the gas-cooled natural uranium reactor and the plutonium breeder reactor, whereas America has her famous five-point programme of designs now being built. The U.S.S.R., on the other hand, would appear to be behind—at least plans were only referred to in very general terms, from which it is not possible to infer how many different types have been seriously pressed. In spite of the taunts often flung at the United States for its over-developed sense of security, the American papers disclose far more detail than the British or Russian papers, and in the Exhibition at Geneva there were beautiful examples of American fuel elements of all kinds.

As Dr. A. M. Weinberg stated in an opening review, there are a large number of types of reactor, of which a dozen or so are very promising; and the centra issue is to trace out of this welter those most likely to succeed. Again, it depends on what is meant by 'succeed'. Great Britain, with a limited gaseous diffusion plant, has chosen to concentrate on the design which uses natural uranium, whereas the U.S.S.R. prefers to build a 100,000-kW. station using a reactor enriched to 2·5 per cent; and when Academician Kurchatov was in Britain recently he stated that it is more economic to use enriched fue in a water-cooled reactor than to use natural uranium in a gas-cooled reactor. The United States five-point plan of reactors uses enriched fuel in all designs. The answer will not be found until the reactors have been built and operated for some years, during which time industry will be developing better designs of the existing types.

The American industrial reactor most advanced in construction is the pressurized water reactor (*P.W.R.*) being built by Westinghouse at Shippingport to supply 60,000 kW. of power to the Duquesne Light Co. and due to operate next year. Light water at 2,000 lb. per sq. in. is both the moderator and the coolant flowing through the reactor at 200 tons a minute and being raised only 34 deg. F. The pressure is kept high to prevent boiling, since boiling and steam formation result in instability of power output, localized hot-spots, and in pitting of the reactor vessel. (It is noted that in another American design boiling is freely allowed, and discussion did not clear up this paradox.) The reactor vessel is of formidable proportions, 33 ft. in height, 9 ft. in internal diameter and $8\frac{1}{2}$-in. wall thickness with a removable closure head. The core is small, only 6 ft. in diameter and height; it contains 12 tons of uranium in the form of oxide with an additional enrichment of $\frac{1}{2}$ per cent of uranium-235 localized in 'seeds' in the core, and will have a breeding coefficient of 0·8, that is, produce eight atoms of plutonium for ten atoms of uranium-235 undergoing fission. The design appears to be conservative and safe: the manufacture of pressure vessels is reliable, absence of boiling avoids many uncertainties, the temperature is moderate—only 540° F.—and the materials are well known; the only 'exotic' material is hafnium, used as a control rod. What is not easy is the detection and removal of burst fuel elements.

By contrast, the Argonne Laboratory has experimented widely with a water-cooled, water-moderated reactor operating at only a few hundred lb. per sq. in., so that boiling occurs low down in the core as the water is pumped upwards, and such a reactor to develop 5,000 kW. of electricity is now under construction. The daring experiments conducted on the first experimental reactor have shown how inherently safe is this design when steam voids are formed in the core, and when pressures are suddenly lowered or raised; no other reactor has been treated in this same free-and-easy fashion. Protagonists of this design also place weight on the lower temperature the fuel elements, with consequent less corrosion mage; but as there is such a big difference in wer output of the pressurized and boiling-water actors, the cost comparison given in the sum- rizing paper in this volume is not significant.

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* Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, held in Geneva, 8 August–20 August, 1955. Vol. 2: Physics: Research Reactors. Pp. viii+471. 8 dollars; 57*s*; 34 Swiss francs. Vol. 3: Power Reactors. Pp. viii+389. 7.50 dollars; 54*s*., 32 Swiss francs. Vol. 14: General Aspects of the Use of Radioactive Isotopes; Dosimetry. Pp. viii+305. 6.50 dollars; 45*s*., 28 Swiss francs. (New York: United Nations; London: H.M. Stationery Office, 1955 and 1956.)

The American sodium-cooled graphite-moderated actor is one of the most daring designs, and is due operate this year at a heat output of 20,000 kW. ot to be connected to an electrical generating ant). The attraction is the avoidance of high essures, the ability to reach high temperatures ,000–1,200° F. are mentioned in two papers, one which is speculative) and the ease—because of sence of a pressure vessel—of replacing fuel ments. The penalty is the necessity to encase the aphite moderator blocks in thin-sheet zirconium ns, and to conquer the problems of sodium or dium–potassium cooling; these had to be resolved r the fast-fission reactors and appear to be spoken with great confidence. North American Aviation . has a plan for a 75,000-kW. generating station sed on the present work, and anticipated costs are w.

One cannot, however, escape from the feeling that ere is a tremendous waste of metallurgical effort in actors so far described. All this advanced metal- rgy has to be undertaken so long as the fuel is sed in solid form; does the homogeneous reactor the liquid-metal fuel reactor point the way to the ture? The former is on the five-point programme, e latter has not yet got so far. The former has a ng history dating back to the Los Alamos 1944 ater-boiler; now it looks forward to producing ,000 kW. of heat this year using highly enriched anyl sulphate solution in heavy water, with a anket of thorium solution in which the breeding efficient may exceed unity. The design calls for ry high pressures—2,000 lb. per sq. in.—to prevent ullition; but the vessel for this power rating is ly 5 ft. in diameter, including the blanket. Another traction is the inherently high stability due to the gative temperature coefficient of reactivity; but ere are serious hazards, the greatest of which is akage, since the whole vessel and all the pipes to eat interchangers, etc., contain solutions carrying ssion products. This reactor does not appear to ve the support of industry; it is the work of the akridge Laboratory of the United States Atomic nergy Commission.

American industry has become much interested in e fast breeder reactor based to a large extent on e Argonne reactor now under construction for ,000 kW. of heat. In this, liquid sodium flows at 1,000 gal./min. past stainless steel tubes containing the core a plutonium–uranium alloy, and in the lanket uranium-238. In spite of the very high specific thermal loading, the reactor is regarded as safe, partly due to the large volume of sodium in the primary system which provides thermal inertia, and great hopes are centred on this engineering development: it holds out the ultimate goal of breeding all the fuel needed for future reactors; indeed, breeding *must* be successful for the long-term success of nuclear power.

The British reactor plans have received wide publicity, but the amount of detail supplied about the Dounreay reactor is far smaller than that for the Argonne reactor; so the reader of these volumes of the Geneva Conference is not able to judge whether the problems are being tackled on very different lines. The note of caution was struck more in the Dounreay description, and for safety the reactor is to be housed in a steel sphere, as is the American *G.E.* reactor; but the Argonne reactor is not so encased.

Vol. 2, "Physics: Research Reactors", supplies the basic information on which the power reactors have been developed, and describes the many forms of research reactors with which reactor experimentation has been and will continue to be done, including the testing of fuel elements in high neutron fluxes.

One-half of Vol. 14 is concerned with the preparation and use of radioactive isotopes in industry in many countries, the other half contains thirty papers on dosimetry. As Dr. P. C. Aebersold says in his opening review paper, "The Importance of Isotopes in Industry", the uses of isotopes have grown rapidly in nine years, but they are still far from attaining their world-wide potential for the gaining of new knowledge. The papers in this volume should be widely read by scientists in industry and in research associations, so that in appreciating what has been done readers may the more vividly appreciate what steps they can take in their own organizations. The diversity of uses is too great to review in a short paragraph; each country has some new examples to quote, but Mr. S. E. Eaton's American paper shows how a company specializing in tracer techniques can range far and wide in suggesting solutions to countless industrial problems of considerable complexity.

With the advent of kilocurie gamma-ray sources, the X-ray supply industry is affected. There is a big jump in the number of firms now using radiography for inspection and fault detection. We are about to enter a new phase of development, when megacuries of cæsium per annum become available from the power reactor processing plants, and when spent fuel elements may be employed to give doses of megarontgens per minute. With sources of these magnitudes, the chemical, agricultural and the food industries may begin to benefit on a really large scale in a few years time.

ECOLOGY OF *ANOPHELES GAMBIAE* GILES

By JAMES G. HALCROW

DURING the past three years, a small research unit of the Colonial Insecticides, Fungicides ad Herbicides Committee has been engaged in an ological study of *Anopheles gambiae* Giles in Mauritius. This insect has survived and increased; et as a result of an intensive house-spraying campaign, the incidence of malaria on the island has een reduced to very small proportions. It was considered desirable that the matter should be investigated.

Many workers in Africa have commented upon the ease with which this anopheline can transmit malaria; yet at no time has a *prima facie* case been made out against it as a vector of malaria in Mauritius. It has always been condemned on African, rather than local, evidence; though a worker in Mauritius, some thirty years ago, declared it was not "a domestic mosquito". The large-scale malaria eradication scheme of 1948–52 for Mauritius, based on residual insecticidal house-spraying, was, unfortunately, not fully documented on its entomological aspects ; but it did eradicate *Anopheles funestus* Giles, while failing to control *A. gambiae*. Malaria is almost unknown in the island, at the time of writing. The problem in 1952 was then a virtual absence of proved malaria in the abundant presence of a potentially powerful vector. Possible theories at that time were based on 'zoophilic' or 'DDT resistant' vectors. I have not obtained confirmation of them at any time ; I found *A. gambiae* to be a facultative feeder and to be generally highly susceptible to effective DDT contact.

The host preferences of *A. gambiae* were in 1952 quite unknown, though the high percentage with thoracic, and proboscal, infections of *Filaria bancrofti* argued against a purely zoophilic feeding regime. Stomach smears of 1,254 insects in all were examined at the Lister Institute, London ; most of them showed blood of bovine origin, but a majority of the insects were found in and around cowsheds. The majority of them preferred to rest in cowsheds, typical counts averaging 20–200 *gambiae* per cowshed. In houses examined, on the other hand, the average was less than one per hundred houses. It is further of interest that malaria and bancroftian filariasis are sometimes confined to the inhabitants of a small group of houses in a village. This 'parochialism' of *gambiae* may be due to the fact that it is not generally an insect of strong and sustained flight, so that little migration from an attractive feeding and resting site takes place. Captive female *A. gambiae* seem better able to mature their ovaries on a diet of human blood (see Table 1).

Table 1. Percentage of female *A. gambiae* maturing ovaries after a single feed of blood

Man	78
Cow	62
Deer	49

In Mauritius, there is a wild-animal reservoir estimated at about ten thousand deer, plus many monkeys and some wild pig. In the sister island of Réunion, the wild animals are absent, and the people may therefore lack a valuable protective barrier against *A. gambiae*.

Figures were obtained which show that the nocturnal population of *A. gambiae* in cowsheds was largely composed of unfed mosquitoes. The day population of females was principally in the late blood-fed or half-gravid stages. Ovarian dissection of both day and night populations showed a ratio of nulliparous to parous insects of approximately 9 : 1. Gravid females were commoner in cowsheds by day than by night ; this suggests an early evening exodus.

By experiment in the insectary, the gonotrophic cycles (the time-interval between partaking of the initial blood meal and the commencement of egg-laying) were studied in the winter and summer seasons. The abdominal/ovarian classification used was that put forward by many authors, namely :

Stage 1.	Unfed :	thin, non-distended abdomen.
Stage 2.	Blood-fed :	abdomen gorged with fresh red blood.
Stage 3.	Half-gravid :	black mass of blood in abdomen ; apex of abdomen becoming yellow-white in colour.
Stage 4.	Gravid :	blood digested, abdomen distended with eggs.

The gonotrophic cycle in winter extended over 97 hr. ; that in summer took 94 hr. to complete. There did appear to be a tendency for the gonotroph cycle to shorten or lengthen according to the hos animal in use.

Activity cycles of *A. gambiae* were studied throug out the night on numerous occasions. (The nocturn study of a nocturnal insect is still so rare as to worthy of note.) It was found that the Mauritia *gambiae* reached its peak of activity earlier in t night than did the *gambiae* of Africa. At first, was not clear whether this might be due to som genetical difference, for an introduction of the mos quito into Mauritius would not, unless it were massed or repeated introduction, carry the fu genetical potentialities of the species. Howeve other Mauritian mosquitoes, for example, *Anophel constani* Lav., and *Culex fatigans* Wd., show th same early peak of nocturnal activity. From oth islands also there have come reports of *gambi* activity reaching a late crepuscular peak. It possible that the rapidly rising relative humidity the night air, in a small island, may cause the cessatio of flight activity.

After field-studies, the nocturnal activity *gambiae* was considered in the insectary, whe 'biting cycles' were studied. The 'biting cycle' w defined as the hour-to-hour fluctuation in a nocturn population of unfed *gambiae*, whether parous nulliparous female, which were seeking a blood-mea The 'activity cycle' was defined as the hour-to-ho fluctuation of a nocturnal population of *gambia* The latter cycle considers the population in genera the former judges the intensity of attack by t female on the host. The 'biting cycle' was foun to be some 1–2 hr. later in its peak than the gener activity cycle. The early nocturnal peak of activit of *gambiae* is of interest in that it coincides with t time of night when the human population are ou of-doors engaged in various and varied social activitie In effect, *A. gambiae* need never enter a house t secure a blood-meal. On the subject of houses, it noteworthy that the walls, treated annually wit DDT, are re-plastered with mud and dung ever New Year and on certain other festivals. A wa sprayed with insecticide two or three days previous may then be covered with fresh plaster and remai untreated until the next spraying.

It was confirmed that *A. gambiae* in Mauritius w a minor vector of bancroftian filariasis ; the maj vector was found to be *Culex fatigans* Wd., a mo quito not easily deviated from man ; indeed, it w noted that 84·0 per cent of the *C. fatigans* collecte from cowsheds had fed, not on cattle, but on ma The status of *A. gambiae* as a vector of malaria far from clear. Past records, when available, indica little of value. Of 4,526 dissections of stomachs an salivary glands since 1952, only two light stoma infections were observed. In the continued ar abundant presence of *A. gambiae* and the prese low level of diagnosed and proved cases of malari it would seem reasonable to regard *A. gambiae* as poor vector of malaria in Mauritius. It is no perhaps, remarkable that despite DDT and ant malarial drugs, malarial cases still occur from ti to time ; what is remarkable is that in spite of adult cides, larvicides, drainage works, and health educ tion, *gambiae* has not only survived but has eve increased its range. Its ability to recover fro natural catastrophes was seen in 1955, when torrenti rains and high winds caused by a close approach a cyclone destroyed the immature stages. Withi days, more immature stages began to appear, presu ably from eggs laid by the gravid females which sheltered indoors and had escaped destruction.

The rapid completion of the life-cycle during the summer months—about seven days from eclosion to adult emergence—undoubtedly helps the insects to make good any losses suffered. The winter life-cycle occupies about fifteen days from eclosion to adult emergence. Various authors have commented that, in Mauritius, the extinct *A. funestus* had a life-cycle at least three times as long as that of *A. gambiae*. It is possible that *A. funestus* was unable to build up its numbers when attacked by residual insecticides because its life-cycle is too long.

The ecology of the egg of *A. gambiae* was confined to eclosion studies, size of egg batches, and resistance shown by the eggs to salinity and desiccation. The duration of the egg stage in waters of known composition was found to be significantly longer in winter than in summer. Egg batches per female were larger in summer, both for the eggs of later gonotrophic cycles as well as for the first cycle. The numbers of eggs per batch fluctuated according to the host animal in use (Table 2).

Table 2

Host animal	Eggs per female *A. gambiae*
Man	140 ± 5·4
Deer	123 ± 8·9
Cow	111 ± 9·4
Guinea pig	105 ± 8·9
Rabbit	100 ± 9·6

Eclosion took place to some extent in water heavily charged with sodium chloride or copper sulphate. Continued development of the emerging larvæ was found to cease when the sodium chloride content rose to 17·5 gm. per litre. Eggs kept on damp filter-paper at room temperatures gave good eclosion-rates after 10–14 days. Normal eclosion was considered to be 78 per cent or more. Eggs placed on dry filter-paper at room temperatures failed to hatch after six days.

Standing agricultural water was found to form at least 43 per cent of all breeding sites. The sites of standing water in cane fields were ever changing; rarely did a site allow for the emergence of more than two generations. As one site drained away, or evaporated, another might appear as little as twelve inches away.

The period when the pupation-rate reached its maximum was studied by observing personally the pupation of 9,785 fourth instar larvæ (see Table 3):

Table 3

Time	Pupation (per cent)
Daylight hours (6.0 a.m.–5.0 p.m.)	12
Twilight ,, (5.0 p.m.–7.0 p.m.)	56
Night ,, (7.0 p.m.–6.0 a.m.)	32

Some little work was done on the parasites and predators of the larvæ of *A. gambiae*. Protozoan and fungal diseases were observed; but few results of any practical value were gathered concerning the predators.

Brief morphological studies were made; for example, (*a*) a study of the tarsal sensillæ, and (*b*) the maxillary index. Of (*a*) little resulted; clear-cut differences of taxonomic value were not to be found between individuals of the main population and individuals of the salt-water group. A comparative study of the maxillary dentitional range of *A. gambiae* and four other Mauritian mosquitoes has been made. The maxillary dentitional range of the Mauritian *A. gambiae* was determined to be twelve to sixteen teeth.

A subsidiary study was carried out on the saline-loving group of *A. gambiae*; known loosely (and wrongly) in Mauritius as either '*A. melas*' or 'salt-water *gambiae*'. In a paper to be published elsewhere, morphological and biological observations will be presented to support the erection of this group to formal sub-specific rank.

The full report on which this brief account is based has been deposited with the Colonial Products Laboratory, Imperial Institute Buildings, London, S.W.7.

THE ABYSSAL FAUNA: ITS ECOLOGY, DISTRIBUTION AND ORIGIN*

By Dr. ANTON FR. BRUUN
The *Galathea* Expedition, 1950–52, Copenhagen

Ecology

BEFORE defining the environment of the abyssal fauna, its relations to the other ecological zones of the deep sea must first be outlined. This is done schematically in Fig. 1, showing the percentage partition in area of the deep-sea floor, with respect to the intervals of depth against the profile. Light and temperature conditions as they apply to tropical and subtropical regions are also indicated.

Fig. 1 shows clearly the small volume of the water masses above the thermocline, centred at about 10° C., in comparison with the cold-water masses below the 10° C. isotherm. The comparison becomes even more striking when it is remembered that on the poleward side of the subtropical areas such cold water is found from the surface to the bottom. But even the water layers of 4–10° C. and the area of the bottom they occupy are relatively small in comparison with the huge body of water with temperatures always below 4° C. and covering the greater part of the deep-sea floor at depths of 2,000 m. or more. These are the true abyssal depths, the typical habitat of the abyssal fauna.

We must here disregard such highly interesting Seas as the Mediterranean, the Sulu and the North Polar, which have no connexion with the oceans at 2,000 m. and have therefore very different temperature conditions in their abyssal reaches. Also, their total area is very limited compared with that of the oceans.

Area. The total area of the oceans and seas adjacent to them is 361×10^6 sq. km. If the upper limit of the abyssal depths is set at about 2,000 m., their area is about 84 per cent of the total area. Even if the depths between 2,000 m. and

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* Substance of three University of London lectures delivered at Birkbeck College on March 5, 7 and 9.

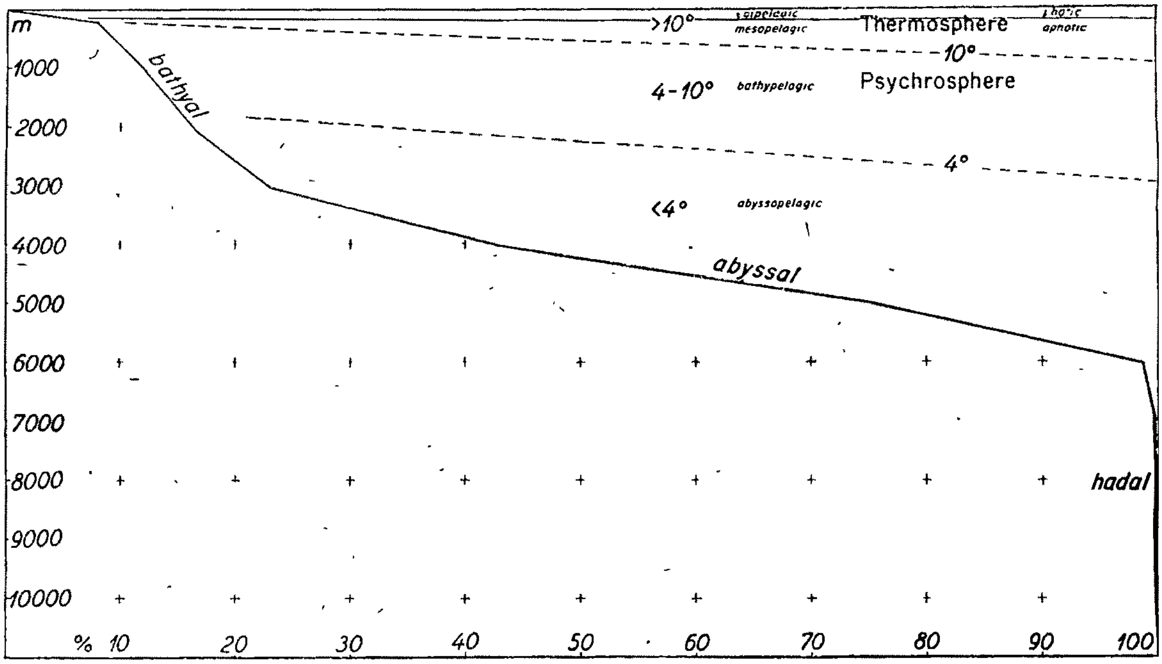

Fig. 1. Ecological zonation of the ocean

3,000 m. are excluded, the total area is only reduced by 6·8 per cent. If the extreme depths beyond 6,000 m. are excluded, there is further reduction of a mere 1·2 per cent. Therefore, by far the greater part, 273×10^6 sq. km. or three-quarters of the area, lies between 3,000 m. and 6,000 m. This is more than half the total area of the Earth (510×10^6 sq. km.). The abyss is thus the largest known ecological unit, but, unfortunately, also the least explored.

Sediments. The bottom is mostly covered by soft ooze or clay. Siliceous oozes occupy 38×10^6 sq. km., calcareous oozes 128×10^6 sq. km., and red clay 102×10^6 sq. km.

Temperatures. The abyssal zone is delimited from the bathyal zone by the temperature isotherm of about 4° C. This means that there will be a very narrow total range in abyssal temperatures, and a still narrower range within geographical areas. Furthermore, there is no seasonal variation in temperature.

Salinity. An average figure may be set at 34·8 per mille, and the variation is only about ± 0·2 per mille.

Oxygen. In general, the bottom water contains sufficient oxygen to support at least some life, as shown by the fact that large azoic areas are unknown. Koczy[1] has demonstrated a certain, sudden decrease of oxygen in the water layers from about 20 to 50 m. above the bottom down to a layer 1 m. above the bottom. In the Indian Ocean, this decrease amounts to values about 10 per cent of the oxygen content of about 4 ml./l. Brouardel and Fage[2] have shown a further decrease of oxygen in the last metre above the bottom at a depth of 460 m.

Alkalinity, pH; *carbon dioxide, phosphate and silicate.* Koczy has also shown a definite gradient of these chemical features close to the bottom, the alkalinity showing a slight increase, while the other constituents decrease. This phenomenon must be closely connected with biological processes; but more observations are badly needed.

Pressure. The ecological factors mentioned abov are not specific for the abyssal zone in the same sens as the hydrostatic pressure, which amounts to value from about 200 to about 1,100 atmospheres. Lac of light and low temperatures may occur at shallowe depths, but in combination with a high hydrostati pressure are only found in abyssal depths. This wa stressed by Fontaine[3], who carried out a series o experiments showing varying resistance to pressur in different animal groups; he also showed tha the rate of metabolism of *Pleuronectes, Gobius* an *Palaemon* increased with pressure. Others hav followed with similar experiments; but in all thes only shallow-water animals have been used. It wa not until ZoBell[4] succeeded in cultivating bacteri from the bottom of the Philippine Trench that th existence of organisms adapted to pressure wa proved. Such barophilic bacteria must be cultivate under a hydrostatic pressure of about 1,000 atmo spheres, and at a low temperature, because they ar also psychrophil and very steriothermal.

It is reasonable to conclude that more highl organized animals may be still more sensitive t pressure.

Food. All organisms living below the photo synthetic zone must depend upon the amount o food existing in or sinking below this zone. The ol idea of a rain of dead bodies of plankton organism reaching the deep-sea floor, has not been sub stantiated by finding such a settling in any quantity But if *food* is thought of in terms of *any energ stored in organic matter,* there is certainly a rain o excrement, cast crustacean skins, tests of salps, etc. which, however, cannot be digested directly b animals. Nevertheless, 30–40 per cent of the remain ing organic carbon can be converted into bacteria cell substance, the rest being oxidized by the bacteri during the process. Such bacteria may serve directl as food, with protozoans, mud-eaters or filter-feede as the second link in a new food-chain.

It is commonly asserted that the greater the dept the less the supply of food. This is probably not so because the abysso-pelagic zone is so poorly populated, even with bacteria, that the amount of organic debris reaching the bottom is much the same whether the depth be 2,000 m. or 10,000 m. provided the supply from the surface is the same. Even any bacterial decomposition during the sinking must be inhibited, because of the steadily increasing pressure, and only at the bottom itself can bacterial activity really start.

It is well known that a certain number of abyssal animals live close to the surface as larval stages, such as the leptocephali of the deep-sea eel *Synaphobranchus*. When such larvæ metamorphose and start living at the bottom, they must provide a considerable amount of directly available food for the abyssal predators. Only a small fraction of the number which descend ultimately grow up for recruitment to the breeding stock.

Other direct sources could be the dead bodies of surface animals which are too big to be swallowed by any predator. Ear bones of whales and the teeth of sharks—the more permanent remains of these animals—are often found on the abyssal floor. A dead whale of 50 tons must attract scavengers for a long time and thus form a local focus of abundant food for predators.

There are several sources of indirectly available supplies; but their relative importance is difficult to estimate.

The amount of dissolved organic matter is probably very important. It is certainly fairly high, about 0·5 mgm./l., according to the few determinations made first by Krogh[5] and more recently by Plunkett and Rakestraw[6]. But more determinations are needed from water very close to the bottom in order to estimate the rate at which organic matter is consumed by bacteria.

Besides the particulate organic matter of animal origin already mentioned, remains of land plants, such as branches, leaves or fruits, together with seaweeds from the coastal belt, have often been included in hauls from deep water (Fig. 2). Except for a very limited amount, all this debris must be converted by bacteria into digestible matter for animals.

In many regions where plant debris has been found to be abundant, the quantity of animals has been correspondingly great.

On the whole, the food supply in the abyssal zone may not be termed plentiful; but it is no more scanty than in any other benthic zone of the deep ocean below the layers in the proximity of the photosynthetic zone.

Animal communities. It is not possible to give even an estimate of the number of species of the abyssal zone, since new species still appear in almost every haul. Furthermore, the taxonomy of several groups needs a thorough revision, which will again reduce the number of species described. It is therefore of very limited interest to state, for example, that eighty-eight species of the holothurian order Elasipoda have been found in depths exceeding 3,000 m.; or, similarly, that the ophiuroid family Ophiolepididae is represented by forty-nine species.

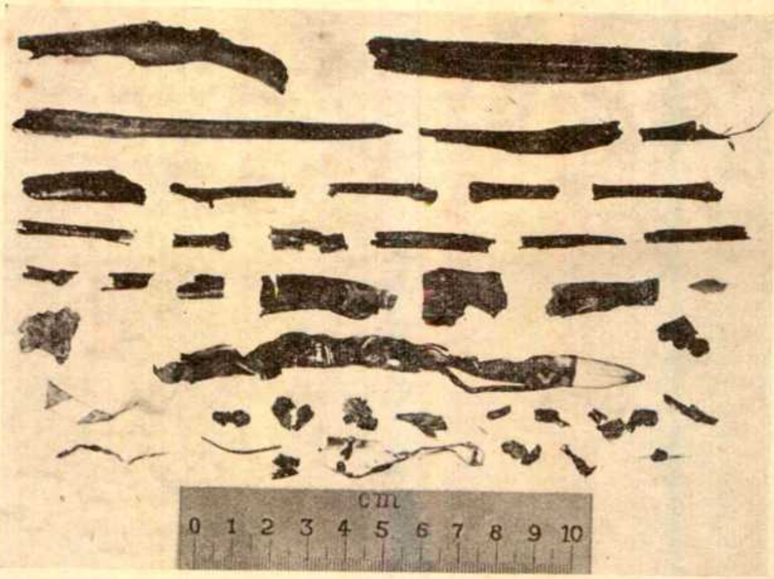

Fig. 2. Plant debris from the bottom of the Philippine Trench, 10,190 m.

Nevertheless, the figures must in some way indicate quite a varied fauna, and the same impression is apparent in several other major taxons.

However, the abyssal fauna can scarcely be compared with the diverse communities of a coral reef. This is not surprising, because most of the environmental conditions in the abyssal zone are so extremely uniform. The food supply and the increasing pressure with depth are the exceptions.

Ecologically, the fauna forms a typical soft-bottom community with a dominance of burrowing species, mixed with sedentary stalked species, like sponges, cœlenterates and tunicates. Exposed rock surfaces, which are relatively rare, have been even less explored than the level bottom and have revealed a poor epifauna. This is so because the quiet conditions allow sedimentation to take place on much steeper slopes than those of shallower water with its strong currents and wave action.

It appears impossible to single out any character of morphological adaptation, which is not also seen in animals from shallower ecological zones.

Distribution

Vertical. Many species have a very wide range, extending upwards even to the continental shelf; but there is no doubt that the number of species decreases steadily with increasing depth. Between 6,000 m. and 7,000 m. a considerable number of major groups disappear. This is the transition zone leading to the depths of the trenches, which at 10,000 m. in the Kurile Trench[7] and the Philippine Trench[8] contain only six and eight species, respectively. The Danish investigations in the shallower Sunda, Banda, New Britain and Kermadec Trenches gave similar results, and systematic studies have shown a large number of new species found nowhere else. Combined with ZoBell's work on barophilic bacteria, the impression is gained that the trenches form an ecological zone of their own, for which the term 'hadal' is suggested (*hades*, the Greek underworld). The all-important biological factor in the hadal zone is the high hydrostatic pressure, 600–1,100 atmospheres.

Even within the true abyssal zone, 2,000–6,000 m., there is a certain degree of segregation into an upper and a lower subzone. The fish *Acanthonus* has been found only in the upper division, whereas another fish, *Bathymicrops*, has been found only in the deeper. In addition, it may be stated that Russian and Danish investigations both found the lower limit of fish at 7,200 m., each of the expeditions finding one specimen at that depth.

Horizontal. If an animal is living at 2,000 m., there is no biological barrier between any of the oceans. Therefore, it would be expected that the true abyssal animals would be cosmopolitan, and so in general they probably are. Both the fishes *Acanthonus* and *Bathymicrops* are, and further examples appear in every systematic treatment of new collections.

But there are certain striking exceptions. One example is the interesting class of Pogonophora, which have been found only in the north-west Pacific and in the equatorial Indonesian Seas. A probable explanation of this distribution could be the great variation in the food supply, which is abundant in both the areas where the Pogonophora have been found. There may well be other similar instances. It seems likely that the food supply is the most important factor governing the horizontal distribution of the true abyssal species.

The hadal species could also be governed by pressure to the extent that if a species has become barophilic, it has no possibility of spreading from one trench to another, so that each trench will tend to contain a special endemic fauna. A fine example of this was found by the late O. Carlgren of a new family of Actinaria represented by one species in the Philippine Trench and another in the Kermadec Trench (an account is in the press).

Origin

The true abyssal fauna is derived from the bathyal fauna, from which such species that can live under the higher pressure and at lower temperatures have spread downwards. Exploration of the abyssal zone has thus added but little to the list of living fossils which it was expected would be discovered when the first stalked crinoids were found more than a century ago. But the majority of stalked crinoids are bathyal, and so are the hexactinellid sponges and the eryoneid crustaceans and the cœlacanth fish *Latimeria*. This bathyal distribution was clearly seen so long ago as 1899 by Perrier[9], when he suggested the name the Palæozoic zone for the depths from 400 m. to 2,000 m. because of the many similarities with the cretaceous fauna.

It seems probable, therefore, that the temperature in abyssal depths in Tertiary time and earlier, when there were no constant polar ice-caps, was between 4° and 10° as in the present bathyal zone. This agrees very well with the results of Emiliani and Edwards[10], who examined the oxygen isotopes of benthic Foraminifera of probably Oligocene age from the eastern central Pacific. They found temperatures around 10° C., where to-day it is about 2·5° C. So the relatively sudden onset of the glacial age and its cooling of oceanic deep water must have been catastrophic for the abyssal and hadal faunas. Only the relatively eurythermic and eurybathic species could survive.

The present composition of the hadal fauna may indicate the types of animals which survived; if taxons higher than subspecies are exclusively of hadal occurrence, they must be relics of a preglacial abyssal or hadal fauna. But besides these old components there must have been a new invasion, which started with the first glaciation and is presumably still going on. The lower part of the bathyal zone and even coastal waters of the polar regions have yielded species of the necessary eurybathic capacity.

The *Challenger* Expedition opened up the abyssal world eighty years ago; but hadal organisms have been known for less than ten years. Collections now being studied may soon lead to changes in some of the points of view given here; but very much more field-work must still be carried out before we have a knowledge of the abyssal and hadal zones which will stand comparison with that of coastal seas.

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NEWS and VIEWS

Biochemistry in the London School of Hygiene and Tropical Medicine: Prof. H. Raistrick, F.R.S.

PROF. HAROLD RAISTRICK, who retires from the chair of biochemistry in the London School of Hygiene and Tropical Medicine at the end of the current session, graduated at Leeds in 1912. There he came under the influence of J. B. Cohen, to whose training in organic chemistry so many British biochemists are indebted. He was engaged for a brief period on research on the proteins of milk and then proceeded to Cambridge, where he worked in the laboratory of Sir Frederick Gowland Hopkins and first became interested in the metabolism of micro-organisms. He was the first grantee in microbiological chemistry of the Medical Research Committee, conducting government research on the production of acetone by fermentation. After receiving the degree of D.Sc. (Leeds) in 1920, he accepted an industrial post and for eight years guided the activities of the newly formed biochemical laboratory of Nobel's Explosives Co. at Ardeer Factory, Stevenston, Ayrshire (later merged into Imperial Chemical Industries, Ltd.). Here he initiated the pioneering work on the metabolic products of the micro-fungi which was to prove the main interest of his research career.

Returning to academic life, in 1929 Prof. Raistrick was appointed to the University chair of biochemistry in the London School of Hygiene and Tropical Medicine. He was then able to publish the investigations undertaken at Ardeer in a series of eighteen papers forming the first group of "Studies in the

Biochemistry of Micro-organisms". This work received very favourable comment; the Sc.D. (Cantab.) and the fellowship of the Royal Society soon followed. The major part of his research work during the tenure of his chair has been devoted to the continuation of the studies on micro-fungi, and the contributions in this main series of papers which has flowed from his laboratory now number nearly one hundred. Prof. Raistrick has served as secretary of the Biochemical Society and has devoted much time to administrative and advisory duties in the University of London. During the Second World War he was honorary scientific adviser on penicillin production to the Minister of Supply; in 1949 he was Bakerian Lecturer of the Royal Society.

Prof. J. H. Birkinshaw

Dr. John Howard Birkinshaw, who is already reader in biochemistry in the London School of Hygiene and Tropical Medicine, is to succeed Prof. Raistrick. Like Prof. Raistrick, Birkinshaw is a graduate of the University of Leeds, eventually gaining the degrees of M.Sc. and D.Sc. from that University. In the First World War he held a commission in the West Yorkshire Regiment, took part in the Somme offensive and was captured at Delville Wood, to be repatriated shortly after the Armistice in 1918. He commenced his research career as a research biochemist in the Ardeer Factory of the Nobel's Explosives Co. Here began his long association with Prof. Raistrick, whom he succeeded as chemist in charge of the Biochemical Department at Ardeer when Raistrick moved to the London School of Hygiene and Tropical Medicine. In 1931, the senior staff of the Biochemical Department at Ardeer moved to Prof. Raistrick's department in London, where Birkinshaw remained until 1937, when he went for a year to the I.C.I. Research Station at Jealott's Hill to work on the conservation of grass protein. In the following year, he was appointed senior lecturer in Raistrick's department at the London School of Hygiene and Tropical Medicine, becoming a reader in the University of London in 1945. Dr. Birkinshaw is a Fellow of the Royal Institute of Chemistry, and has been a secretary of the Biochemical Society. The greater part of his research has been devoted to the study of metabolic products of micro-fungi, a field which he and Prof. Raistrick have together developed with great distinction.

Psychology at Oxford: Prof. G. Humphrey

When Prof. George Humphrey retires from the chair of psychology in the University of Oxford next September, he will be able to look back over the past nine years with great satisfaction. He went to Oxford in 1947, after a distinguished career in the United States and Canada, returning as a professor to the University which he had first attended as an undergraduate. Anybody who visited the Institute of Experimental Psychology, in the Banbury Road, then, and who revisits it now, will speedily realize how great a development has taken place. It is fair to say that psychology at Oxford has made more advances during these years than at any earlier period, and in particular that excellent working relations have been established with other academic studies. All is now well in train for still more striking developments. It is remarkable that, with all this, Prof. Humphrey has also found the time to complete and publish those studies in the experimental psychology of thinking for which he has now become known throughout the world.

Prof. R. C. Oldfield

Prof. R. C. Oldfield, who is to succeed Prof. George Humphrey at Oxford, took his first training at Cambridge, reading the Natural Science Tripos, Part 1, and Moral Sciences Tripos, Part 2. He was an exhibitioner in moral sciences at Peterhouse and held the Arnold Gerstenberg studentship in philosophy, and the Leverhulme fellowship in industrial psychology. For a time he worked with Prof. Cairns in Oxford on head injuries, holding a Rockefeller research fellowship. During the Second World War he was with the Radar Branch of the R.A.F., being mentioned in dispatches. After a period of lecturing at Oxford, first in general then in experimental psychology, he was called to the chair at Reading in 1950. He was a founder-member of the Experimental Psychology Group and edited the *Quarterly Journal of Experimental Psychology* for some years, and still serves as associate editor. His interests in psychology have been unusually broad, extending from applied psychology (his monograph on the "Psychology of the Interview" is well known) to the effects of head injuries and the contrivance of a number of ingenious pieces of apparatus such as that for the continuous recording of sensory thresholds. In addition, he has published many experimental and theoretical papers covering a wide range of subjects. During his six years tenure of the chair, the department at Reading has steadily increased its reputation for progressive experimental work.

Mathematics at Glasgow: Prof. I. N. Sneddon

Prof. I. N. Sneddon, of the University College of North Staffordshire, has been appointed to the newly created Simson chair of mathematics in the University of Glasgow. Named after Robert Simson, who was professor of mathematics in Glasgow during 1711–61, the new chair has been set up in order to strengthen the link between the Mathematics Department and the Faculty of Engineering. The new professor will be responsible for the mathematics courses given to students of engineering and for the advancement and exposition of mathematical methods. The need for engineers skilled in mathematical techniques of various kinds has never been greater than at the present time, and there is great scope for the holder of such a chair to meet this need and develop his subject. It would be hard to find anyone better fitted to do this work than Prof. Sneddon. Appointed at the early age of thirty to the chair of mathematics at the University College of North Staffordshire, he has been responsible for the setting up and working out of new courses of mathematics there and has still found time to carry on his own research work and write several books, as well as doing valuable work on committees of the Scientific Advisory Council. He has an impressive range of mathematical techniques at his disposal which he has applied to a wide range of subjects in applied mathematics and theoretical physics. His main work has been on elasticity, and his recent work on the generation of waves in elastic solids by variable body forces is of particular interest.

Washington University, St. Louis, Mo.: Physics Appointments

Dr. E. U. Condon, visiting professor of physics at the University of Pennsylvania, has been appointed professor of physics and chairman of the Department of Physics of Washington University, St. Louis, Mo., in succession to Prof. George E. Pake, who has been appointed to the chair of physics at Stanford University. Dr. Condon was previously director of research and development of the Corning Glass Works during 1951–55, and before that was director of the National Bureau of Standards, Washington, D.C. In 1953 he was president of the American Association for the Advancement of Science. Two other appointments in the Department of Physics have also been made: Dr. M. W. Friedlander, of the University of Bristol, England, to be a research associate with the task of establishing a nuclear emulsion group for the study of high-energy nuclear processes; and E. B. D. Lambe, of Princeton University and the University of British Columbia, whose speciality is paramagnetic resonance, to be assistant professor of physics.

University of Durham

THE University of Durham has announced the following appointments: Dr. W. B. Fisher, reader in geography, to the professorship of geography in the Durham Division; Dr. P. L. Robinson, reader in inorganic chemistry, to a personal professorship of inorganic chemistry in the Newcastle Division; Dr. E. G. Richardson, reader in physics, to a personal professorship of acoustics in the Newcastle Division; Dr. J. Weiss, reader in the mechanism of chemical reactions, to a personal professorship of radiation chemistry in the Newcastle Division.

Falkland Islands Geological Work at Birmingham

A CONTRACT has been concluded between the Colonial Office and the University of Birmingham, as a result of which the geological work of the Falkland Islands Dependencies Scientific Bureau (the director of which is Sir Raymond Priestley) will for the next three years be done in the Department of Geology at Birmingham. The primary object of this arrangement is the production of a basic geological map and evaluation of the stratigraphy and economic resources of the Dependencies. Field work in the antarctic will continue as before, under the control of the Governor of the Falkland Islands. At Birmingham, the facilities of apparatus, comparison material and library will be made available to holders of newly established fellowships, some of whom will be appointed to deal with petrological and palæontological collections already made, while others will be men who have returned from a tour of field work and will require a further year or two years to work out their results. To co-ordinate this work, the University has appointed, under the title of Senior Research Fellow in the Department of Geology, Dr. R. J. Adie, who has, among other qualifications for this position, several years of practical experience in the Dependencies, and a number of publications on their geology.

Training B.B.C. Engineers

PRIOR to 1946, technical training within the British Broadcasting Corporation was carried on in a number of regional studio centres and at some of the large transmitting stations. It was then found necessary to centralize engineering training at Wood Norton Hall, near Evesham, in a special department, which has just passed its tenth anniversary. The head of this B.B.C. Engineering Training Department is Dr. K. R. Sturley, formerly assistant principal of Marconi College, Chelmsford. With the completion of some new buildings this year, about two hundred students can be accommodated on full-time residential courses of training, which cover both sound and television broadcasting. Every effort is made to avoid duplicating the training in electrical engineering given in universities and technical colleges; but the application of basic principles to the equipment and methods used by the B.B.C. is studied in detail. While radio engineering normally calls for a very high standard of mathematics and technical knowledge, a feature of the B.B.C. courses is the selection and presentation of special instruction in broadcasting engineering so that it can be readily understood by staff without advanced mathematical knowledge. This involves the use of special demonstration equipment, most of which is constructed in the department's laboratories and workshops.

The various courses cover such subjects as sound recording, acoustics, studio lighting, and transmitters and aerial design for various frequencies. The courses vary in length up to twelve weeks, terminating in examinations, and the successful candidates are then eligible for promotion. A series of booklets, entitled "Engineering Training Supplements", have been prepared by the staff, dealing with such subjects as the principles of television lighting, audio-frequency amplifiers and frequency modulation; and these are used to augment the lectures and demonstrations. In the past ten years, nearly four thousand men and women have passed through the Department; and during 1956 the number attending the various courses is expected to rise to more than eight hundred.

Industrial Trade Associations in Great Britain

IN a broadsheet issued last year (*Planning*, 21, No. 383; 1955), Political and Economic Planning presents a preliminary account of a new survey of manufacturers' trade associations which is being conducted in co-operation with industry. It excludes associations concerned solely with research or with labour or management and also general bodies which represent industry as a whole, and, in addition, it excludes associations consisting entirely of distributors. Besides an analysis of the services offered by associations to their members, the inquiry attempts to assess the effectiveness of trade associations' activities in representing members from the point of view of various bodies which have contacts with such associations, and it is also intended to approach many manufacturing firms to discover what trade associations mean to them in the course of their business. There appear now, in 1955, to be more than a thousand such associations in existence; of these, more than two hundred are concerned with the textile and clothing industries and more than a hundred with each of the following industries: chemicals and allied trades; metal manufacturers; metal goods; engineering and shipbuilding; and food, drink and tobacco. Two main types of general, broadly based associations covering many specific interests can be distinguished: the federation comprising local or product associations, such as the British Man-Made Fibres Federation and the Wool Textile Delegation; and the large industry-wide association which may or may not have local or product associations affiliated to it, of which the British Electrical and Allied Manufacturers Association is an example. The broadsheet lists some thirty-seven different activities undertaken by some or other associations and reviews briefly the three main aspects of their work: representation of the industry; provision of common services (including exchange of information and experience and publicity); and economic regulation. Of the first, the broadsheet notes, besides presentation of a united front to other organizations, including government departments, the value of trade associations as a source of expert advice; of the second, that much valuable work is done in the fields of safety and health; and of the third, that not more than 15–20 per cent are concerned in any way with prices.

Taxonomy and Origins of Cultivated Bananas

A FURTHER useful and interesting contribution to our knowledge of these topics has been made by N. W. Simmonds and K. Shepherd (*J. Linn. Soc.*, Botany, **55**, No. 359, 302; 1955). Two wild species, *Musa acuminata* Colla and *M. balbisiana* Colla, are considered to be the sources from which virtually all the edible bananas have originated. Earlier investigations had led to the view that there were edible diploid and triploid forms of *M. acuminata*, of diploid and triploid forms of interspecific hybrid origin, and of triploid forms of *M. balbisiana*. Simmonds and Shepherd now point out, however, that this view of banana taxonomy presents difficulties, in that no edible diploid forms of *M. balbisiana* are known, and that, although mechanisms for the production of vigorous tetraploid bananas are well known from cytogenetic experiments, only one such banana is known to occur naturally. They have now used a taxonomic scoring method for classifying the edible bananas and to provide evidence on their evolution. Edible diploid forms of *Musa acuminata* are thought to be the primary source of the whole group to which another species, *M. balbisiana*, has contributed by hybridization. Thus there exist diploid and triploid edible forms of *M. acuminata* and diploid, triploid and tetraploid hybrid types of genetic constitutions that vary according to their histories. There is a faint possibility that a third wild species has contributed to the origins of a small group of triploid hybrid types. Triploidy was probably established under human selection for vigour and fruit size; tetraploidy is inexplicably rare. The centre of origin of the group is Indo-Malaya, and Malaya is probably the primary centre. The two Linnæan species, *M. paradisiaca* and *M. sapientum*, refer to identifiable edible varieties which are both shown here to be of hybrid origin. The names, therefore, may be rejected from the nomenclature of the wild bananas.

Poultry Housing

POULTRY keeping in England and Wales has undergone great changes since the last edition of Bulletin No. 56 "Poultry Housing" was published by the Ministry of Agriculture and Fisheries in 1935. Interest in intensive and specialized methods has much increased, and the type of housing and equipment required has been altered accordingly. A complete revision of the Bulletin has now been carried out, keeping in mind the needs of those following both the older and newer methods. The approach to the subject is essentially practical, and the Bulletin, which is now in its fifth edition (pp. 56+4 plates. London: H.M.S.O., 1955; 2*s*. 6*d*. net), contains a large number of excellent diagrams and photographs. Before describing the principles of design and construction, useful advice is given on layout, choice of building materials and the accommodation requirements of different classes of birds. Stress is laid on the importance of good ventilation, lighting and protection from extremes of weather, and practical information given as to how these needs may best be met. The Bulletin should prove helpful to poultry keepers of all types in establishing an efficient unit at a minimum cost.

Scientific Film Review

AS a result of a change in publication policy by the Scientific Film Association, the *Scientific Film Review* has been issued in a new format. The change is intended to create a journal which not only contains more film reviews than were previously published annually but which also provides a means of informing members and subscribers of the activities of the Association and of developments in the production and application of scientific and industrial films. The new journal will appear every second month. Three issues each year will contain film reviews and appraisals, articles on various aspects of scientific and industrial films, and other information of interest to all concerned with the application of film to scientific and industrial problems. The other three issues will generally be devoted to films on specific subjects. The first special issue of this kind will be published in June and will be devoted to films on chemistry. The present issue (2, No. 1; April 1956) contains articles on the film and work study, first steps in industrial film making and the use and abuse of film in medical illustration. There is also a classified list of medical films which have been notified during the past two years.

Health Education in the U.S.S.R.

IN September 1955 a group of fifteen medical men went to the Soviet Union to study preventive medicine. They made a journey covering some eight thousand miles from Leningrad to Moscow, Tashkent, Samarkand, Sochi, Stalingrad, back to Moscow and finally to Leningrad. Their experiences have been recorded by Dr. John Burton (*Health Education*, 14, No. 1; March 1956). In the U.S.S.R., the doctor considers the purpose of medicine not to be the alleviation of suffering but the raising of the standard of living; prevention takes precedence over cure. The health services are not divided into cure and prevention, as they are in Great Britain, with hospitals and general practice on one side and public health on the other. Their divisions are pædiatrics, adult medicine and environmental sanitation. Prevention and cure in these fields are carried on simultaneously in the same building, namely, the polyclinic. Every health worker—nurse, physician, sanitarian or surgeon—studies health education during his or her training.

Decisions on Zoological Names for Certain Birds

THE International Commission on Zoological Nomenclature has recently taken a series of decisions on the names for certain birds regarding which applications to the Commission were published in October 1952 in Part 1/3, Vol. 9, of the *Bulletin of Zoological Nomenclature*. Among the decisions so taken, the following are of wide general interest: (1) suppression of the generic name *Colymbus* Linnæus, 1758, and acceptance of the generic name *Gavia* Forster, 1788, for the divers (loons) and of *Podiceps* Latham, 1787, for the grebes (Opinion 401); (2) validation of the generic name *Pyrrhocorax* [Tunstall], 1771, for the chough by the suppression of the name *Coracia* Brisson, 1760 (Opinion 404); (3) suppression of the specific name *ericetorum* Turton, 1807, and acceptance of the name *philomelos* Brehm, 1831, for the song thrush (Opinion 405); (4) suppression for nomenclatorial purposes of the names by Linnæus published in 1776 in the "Catalogue of Birds, Beasts, . . . in Edwards' Natural History" (Opinion 412); (5) validation of the name *Columba migratoria* Linnæus, 1766, for the passenger pigeon (Direction 18); (6) validation of the generic names *Bubo* Dumeril, 1806, *Coturnix* Bonnaterre, 1790, *Egretta* Forster, 1817, and *Oriolus* Linnæus, 1766, by the suppression of older homonyms (Direction 21); (7) acceptance of *Gallinago* Brisson, 1760, and rejection of *Capella* Frenzel, 1801, as the generic name for the snipe (Direction 39). These decisions are being published. All inquiries should be addressed to the Publications Officer, International Trust for Zoological Nomenclature, 41 Queen's Gate, London, S.W.7.

Northern Advisory Council for Further Education

The eighth annual report of the Northern Advisory Council for Further Education shows how one of these regional organizations is stimulating and canalizing the development of technical education in its area. Growing interest in fuel efficiency, for example, has been followed not only by the further education and training of boiler-house operatives but also by the provision of a refresher course in fuel technology for works and plant engineers at Middlesbrough. Suggestions by the Ministry of Education that local authorities could usefully develop their range of advanced courses has led to the organization of *ad hoc* courses in analytical chemistry at Whitehaven, work study at Darlington, Gateshead and Newcastle, and the testing of materials and the design of fabricated structures at Sunderland. Courses projected for the 1955–56 session include one on surges at Newcastle, transistors at Workington, lubrication at Middlesbrough, and metallic corrosion and protection at Sunderland. All the authorities within the region are considering the organization of courses for industrial personnel in communications and report writing. Copies of the report can be obtained from the Secretary, National Advisory Council for Further Education, 5 Grosvenor Villas, Grosvenor Road, Newcastle upon Tyne, 2.

National Science Foundation, Washington, D.C.: Fellowships for 1956–57

The National Science Foundation, Washington, D.C., has announced the award of 775 pre-doctoral graduate fellowships and 80 post-doctoral fellowships in the natural sciences and allied fields for the academic year 1956–57. Of the former, 296 fellowships have been awarded to first-year students, 302 to students in their intermediate years, and 177 to those in their last year. The distribution among subjects is as follows: chemistry, 182; physics, 165; engineering sciences, 109; mathematical sciences, 67; zoology, 58; earth sciences, 40; psychology, 26; biochemistry, 25; microbiology, 20; botany, 16; medical sciences, 14; agriculture, 11; anthropology, 11; genetics, 7; astronomy, 7; general biology, 3; and biophysics, 3. In addition, 11 awards have been made in fields where the natural sciences converge with the social sciences. Of the post-doctoral awards, 29 have been made in the life sciences, 19 in chemistry, 13 in the mathematical sciences, 9 in physics and astronomy, 5 in the earth sciences, and 2 in the engineering sciences. All the awards are tenable at any accredited non-profit educational institution of higher learning in the United States or abroad. The pre-doctoral fellowships are worth 1,400 dollars for the first year, rising to 1,800 dollars for those in their last year, and post-doctoral fellowships are worth 3,400 dollars. The fellowships include additional allowances for dependants, tuition and other normal expenses.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: G. W. Anderson (agricultural officer, Uganda), senior agricultural officer, Uganda; D. G. Jones (agricultural officer, Tanganyika), assistant director of agriculture, Tanganyika; D. K. Jones (agricultural officer, Cyprus), senior agricultural officer, Cyprus; R. B. Smith (agricultural officer, Trinidad), agronomist, Trinidad; R. B. Warner (senior agricultural officer, Western Region, Nigeria), principal agricultural officer, Western Region, Nigeria; C. C. Webster (chief research officer, Kenya), deputy director of agriculture, Federation of Malaya; J. D. Yelf (agricultural officer, Northern Rhodesia), senior agricultural officer, Fiji; W. V. Calder (assistant conservator of forests, Tanganyika), assistant conservator of forests, Uganda; W. H. Jack, J. W. C. Mooney, D. Sim, J. W. Wheelan and J. C. Wilson (assistant conservators of forests, Gold Coast), senior assistant conservators of forests, Gold Coast; H. A. Douglas, D. C. Duff and D. A. Lane (senior assistant conservators of forests, Gold Coast), conservators of forests, Gold Coast; D. Moore (assistant conservator of forests, Trinidad), deputy conservator of forests, Trinidad; P. C. Randell (senior assistant conservator of forests, Northern Region, Nigeria), conservator of forests, Northern Region, Nigeria; J. H. N. Smith (assistant conservator of forests), conservator of forests, Northern Rhodesia; A. E. G. Storrs (assistant conservator of forests, Gold Coast), assistant conservator of forests, Northern Rhodesia; I. G. Hughes (geologist, Gold Coast), senior geologist, Gold Coast; G. C. Billington (senior statistician, Gold Coast), deputy statistician, Gold Coast; J. M. Simmond (statistician, Gold Coast), senior statistician, Gold Coast; W. Stewart (senior pharmacist, Eastern Region, Nigeria), chief pharmacist, Eastern Region, Nigeria; A. E. H. Phillips, technical publications officer (agriculture), Federation of Nigeria; M. Dagg, scientific officer, East Africa High Commission; Miss S. J. Darke, medical research officer, grade III, East Africa High Commission; G. B. Aneuryn-Evans, statistician, Federation of Nigeria; P. Durran, veterinary officer, Northern Region, Nigeria; J. McP. Fletcher, assistant director of agriculture (veterinary and animal husbandry), British Guiana; A. D. Morris, veterinary officer, Western Region, Nigeria; D. A. Richardson, veterinary officer, Nyasaland.

Royal Society of South Africa: Officers

The following have been elected as officers and members of council for 1956 of the Royal Society of South Africa: *President*, S. H. Haughton; *Honorary General Secretary*, W. J. Talbot; *Honorary Treasurer*, N. Sapeika; *Joint Honorary Editors*, W. J. Copenhagen and A. M. Talbot; *Honorary Librarian*, E. Newbery; *Other Members of Council*, W. F. Barker, H. B. S. Cooke, J. H. Day, A. J. H. Goodwin, S. M. Naude, W. S. Rapson, S. H. Skaife and R. H. Stoy.

Royal Aeronautical Society: Officers

The following have been appointed officers for 1956–57 of the Royal Aeronautical Society: *President*,

E. T. Jones; *Past Presidents*, N. E. Rowe, Sir Sydney Camm and Sir William Farren; *President-elect*, G. R. Edwards; *Vice-Presidents*, Sir Arnold Hall, P. G. Masefield and Dr. E. S. Moult; *Honorary Treasurer*, Major G. P. Bulman; and *Secretary*, A. M. Ballantyne.

Rutherford Memorial Lecture and Scholarship

Under the terms of the scheme to commemorate the late Lord Rutherford of Nelson, the Council of the Royal Society has appointed Prof. E. N. da C. Andrade to deliver the Rutherford Memorial Lecture for 1957 in Australia.

The Council of the Royal Society has also appointed Mr. A. M. Segar, a graduate of the University of Melbourne, as a Rutherford Scholar for three years from October 1, to carry out studies in nuclear physics at the University of Birmingham.

Human Problems of Industrial Communities within the British Commonwealth

A study conference on "The Human Problems of Industrial Communities within the Commonwealth and Empire", under the presidency of H.R.H. the Duke of Edinburgh, and with Sir Harold Hartley as chairman, will be held in Oxford during July 9–27. The purpose of the conference is to conduct a practical study of the human aspects of industrialization, and in particular those factors which make for satisfaction, efficiency and understanding, both inside industrial organizations and in the everyday relations between industry and the community around it. It will not deal, however, with those matters which come within the normal scope of industrial negotiation. As the conference is independent in character, no government or organization is represented officially, and the members have all been invited as individuals and not delegates. About 280 men and women will be attending, mainly 25–45 years old, and all of them responsible persons engaged in the manager/employer or trade union/operative roles of industry (including industrially organized agriculture and government-owned undertakings). The approximate distribution of membership is: Great Britain, 90; Canada, 30; Australia, 25; India, 25; Union of South Africa, 18; Malaya and the Far East, 14; Caribbean area, 13; Federation of Rhodesia and Nyasaland, 12; Pakistan, 12; West Africa, 11; New Zealand, 10; East Africa, 7; Oceanic areas, 7; and Ceylon, 6. The conference will be divided into twenty study groups of fourteen members each, and after the introductory sessions they will set off for nine days on independent tours of industrial centres in Britain. The last five days of the conference will be spent in Oxford, when the final reports of each group will be discussed. Further information can be obtained from the conference secretary, Peter Parker, 48 Bryanston Square, London, W.1.

Announcements

The Warner Memorial Medal of the Textile Institute has been awarded to Dr. J. M. Preston, research manager of British Enka, Ltd., of Aintree. The Medal was inaugurated in 1930, in memory of the late Sir Frank Warner, a past president and chairman of Council of the Institute, and is awarded for outstanding work in textile science and technology, the results of which have been published, and particularly for work published in the *Journal of the Textile Institute*.

The Salters' Company has elected the following to be Salters' Fellows for the year 1956–57: F. W. Eastwood and R. C. Sheppard (Department of Organic Chemistry, Cambridge); Dr. L. Keay (Queen Mary College, London); and Dr. M. J. Stephen (continuation of fellowship for 1955–56; Department of Mathematics, Oxford). Salters' scholarships have been awarded to the following: A. R. Sanderson (King's College, Newcastle upon Tyne); P. S. Houston (Battersea Polytechnic, London); A. A. Webb and P. L. Levine (Imperial College of Science and Technology, London); and B. B. Hunt (University of Cambridge).

Sir K. S. Krishnan, director of the National Physical Laboratory of India, New Delhi, will give a lecture at the Royal Society on June 28 at 4.30 p.m. in which he will give a short account of the scientific and technical work done in the various divisions of the Laboratory. The lecture is open to the public, who should write beforehand, however, to the Assistant Secretary, Royal Society, Burlington House, London, W.1, notifying their intention to be present.

The Manchester Joint Research Council is holding a meeting on "Automation" in the University of Manchester on July 9. The meeting will be addressed by the Earl of Halsbury. Further information can be obtained from the Council, c/o Manchester Chamber of Commerce, Ship Canal House, King Street, Manchester 2.

The Nutrition Society is holding a symposium on "Grassland and the Feeding of Livestock" in the University of Reading on July 20, under the chairmanship of Prof. H. D. Kay. Further information can be obtained from the honorary programmes secretary of the Society, Dr. R. J. L. Allen, c/o Beecham Foods, Ltd., Brentford, Middlesex.

The Plant Breeders' Conference organized by the Agricultural Research Council will be held this year in the Plant Breeding Institute, Cambridge, during July 4–5. About a hundred representatives are expected to attend, including the staffs of plant breeding institutes, other plant breeders and geneticists from university departments.

A symposium on "Chemisorption", organized by the Chemical Society, will be held in the University College of North Staffordshire, Keele, during July 16–19. After an opening session on the theory of chemisorption, there will be four sessions dealing with chemisorption on insulators, metals, carbon and semiconductors, respectively. The fee for the symposium is 2 guineas (10*s*. for Fellows of the Society). Registration forms, to be returned by July 1, and further information can be obtained from the General Secretary, Chemical Society, Burlington House, London, W.1.

The Non-Destructive Testing Group of the Institute of Physics will hold its summer meeting during July 11–14 in the H. H. Wills Physical Laboratory, University of Bristol, when the subject will be "Physics of Some New Aspects of Non-Destructive Testing". The proceedings will be published later as a supplement of the *British Journal of Applied Physics*. The conference will be open to non-members of the Group. Enrolment forms, to be returned by June 25, can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

THE GROWTH OF LEAVES

THE University of Nottingham held its third Easter school in agricultural science during April 23–25. It took the form of a discussion, with demonstrations, on leaf growth. Prof. F. G. Gregory (Imperial College, London) opened the symposium by outlining some general aspects of leaf growth. The initiation of leaf primordia poses certain questions, especially if a hormone theory is invoked, since two groups of cells arise from the same apex—one forms a leaf capable of only limited growth and the other the axillary bud with the potential of unlimited growth. Cessation of cell division restricts the growth of the leaf, the size of which is determined by the number of primordial cells, the rate and duration of division and the size of the mature cells. Analysis of the growth curves of leaves can assist in understanding the way in which various factors influence leaf development. Temperatures below the optimum, for example, mainly influence the rate of growth of the primordia. A photochemical reaction is involved in the production of specific leaf-forming substances; but the nature of the reactions involved in leaf growth is little understood. Prof. E. Bünning (University of Tübingen) pointed out that capacity for division and unlimited growth are common properties of protoplasm, but that these are restrained by polarity and the close proximity of meristematic areas. Meristemoids arise in areas sufficiently removed from other meristems, and these in turn tend to suppress this tendency to unlimited growth. The self-duplication of substances produced by developing cells is responsible for the stable organization and ordered differentiation of the plant. The changes which occur during the growth and differentiation of cells were described by Drs. J. K. Heyes and R. Brown (Agricultural Research Council Unit of Plant Cell Physiology, University of Oxford). Cell enlargement is not simply the expansion of a metabolic system of constant pattern but involves a system in which the pattern itself changes. Metabolic activity is low in meristematic cells due to a high proportion of protein with low catalytic activity. During expansion, the relative proportion of catalytically active protein as well as the total protein increases, and there are changes in the activity of different enzymes which determine the rate and course of growth.

The inception of leaf primordia in several different plants was described by Prof. C. W. Wardlaw (University of Manchester). The position of inception of the primordium and its symmetry, orientation and rate of growth are regulated by the activity of the apex as a whole and can be disturbed by surgical and chemical treatments. There is need for much closer study of the constitution and metabolism of cells in the different regions of the apex, since these determine the formation of growth centres and control the geometrical pattern of leaf arrangement. This arrangement, or phyllotaxis, was rigidly defined by Dr. F. J. Richards (Imperial College, London), who indicated alternative methods of estimating phyllotaxis height. An equation was also derived which has wide applications to growing and dividing systems generally. In one form it yields a relation between the cross-sectional area of an apex, the slope of the apical surface relative to the longitudinal axis, the primordial insertion area, the plastochrone, and the difference between two transverse growth-rates; it then consists of two parts, each of which represents the phyllotaxis height corresponding to the particular plastochrone considered. The metabolic changes in such a system were examined by Drs. N. Sunderland, J. K. Heyes and R. Brown (Agricultural Research Council Unit of Plant Cell Physiology, University of Oxford). Such changes may be regarded as a consequence of the primary differentiation from the apex of the tunica with low metabolic activity and the corpus with high activity. Cell division and protein accumulation are restricted in the corpus; but substrates are transferred from it to the tunica to supply materials for the rapid division and protein synthesis which occurs in this region of low inherent synthetic activity. A similar pattern occurs during development of the leaf primordium when metabolic activity increases from a low to a high level.

The changes which occur at different stages during expansion, producing a variety of different leaf forms, were outlined by Dr. H. Jones (University College, Aberystwyth). In juvenile leaves the primordial form persists to maturity; in other leaves, changes may occur at an early stage of development and may also be related to changes in width of the shoot apex. Changes in shape during expansion result from localized differences in divisions and growth; these may be analysed by using the allometric relation. Size and shape may be altered by various physical and chemical agents. From defoliation experiments with apple, Mr. H. W. B. Barlow and Mr. C. R. Hancock (East Malling Research Station) postulated that at least three different substances or groups of substances are produced by leaves and influence the growth of other leaves. One of these groups probably consists of the major photosynthetic products, a second is a factor (or factors) produced by immature leaves which influences internode extension, and the third a leaf-growth factor which influences cell division. The influence of length of day on leaf development was discussed by Prof. E. Bünning (University of Tübingen). Short days accelerate leaf production by long-day plants and retard it in short-day plants, but the rate of ageing of leaves of both types is hastened in long days. Although there is little difference in the total growth made during the light and the dark period, there are definite fluctuations in growth-rate during these periods, the maximum occurring at different times depending on the species. Prof. W. T. Williams (University of Southampton) discussed the association of light with leaf growth in terms of the etiolation phenomena of leaf suppression and internode extension which is exhibited in its absence. Suppression of etiolation by brief flashes of light is associated with the initiation of cell division; but the amount of division set in train is out of all proportion to the light stimulus given. It appears that the synthesis of leaf proteins is automatically initiated by a brief period of light; the process once started continues, irrespective of further light.

During the final session, the effect of external factors on leaf growth was discussed. Prof. F. L. Milthorpe (University of Nottingham) emphasized that most changes occur during the primordial stage. Although low temperature retards all processes, differentiation of primordia appears to continue at a higher rate than does the rate of division and expansion of cells leading to growth of a leaf. The stage of growth is also important; following a temperature check, a higher relative growth-rate of leaves occurs if some leaves have expanded than if no leaves are present. The influence of conditions at germination persists long into the growing period. Prof. G. E. Blackman (University of Oxford) discussed the effects of light and temperature on leaf growth. These vary with the species: reduction of light intensity below full spring and summer daylight may have little effect on the leaf area of one group of plants; in another group, there may be a large increase in leaf surface with reduced light almost to the compensation point; whereas in a third the effect may be intermediate. There is, in general, a direct curvilinear relation of net assimilation-rate and an inverse relation of the leaf area ratio with light intensity; the resultant effect on relative growth-rate, being the product of these terms, depends on the magnitudes of the responses involved in these two relations. The retarding effect of increasing light on leaf expansion occurs with intensities greater than 300–600 ft.-candles; at lower intensities there is a positive effect. Leaf area increases with temperature up to about 25° C., but interactions occur between different levels of temperature and light. Dr. H. L. Penman (Rothamsted Experimental Station) showed that the growth of grass is closely proportional to the total energy supplied at the surface, and also to the potential transpiration. Water becomes limiting at small values of soil moisture deficit; these values are smaller with low than with high nitrogen supply. The slope of the curve relating growth to incoming radiation is also influenced by the nitrogen-level. Dr. D. J. Watson (Rothamsted Experimental Station) emphasized the general conclusion that the variation in dry-weight yield per acre is determined mainly by leaf growth. Variations in the rate of photosynthesis have little influence. The maintenance of dense leaf coverage during the major portion of the growth period provides the main possibility of increasing yield. There is a limit, however, to the increase in returns possible, as mutual shading of leaves ultimately reduces the net assimilation-rate sufficiently to offset the gain from the larger leaf surface. Yield of grain depends largely on a large leaf area during grain formation.

The points raised in the papers were vigorously discussed, and some of the conclusions and techniques used were demonstrated. Full proceedings will be published elsewhere.

F. L. MILTHORPE

FRESHWATER BIOLOGY IN SCOTLAND

THE symposium during April 9–10 on freshwater biology in Scotland, arranged by the Institute of Biology (Scottish Branch), was the first occasion when a comprehensive survey of the progress of work on Scottish fresh waters has been presented. This being so, it is natural that it should cover a wide diversity of subjects. Subjects which ranged from the effects of hydroelectric schemes on migratory fish to the emergence of aquatic insects were submitted for discussion by speakers from the Universities of Edinburgh and Glasgow, the Brown Trout Research Laboratory, Pitlochry, the Oceanographic Laboratory, Leith, and the North of Scotland Hydro-electric Board. The topics brought forward for discussion in the first two sessions were not unrelated, and most can be fitted into a sequence commencing with conditions for life in Highland waters and passing to ecological aspects of the flora and fauna.

It was reported that streams of the catchment areas of Highland lakes and rivers are markedly subject to excessively rapid run-off, partly due to the removal of vegetation by clearing of timber and the burning of moors and partly also to extensive channel draining of sheep pastures. When peat is exposed it is not as efficient a water store as might be supposed. Rainfall reduces the surface layer to a colloidal gel, which inhibits deeper penetration and enhances rapid surface drainage into water-courses, which, in their upper reaches, usually flow down steep slopes. The result is extensive erosion in the lower reaches under storm conditions. Rapid drainage and influx of peat derivatives into Scottish lakes are contributory to the main cause, the mineralogical nature of the Highlands, of the paucity of plant nutrients in these waters. More than half those studied have a calcium content (expressed as $CaCO_3$) of less than 10 p.p.m. and nearly all have less than 50 p.p.m. They have not evolved to a degree of eutrophy permitting the reversible oxidation-reduction process described by Ohle[1] and Mortimer[2], with the result that plant nutrients tend to be occluded in the bottom muds and their main source lies in the small amounts brought in by inflowing streams.

Studies on phytoplankton in Scottish lakes, especially the application of Nygaard's[3] 'compound quotient' to a general survey, emphasize the oligotrophic nature of the majority. This quotient, which is the number of species characteristic of eutrophic waters (for example, species of Chlorococcales and Myxophyceae) divided by the number of species characteristic of oligotrophic waters (for example, species of Desmidaceae), displays a correlation with chemical evidence and with productivity of bottom fauna. Where past records exist, it has been possible to demonstrate the rate of evolution of a lake. Loch Leven, in Fife, with a quotient of 2, fifty years ago ranked as mesotrophic. To-day, with a quotient of 8, it is eutrophic. Loch Lomond, on the other hand, has shown no change over the same period.

Known in England only in the Lake District, the cladoceran crustacean, *Holopedium gibberum*, is absent from eutrophic waters but abundant in many oligotrophic lakes in Scotland. The conditions governing its distribution are not yet fully understood, for it is absent from some water bodies which appear to be closely similar to those in which it does occur. A possible clue to the uneven distribution is the presence of a certain minimum amount of dissolved organic material in the water.

The impermanence of fresh waters was discussed from another aspect, that of their invasion by pulmonate gastropods. It was suggested that the co-existence of pulmonates with a wide range of adaptations, from the great phenotypic plasticity and high ratio of selection—that is, number of individuals surviving to breed annually—of *Lymnaea peregra* to the great genotypic specialization and low ratio of selection of *Ancylus fluviatilis*, may be credited to the instability of freshwater habitats relative to their marine counterparts.

In papers on freshwater fishes and their parasites, during the second day of the meeting, interest lay in new or little-known occurrences in Scotland. Among endoparasites of fishes, the strigeid trematode, *Cotylurus erraticus*, was reported to form massive metacercarial infestations around the heart of powan, *Coregonus clupeoides*; with an incidence of 100 per cent in Loch Lomond, but apparently absent from these fish in Loch Eck, their only other habitat. Present also in trout from Lochs Lomond and Leven, *Cotylurus* does not attain in them the same high infestation. This difference in degree of infestation may be related to differing habits of the hosts, in that trout are fluviatile for at least their first year, whereas *Coregonus* spends its whole life in the lake.

The pseudophyllidean cestode, *Triaenophorus nodulosus*, occurs in pike in Loch Lomond, and its finding constitutes the second record for Britain. Since plerocercoids of this species have been found only in yearling pike, it would appear that the life-cycle is dependent on cannibalism. Apart from the consideration of their parasites, pike were shown to have a phase in development which is probably the retention of an archaic actinopterygian characteristic. The embryos hatch when the branchial region, pectoral fins and mouth are still imperfectly developed and, for a period of about ten days, hang suspended from water plants. They are attached to the support by the secretion of two cement glands placed in front of the eyes.

An addition to the Scottish fauna was established among the fishes. A biometrical study of char, *Salvelinus alpinus*, recently discovered in Loch Eck, Argyll, yielded results which give this fish the rank of a distinct sub-species.

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[1] Ohle, W., *Naturwiss.*, 25, 3 (1937).

[2] Mortimer, C. H., *J. Ecol.*, 29 (2), 49 (1941).

[3] Nygaard, G., *Kon. Danske Videnskabernes Selskab.*, *Biol. Skr.*, 7 (1) 293 (1949).

CHEMISTRY OF OXYGENATED HETEROCYCLIC COMPOUNDS

INTERNATIONAL COLLOQUIUM AT LYONS

LESS than two months after the Dublin symposium on naturally occurring pyrones (see *Nature*, 176, 637; 1955), a similar meeting, devoted more particularly to naturally occurring flavonoid compounds, was held in Lyons during September 5–10. Twenty-six scientists from ten different countries took part in these discussions, during which the different aspects of the chemistry of oxygenated heterocyclics were reviewed.

The first series of reports were in the field of organic chemistry. M. Mousseron (Montpellier) discussed the reactions of epoxides in relation to their steric structure. He suggested a new method for their quantitative estimation in the presence of —SCN ions. The fixation of water by epoxy-1 : 2-*cyclo*alkanes was discussed. The epoxide structure occurs in the transition states of many reactions and leads to compounds having a *trans* configuration.

G. Sandris and G. Ourisson (Paris) discussed the synthesis and properties of 2 : 2 : 5 : 5-tetramethyltetrahydrofuran. Mention was made of the effect, on the spectral properties of this type of compound, of replacement of the heterocyclic oxygen by methylene. In some cases, for example, when there was an α-diketonic group in the 3- or 4-position, the authors achieved a molecular rearrangement to a four-membered ring (trimethylene oxide).

The chemistry of coumarins in general was reviewed by N. P. Buu-Hoï (Paris). The most reactive position in coumarone is the 2-position while in thionaphthene it is at the 3-carbon. A molecule like brasane is far less reactive than the analogous polycyclic hydrocarbon (naphthacene).

C. Mentzer (Lyons) gave an account of the synthetic methods leading to benzopyrone compounds (coumarins, chromones, flavones and their derivatives). The methods were classified according to linkages formed. The condensation of an aromatic C_6 group with C_3 molecules was discussed in detail. A complete list of coumarins, chromones and flavanones obtained by the author and his collaborators by the 'thermal condensation' of phenols with malonic or β-ketonic esters, was given.

A. Dreiding (Zurich) has synthesized 5:6:7:8-tetrahydrocoumarin by a Reformatsky reaction between ethyl monobromacetate and 2-(hydroxymethylene) *cyclo*hexanone. It may be possible to apply this method to the synthesis of other α-pyrones starting from β-dicarbonyl derivatives.

In a second series of papers, the oxygenated heterocyclics were discussed with emphasis on the biochemical aspects. As in the Dublin symposium, the flavones and their derivatives, as well as other less well-known lactones, were the focus of attention.

T. R. Seshadri (Delhi) showed the possibility of the *in vitro* transformation of flavanones into dihydroflavonols by the addition of an oxygen atom to the 3-position. This can be achieved : (*a*) by bromination or iodination of the acetyl derivative of the flavanone and subsequent treatment with silver acetate ; (*b*) by the action of lead tetra-acetate ; (*c*) by the action of Fenton's reagent (hydrogen peroxide + ferrous ion) on the acetyl derivatives.

T. S. Wheeler and E. M. Philbin (Dublin) discussed molecular rearrangements in the flavonoid field. The Wessely–Moser rearrangement has been extended to chromanols and dihydroxyxanthones. A new type of rearrangement was described in which the 2-aryl nucleus takes the place of the second benzene nucleus in the flavone molecule.

The chemistry of natural aurones was reviewed by T. A. Geissman (Los Angeles). These substances (benzal-2-coumaranones) occur in many higher plants of the genera *Cosmos*, *Coreopsis*, etc. The author, who recalled the work of Marini-Bettolo, Hattori and others, has studied their synthesis, properties, detection in plants, isolation and spectral properties in relation to structure.

S. Hattori and M. Shimokoriyma (Tokyo) presented two reports, one dealing with flavonic glycosides from the leaves of *Calystegia japonica* and *hederacea*, the other on the localization of the flavonoid pigments in '*Cosmos sulphureus*'. It is interesting to note that *Calystegia japonica* Choisy (Convolvulaceae) contains a rhamnoglucoside of kæmpferol, in which the disaccharide unit located in position 3 has been identified as rutinose, while *Calystegia hederacea*, a species so similar as to be easily mistaken for the former, contains kæmpferol 3-galactoside identical with trifolin from the flowers of *Trifolium repens*.

Dihydroflavonols were discussed by J. Gripenberg (Helsinki). These compounds are of interest because of the manner in which they become rearranged in alkaline media. In contrast to what happens in aurones, the rearrangements of dihydroflavonols are accompanied by contraction of the heterocyclic ring.

T. Swain (Cambridge), in the course of investigations on the chemical composition of some horticultural varieties of *Dahlia variabilis*, has found that the petals and leaves of some of these plants contain aglycones, which have not hitherto been discovered in this species, namely, sulphuretin, 2′ : 4 : 4′-trihydroxychalkone, naringenin, eriodictyol, quercetin and kæmpferol.

H. Erdtman (Stockholm) outlined the comparative biochemistry of the genus *Pinus*. The following flavonoid constituents have been identified in extracts of the heartwoods of these species : chrysin, tectochrysin, 6-methylchrysin, 2 : 3-dihydrochrysin, 2 : 3-dihydrotectochrysin, pinobanksin, pinobanksin 7-methyl ether, strobopinin, cryptostrobin, and strobobanksin. Here the distribution of these substances shows a positive taxonomic interest. Botanists divide the genus *Pinus* into two parts, namely, diploxylon and haploxylon. In the diploxylon species, no flavones are encountered, only flavanones occur ; in the haploxylon species, however, flavones and flavanones exist simultaneously.

F. E. King (Nottingham) has isolated derivatives of the catechin group (3-hydroxyflavans) in the heartwoods of many species of *Afzelia*. He re-examined classical views concerning the structure of such derivatives and, in the light of present stereochemical theory, he concludes that the 'epi' series should have a 'cis' configuration. Melacacidin, another component isolated from the wood of *Acacia melanoxylon*, has been identified as 7 : 8 : 3′ : 4′-tetrahydroxyflavan-3 : 4-diol and must be considered as a typical leucoanthocyanidin.

H. Schmid (Zurich) dealt with the chemistry of non-benzopyronic lactones. He described their chemistry and physical properties in relation to molecular structure. Various methods of determining the nature of the heterocyclic ring (pentagonal or hexagonal), the number and positions of the double bonds, etc., were given. He reviewed some naturally occurring well-defined types, for example, protoanemonin, kawain, nepetalactone, etc.

W. Whalley (Liverpool) spoke about sclerotiorin and rotiorin, which are pigments obtained from several strains of *Penicillium scleroteorum*. They have the empirical formulæ $C_{21}H_{23}O_5Cl$ and $C_{21}H_{22}O_5$, respectively, and both contain the same branched C_9 ethylenic chain. They almost certainly possess an α-pyrone ring characterized by the fact that the heterocyclic oxygen can be replaced by —NH— with subsequent formation of the corresponding α-pyridone.

The structure of calophyllolide, a compound isolated from the nuts of *Calophyllum inophyllum*, was discussed by Mme. Polonsky (Paris). This has the empirical formula $C_{25}H_{22}O_5 \pm CH_2$. It is an αβ-unsaturated-γ-enol-lactone having one methoxyl group. With 40 per cent potassium hydroxide it gives 5-hydroxy-7-methoxy-4-phenylcoumarin ($C_{16}H_{12}O_4$), the structure of which was confirmed by comparison with an authentic sample.

A third series of reports were devoted to analytical work.

Mme. G. Aulin-Erdtman (Stockholm) described the Δε method and its possible application to the analysis of flavone and flavone derivatives. This method is based on the modification of the ultra-violet spectra caused by ionization or other convenient chemical reactions. The change in ε-values determined at various wave-lengths (λ) is represented graphically, giving a Δε curve. This curve is a characteristic of the chromophore, which can be modified and is independent of non-reactive chromophores. The method is sometimes better than ordinary ultra-violet examination in analysing complex natural extracts.

Finally, two papers dealing with the biological properties of oxygenated heterocyclics were presented.

F. Tayeau (Bordeaux) has shown that leucocyanidol, isolated from the teguments of the arachid nut, increases vascular resistance both in animals and in men. Moreover, it possesses anti-anaphylactic properties which might be explained by its inhibitory power towards hyaluronidase. It is fixed by seric proteins, more particularly by the globulin fraction. At a certain concentration it induces formation in serum of a precipitate containing all the lipids and only very small quantities of proteins.

H. Ferrando and J. Bost (Lyons) have studied the action *in situ* of several flavones on the intestines of rabbits. Ferguson has already shown that tricin (5 : 7 : 4′-trihydroxy-3 : 5-dimethoxyflavone) strongly inhibits contraction of this organ. Its 4′-methoxy derivative, on the contrary, reduces the effects of tricin.

It will be seen from the summaries that much current work in the field of oxygenated heterocyclics was presented at this colloquium. It is to be regretted, however, that a number of centres of research in the United States, Australia, Africa and Asia could not, owing to geographical considerations, send representatives to the colloquium.

ANIMAL SOUNDS IN THE SEA

During the Second World War the ocean waters were widely explored for the first time with sensitive listening devices. Submarine eavesdroppers heard sounds which they took to be from ships where there were no ships, and many mysterious 'beeps', 'groans', 'croaks', 'crackles', 'whistles' and 'moans' came to their earphones. It was suspected that these noises were the chatter of underwater animals, and, after the War, the U.S. Office of Naval Research launched a comprehensive study of sea-animal sounds. This study has been reported by Marie Poland Fish (*Sci. Amer.*, April 1956).

Scientific workers have listened with hydrophones and recorded on tape the sounds of hundreds of species of animals, from shrimps to porpoises. The articulate denizens of the sea 'speak' a confusing variety of dialects, but each is distinctive, and with experience it is possible to identify the kind of animal by its sounds, as one recognizes a familiar voice on the telephone. Listening to tropical fishes in the waters of the Caribbean, trained recorders can recognize them on approach before they come into view. Fishes and other sea animals have no vocal organs : they make sounds in diverse and intriguing ways which sometimes involve a large part of the anatomy.

One group produces sound by vibrating the walls of their balloon-like air bladder, the bladder acting like a sound-box or drum. The toadfish, for example, sets up vibrations of its bladder by means of muscle contractions, and the sound emitted ranges from a grunt to a 'fog-horn' boom. Experiments have shown that the sound originates in the air bladder. When the bladder was removed, the fish could produce no sound. But the air bladder alone, placed in a jar of sea water and stimulated by electricity, emitted grunts which were typically 'toadfish' to the ear.

A second class of sound-makers produce noises by scraping one body part against another; this is particularly common with the 'teeth-grinders'. The squirrelfish, for example, grinds together toothed areas in the back of its mouth, called gill teeth, and so generates a sound which is amplified by the adjacent air bladder and becomes a rasping grunt.

One of the most puzzling sounds which was encountered was that of the sculpins, a family of spiny sea fishes like the freshwater bullhead. These fishes issue a dull low-pitched drone which suggests the hum of an electric generator. The sculpin has no air bladder, and it was difficult to understand how the fish produced its sound. Examination of its anatomy and recent experiments suggest that the noise is made by rapid vibration of muscles attached to certain bones in its skeleton.

The most garrulous fish is the sea robin. Most fishes try to make a silent escape when something strange approaches. This is not the case with sea robins, which keep up a barrage of grunting and cackling—disturbed or undisturbed. A tame sea robin in an aquarium clucks softly when stroked, like a purring cat, but if handled too much will break away in seeming annoyance and emit a burst of noise. Other fishes appear to be noisy only when noise is called for. With the approach of a ship, fishes usually cease their chatter instantly.

Fish apparently make noises for a great variety of reasons. They use sound to communicate. Squirrelfishes, which are inclined to be nocturnal; eels and catfishes, which live in muddy, murky waters; croakers, which become most active after sunset—these and similar species must find sound useful for aggregating. Many fish become most loquacious during the spawning season.

Competition seems to be a common stimulus to sound. Sprinkling of food in a tank of sonic fishes incites a general noisy commotion.

Experiments have indicated that sea horses may use sound for orientation. During the first few days of captivity they make vigorous snapping noises, apparently associated with the strangeness of the new environment.

Of the more primitive forms of life, the shrimps make most noise. The combined popping of thousands of shrimps in their unseen beds makes a crackling chorus day and night. Experiments indicate that this noise accompanies the ejection of jets of water which the shrimps use for offence and defence.

In the case of marine mammals, the noises of whales and porpoises may be heard all over the oceans. The noises have been described as "propeller or screw noises", and clucking and squealing sounds covering the whole sound band and 'pings' suggestive of echo-ranging.

Learning sea sounds and languages has certain practical uses. Already the U.S. Navy has found the research helpful for predicting underwater sound conditions in strategic areas, for developing underwater acoustic gear and for training sonar operators. Commercial fishermen are using acoustic finders to locate schools of fish. They would like 'hearing aids' which could spot concentrations of food fish, identify them by their sounds and track their movements in bird-dog fashion. It may eventually be possible to use stationary, remotely controlled listening posts, comparable to sonar buoys, which will detect and broadcast the position of migratory fishes.

CHELATING AGENTS AS PLANT GROWTH SUBSTANCES

A POSSIBLE CLUE TO THE MODE OF ACTION OF AUXIN

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THE observation which gave rise to this work was made during an attempt to prevent the inhibiting effect of chromatographic paper on the growth of wheat coleoptile sections in the 'straight growth' test as modified by Hancock and Barlow[1]. It was found that acid-washed paper, treated with ethylenediaminetetra-acetate (EDTA) and washed, caused significantly more growth than occurred in the complete absence of paper. An experiment was therefore carried out without any paper, in which EDTA was given at concentrations of zero and 10^{-10} to 10^{-5} *M*, both with and without 10^{-5} *M* 3-indolylacetic acid (IAA). It was found that after 19 hours 10^{-5} *M* EDTA alone gave practically the same increment of growth compared with controls as did 10^{-5} *M* IAA alone, and even 10^{-10} *M* EDTA alone apparently caused some increase.

In this experiment the interaction between IAA and EDTA did not approach statistical significance ($P \simeq 0{\cdot}2$), consistent with the hypothesis that their effects were independent and additive.

Similar experiments were then carried out using seven chelating agents, of very various molecular structure, at concentrations of zero, 10^{-9} *M*, 10^{-7} *M* and 10^{-5} *M* in combination with zero and 10^{-5} *M* IAA. It was found that all the agents tried could act as growth substances, namely, EDTA, uramildiacetic acid (UDA), anthranilic acid diacetic acid (AADA), nitrilotriacetic acid (NTA), iminodiacetic acid (IDA), 8-hydroxyquinoline (8HQ) and sodium diethyldithiocarbamate (DIECA). It was found that although DIECA, a heavy metal enzyme inhibitor, could act as a growth-promoting substance, another such inhibitor, namely, potassium cyanide, which was not a chelating agent, depressed growth at the same concentrations. In this series of experiments no indications of interactions with IAA were found,

Table 1. Mean Length (cm.) of Wheat Coleoptile Sections, originally 1 cm., after 19 hours at 25° C. (1.12.55). Five Replicates, each of Five Coleoptiles

	EDTA:	0 *M*	10^{-10} *M*	10^{-9} *M*	10^{-8} *M*	10^{-7} *M*	10^{-6} *M*	10^{-5} *M*
IAA	0 *M*	1·81	1·91	1·91	1·93	1·95	2·02	2·05
	10^{-5} *M*	2·06	2·06	2·07	2·07	2·08	2·13	2·25
	Mean	1·94	1·99	1·99	2·00	2·02	2·08	2·15

Significant difference (P 0·05) for means of + and − IAA = 0·055

Table 2. MEAN LENGTH (cm.) OF WHEAT COLEOPTILE SECTIONS (ORIGINALLY 1 cm.) AFTER 24 HOURS GROWTH AT 25° C. THREE REPLICATES OF FIVE COLEOPTILES EACH THROUGHOUT

Date	Molar conc. of IAA	Agent	Molar concentration of agent 10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	Significant difference P 0·05	P 0·01
25.1.56	0	Nil	1·64		1·63		1·64		0·028	0·038
		NTA	**1·70**		**1·81**		**1·82**			
		IDA	**1·71**		**1·83**		**1·85**			
		AADA	**1·71**		**1·75**		**1·85**			
	10^{-5}	Nil	2·08		2·08		2·08			
		NTA	2·10		**2·16**		**2·23**			
		IDA	**2·12**		**2·15**		**2·18**			
		AADA	**2·11**		**2·17**		**2·20**			
11.2.56	0	Nil	1·81		1·79		1·79		0·028	0·037
		UDA	1·80		**1·85**		**1·89**			
		ααDP	1·80		1·80		**1·83**			
		γγDP	1·81		1·80		1·77			
	10^{-5}	Nil	2·02		2·02		2·03			
		UDA	2·04		**2·10**		**2·09**			
		ααDP	2·03		2·04		**2·06**			
		γγDP	2·00		2·00		**2·00**			
21.3.56	0	Nil			1·91	1·91	1·90	1·90	0·032	0·043
		ααDP			1·91	1·92	**1·94**	**1·94**		
		γγDP			**1·87**	**1·85**	**1·85**	**1·86**		
	10^{-5}	Nil			2·13	2·13	2·12	2·13		
		ααDP			2·12	2·14	**2·20**	**2·17**		
		γγDP			**2·09**	**2·06**	**2·03**	**2·03**		
19.2.56	0	Nil	1·72	1·75	1·75	1·74			0·029	0·039
		8HQ	**1·82**	**1·84**	**1·88**	**1·89**				
		2HQ	**1·75**	**1·71**	**1·71**	1·73				
	10^{-5}	Nil	2·06	2·06	2·08	2·07				
		8HQ	**2·10**	**2·10**	**2·15**	**2·12**				
		2HQ	2·08	2·07	2·06	2·06				
1.2.56	0	Nil	1·84	1·85	1·84	1·85			0·031	0·041
		DIECA	**1·89**	**1·97**	**1·92**	1·88				
		KCN	1·85	1·85	**1·74**	**1·73**				
	10^{-5}	Nil	1·98	1·98	1·98	1·98				
		DIECA	**2·05**	**2·04**	**2·09**	**2·05**				
		KCN	2·00	1·99	1·98	1·99				

Values in heavy type differ significantly from the corresponding control (nil). Key to agents: NTA = nitrilotriacetic acid; IDA = iododiacetic acid; AADA = anthranilic acid diacetic acid; UDA = uramildiacetic acid; ααDP = αα-dipyridyl; γγDP = γγ-dipyridyl; 8HQ = 8-hydroxyquinoline; 2HQ = 2-hydroxyquinoline; DIECA = sodium diethyldithiocarbamate; KCN = potassium cyanide

except for 8HQ and DIECA, which both tended to cause less growth at 10^{-5} *M* than at 10^{-7} *M* in the presence of IAA but not in its absence.

At the suggestion of Dr. W. R. Rees, of this Institute, a similar experiment was carried out using 8HQ and its two analogues α-naphthol and quinoline. The chelating agent 8HQ increased growth as before, while the non-chelating analogues depressed growth in all concentrations used, whether with or without IAA.

It seemed clear that the various chelating agents must act as growth substances by virtue of their chelating properties, and this raised the possibility that IAA might act in the same way. We consulted Dr. E. R. Roberts, of the Chemistry Department, Imperial College of Science and Technology, who kindly informed us that in his view the distance between the imino and carboxyl groups of IAA was suitable for chelation to occur with the formation of a seven-membered ring. Such chelate compounds would be most stable with heavy metal ions such as Cu^{++} or Co^{+++}. Even if true chelates were not formed by IAA, complex formation would certainly be expected.

Nearly all the above preliminary experiments have since been repeated using a revised technique for setting up the coleoptile sections in the treatments, which gives consistently a standard deviation for one 'replication' (the mean of five coleoptile sections) of about 0·02 cm. or 1 per cent of the mean length after 24 hours. This has very greatly improved the precision of treatment comparisons, and therefore numerical results from these later experiments only are presented in Table 2.

All the chelating agents significantly increased growth, both in the absence and presence of IAA. In only one case did a non-chelating analogue (just) significantly increase growth (2HQ at 10^{-9} *M* without IAA), and here the corresponding 'control' value was an unusually low one, being 'significantly' less than two other 'controls'; this may well have been a fortuitous difference therefore. In a number of cases the non-chelating analogues actually depressed growth, and this was again also true of potassium cyanide. It is not proposed to discuss the interactions with IAA at this juncture.

Before carrying out the experiments recorded in Table 2, it had seemed necessary to test the possibility that all the observed effects of chelating agents in our experiments (including perhaps even those of IAA) might be due to their removing harmful metal ions from the distilled water used. Distilled water from our usual source (a tinned boiler and 'Pyrex' glass condenser) was compared with water of very low ion content from a 'Biodeminrolit' mixed-bed ion-exchange resin column. Differences in growth between sections in the two samples of water were extremely small and entirely non-significant whether in the absence or presence of IAA and EDTA (10^{-5} *M*) alone or together. In this rather precise experiment a highly significant ($P < 0·001$) interaction of IAA and EDTA was found such that the combined stimulating effect was less than the sum of the effects of the agents acting separately (Table 3).

Table 3. MEAN LENGTH (cm.) OF WHEAT COLEOPTILE SECTIONS, ORIGINALLY 1 cm., AFTER 24 HOURS GROWTH AT 25° C. FIVE REPLICATES, EACH OF FIVE COLEOPTILES (18.1.56)

EDTA:		0 *M*	10^{-5} *M*
IAA	0 *M*	1·84	2·09
	10^{-5} *M*	2·11	2·24

Significant difference (P 0 05) = 0 02; (P 0·001) = 0 03

On the hypothesis that the two agents were acting in exactly the same way, an interaction in this sense would be expected if response tended to be linear with log concentration rather than with concentration itself. It should be noted, however, that the response to EDTA alone was just significantly less than that to IAA alone, although the difference in response was only 8 per cent.

Further experiments were designed explicitly to test the hypothesis that EDTA and IAA were identical in their action. The first two of these, with mixtures of the two agents in proportions 0 : 100, 25 : 75, 50 : 50, 75 : 25 and 100 : 0, at total concentrations of 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4} *M* and 10^{-8}, 10^{-7}, 10^{-6} *M* respectively, showed in all cases somewhat more growth after 24 hours with the higher proportions of IAA. It seemed possible that this might be due to slower penetration of the EDTA into the tissues, and in two further experiments growth-time studies were made. In these, mixtures in the proportions 0 : 100, 50 : 50 and 100 : 0 at a total concentration of 10^{-6} *M* were used; fresh samples of coleoptile sections were measured at 3, 6, 12, 24 and 48 (or 36) hours. At 48 hours, in the first of these experiments, signs of morbid changes were observed; the results of the second experiment, therefore, are presented in Fig. 1.

It will be seen that the curve for pure EDTA rose more slowly than that for pure IAA, consistent with the hypothesis of slower penetration, but that by 36 hours the total growth was almost exactly the same. The significance of the interaction between the two agents can be tested by that of the quadratic coefficient in the regression of length on proportion of IAA; a coefficient not significantly different from zero is consistent with identical internal action of the two agents and a linear (or additive) response to amount penetrated. This coefficient varies very significantly with time, and most interest is attached to the interaction at 36 hours when penetration by both agents was probably almost complete. Here the combined effect in the 50 : 50 mixture was to give less total growth ($P < 0{\cdot}001$) than in either of the pure solutions, thus disproving the hypothesis of identical internal action of the two agents. On the other occasions, the effects were apparently additive at 3, 12 and 24 hours; but at 6 hours the combined agents again gave less growth than the mean of that in the two pure solutions.

It should be noted that for every chelating agent tried the greatest coleoptile extension obtained at 24 hours with the agent alone was significantly less than with 10^{-5} *M* IAA alone (Table 2). In some cases, at least, this might well be due to slower penetration, as with EDTA.

The results so far discussed are all for coleoptile growth; but three experiments on root growth have been carried out, in which intact wheat seedlings were grown in solutions of EDTA and IAA alone and combined. The results for the second and third of these experiments are presented in Tables 4 and 5. The solutions were made up in distilled water, without nutrients, and changed every 3 days. After 8 or 9 days growth the total length of roots on each plant and its longest root were measured. The treatment means for total length only are presented, as the longest root data showed very similar effects.

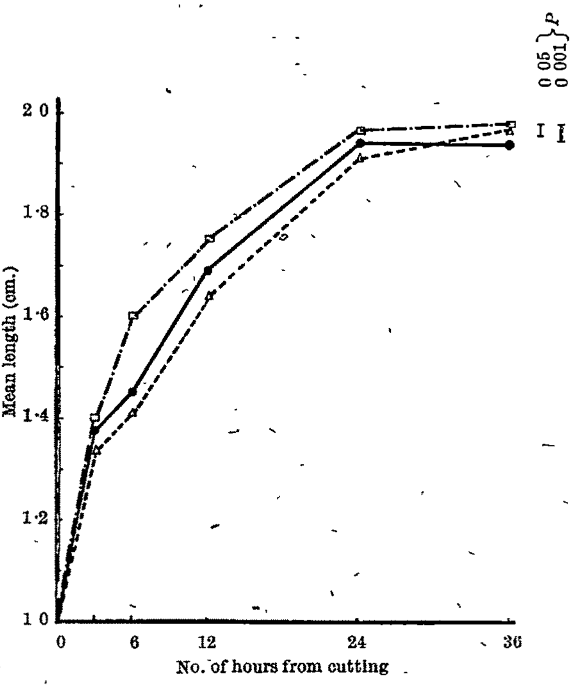

Fig. 1. ●—, 50 . 50 EDTA, IAA; □—·—, IAA only (10^{-6} *M*); △----, IAA only (10^{-6} *M*)

IAA or EDTA alone show essentially similar effects; in fact, the two agents give almost the same results throughout the experiments. There is, however, evidence of a most remarkable mutual antagonism; thus the inhibitory effect of a 10^{-5} *M* concentration of *either* agent is completely or almost completely removed by the presence of a 10^{-9} or 10^{-11} *M* concentration of the other (that is, at one-hundred-thousandth or one-millionth the concentration). The underlying mechanism of this extraordinary mutual antagonism is obscure, and it is not proposed to speculate about it here. Clearly, however, although the main conclusions would be unaltered by interchanging the names IAA and EDTA in the tables, the mode of operation of the two agents cannot be identical; for adding 10^{-11} *M* IAA to 10^{-5} *M* IAA could scarcely prevent inhibition. It must be remembered that in coleoptile growth we have

Table 4. TOTAL LENGTH OF ROOTS (cm. per plant) OF WHEAT SEEDLINGS AFTER EIGHT DAYS GROWTH. TWO REPLICATES, EACH OF THREE PLANTS (23.3.56)

EDTA:		0 *M*	10^{-11} *M*	10^{-9} *M*	10^{-7} *M*	10^{-5} *M*
IAA	0 *M*	*25·1*	*25·6*	*24·9*	*24·3*	12·5
	10^{-11} *M*	*26·1*	*27·3*	*24·6*	*25·8*	*24 1*
	10^{-9} *M*	*22 5*	*26·4*	*23·0*	*22·6*	*25 2*
	10^{-7} *M*	13 2	*24·4*	21·5	15 0	13 5
	10^{-5} *M*	12·1	*23·5*	20·4	12·7	10 9

Significant difference (P 0·05) = 2·64; (P 0·001) = 4·79
Values in *italics* do not differ significantly from that for water alone

Table 5. TOTAL LENGTH OF ROOTS (cm. per plant) OF WHEAT SEEDLINGS AFTER NINE DAYS GROWTH. TWO REPLICATES, EACH OF THREE PLANTS (21.4.56)

EDTA:		0 *M*	10^{-11} *M*	10^{-9} *M*	10^{-7} *M*	10^{-5} *M*
IAA	0 *M*	*24 9*	*26 0*	21 0	16·3	8 9
	10^{-11} *M*	*25·8*	*26·3*	*24·2*	22·5	22·5
	10^{-9} *M*	*24·7*	*25·2*	*24·8*	22·0	21·3
	10^{-7} *M*	16·8	21·6	*22·8*	20·2	15 4
	10^{-5} *M*	6·5	*23·8*	*23 0*	16·1	11·3

Significant difference (P 0·05) = 2 39; (P 0·001) = 4·32

Values in *italics* do not differ significantly from that for water alone been concerned with stimulation, but that here nhibition is the main effect; the slight stimulation at 10^{-11} *M* fails to reach significance even for the two agents together. It seems likely that the pathways of stimulation and inhibition may be entirely different, and thus quite different types of interaction between IAA and EDTA for coleoptile and root growth might be expected. Experiments on inhibition of coleoptile growth by supraoptimal concentrations would be of interest and it is hoped to undertake these shortly.

The first root-growth experiment, with a different variety of wheat, showed a similar type of mutual antagonism between EDTA and IAA, but here a concentration of 10^{-7} *M* of one agent was needed to remove the inhibition due to a 10^{-5} *M* concentration of the other.

During the course of this investigation, between the carrying out of the preliminary experiments and those with the revised technique, Prof. T. A. Bennet-Clark very kindly showed us the proof of his paper at the Wye Growth Substance Conference[2], in which he reports the finding that EDTA in concentrations from 10^{-5} *M* to 10^{-3} *M* can act as a growth promoter in the straight-growth test and suggests that the calcium metabolism of the cell wall is concerned.

All the biological evidence presented here would seem consistent with the hypothesis that IAA acts on growth in the same way as a chelating agent, either by forming true chelate compounds or complexes of some sort, although its mode of operation cannot be *identical* with that of EDTA in view of the peculiar interactions which occur between the two; as yet, however, we have obtained no experimental chemical evidence of such complex formation by IAA. If it in fact acts as a growth substance by virtue of complex-forming properties, there would seem to be three ways in which it might do so: first, it might act by removing metal ions which would otherwise restrict growth, as in the suggested effect of EDTA in removing calcium from pectate in the cell wall[2], though chelation of heavy metals would seem more probable; secondly, it might act as an enzyme inhibitor, either by removing metals needed as coenzymes or perhaps by 'covering up' metals in prosthetic groups. In this connexion it may be noted that Smith, Lumry and Polglase, cited by Martell and Calvin[3], found that IAA strongly inhibited the Mg-stimulated enzyme carboxypeptidase. Thirdly, work by Calvin[4] and Weller and Mills[5] has shown that a complex of an acetate and two quinoline molecules with copper can transfer hydrogen and thus function as a catalyst for the hydrogenation of suitable hydrogen acceptors—IAA might form complexes which could function in a similar manner. It will be noted that in the first two suggestions IAA would be inhibiting some aspect of metabolism; in the third, it would be itself contributing positively to metabolism. If IAA could function in two or all three of these ways, its extraordinary range of known effects on growth and development would be less surprising.

Synthetic auxins in general may also act through their complex-forming activities. Thus, for example, 2-4-dichlorophenoxyacetic acid is, in Dr. E. R. Roberts's opinion, more likely to form metal complexes than phenoxyacetic acid (which is inactive[6]). This would explain the very wide variety of compounds which are found active, including in the present work many which do not conform to the structural pattern generally postulated for auxins (for example, by Thimann[6]), and would also account for their similar but wide range of effects.

Further work, including experiments with various metallic ions, is in progress, and detailed publication will follow in due course.

We are grateful to Drs. W. R. Rees and J. Edelman, of this Institute, for helpful suggestions and discussions, in particular to the former for suggesting the experiments with analogues of 8-hydroxyquinoline; also to Dr. E. R. Roberts, of the Chemistry Department, Imperial College, for providing the theoretical evidence that indolylacetic acid is likely to act as a chelating or complex-forming agent.

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AN UNORTHODOX VIEW OF THE WEATHER

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FOR more than a generation the concept of the general circulation of the atmosphere has played a dominant part in the science of meteorology. It has helped explain many of the mysteries of weather phenomena and been responsible for great advances in this field of endeavour. The working tool of the forecasting meteorologist is the synoptic chart, which shows the pressure distribution over the surface of the Earth at any given time. Being based on measurements of barometric pressure at many points on the Earth's surface, the chart represents a very real physical situation. It gives vital information on the movement of air masses and has become the most important aid to forecasting the weather. It is especially useful for aircraft, which have the problem of moving around within those air masses. But it has its weaknesses, particularly on the question which is of most interest to the man in the street, namely, the forecast of whether it will rain to-morrow.

The method of preparing a forecast of rain from the chart has been variously described as 'a matter of intuition' or 'an empirical process which draws on past experience'. How is it that intuition and empiricism come into this important function and how can they be taken out? The forecaster has available to him a large number of physical measurements collected from a wide network of observing stations. Some of these, like the instability of the

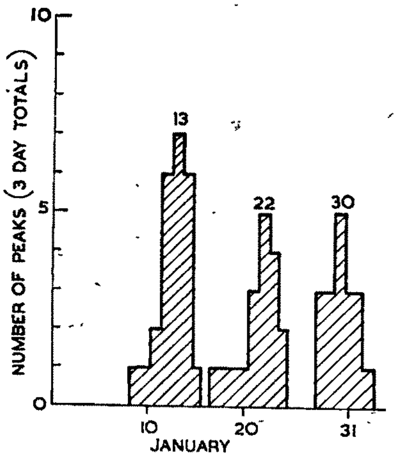

Fig 1. Histogram of the dates in January on which the concentration of freezing nuclei was observed to be high in the three years 1954, 1955 and 1956

atmosphere and the amount of moisture aloft, are closely related to whether clouds will form. But a measurement which has a direct physical connexion with the formation of rain is lacking.

It has been known for some time that such a measurement is possible; but its importance has not been fully appreciated. In the study of cloud physics, it is well established that the number and properties of the freezing nuclei present in the atmosphere determine whether rain will form in a supercooled cloud. Freezing nuclei, in this context, may be defined as particles on which ice crystals can grow from the vapour phase, or else materials which in solution in a water droplet or in contact with it will induce it to freeze. Measurement of the concentration of freezing nuclei and the temperature at which they become active is not easy; but if such measurements are made in aircraft or at sites which are free from the interfering effects of dust from terrestrial or industrial sources, several interesting facts emerge. It is found, for example, that while measurements of the concentration of freezing nuclei are consistent among themselves in one area or over a few hours at a time, changes of several hundred to one are possible from one day to the next. Many of the quantities used in meteorology, such as barometric pressure, vary at most by a few per cent and can only be linked with the formation of rain by what is admitted to be a subjective process. By contrast, the number of freezing nuclei in the atmosphere has a direct bearing on the formation of rain. It may vary by orders of magnitude from one day to the next; but the unfortunate forecaster is unaware that such a change has taken place. Could this be the reason why forecasts of rain sometimes go wrong? Could a sudden and unobserved increase in freezing nucleus concentration lead to the development of rain which did not appear likely from the synoptic chart?

Table 1. Dates of High Counts of Freezing Nuclei in January 1954–56

Year	Place	Date (January)		
1954	Sydney	12 14	22	31
1955	Sydney	13	23	29
	Hawaii	10	23	29
	Arizona	—	—	—
	Panama	13	18	31
1956	South Africa	13	—	29
	West Australia	13	22	Feb. 1
	Sydney	—	—	—
	San Francisco	13	21	—

For a proper assessment of the role of freezing nuclei, measurements are needed in many parts of the world. These are just beginning to be made on a routine basis, and they already point to a further intriguing possibility—that the sudden changes occur at almost identical times in different parts of the world. Smith, Kassander and Twomey[1] have reported measurements made in Sydney in January 1954 and again in Sydney, the Hawaiian Islands and Panama in January 1955, which showed there were sudden increases in the number of freezing nuclei on the dates given in the first part of Table 1. Similar measurements made in Arizona showed no significant variations. In January 1956 there were no increases in Sydney comparable in magnitude with those of previous years; but measurements in South Africa, Western Australia and the west coast of the United States showed marked increases on the dates shown in the latter part of Table 1. I am indebted to Dr. S. C. Mossop, of the National Physical Laboratory, Pretoria, Dr. E. K. Bigg, of the Radiophysics Laboratory, and Dr. R. N. Bracewell, of Stanford University, for permission to quote these results. The peaks do not always appear in all localities; but when they do occur, they are nearly simultaneous in widely separated parts of the globe. Furthermore, they seem to recur on approximately the same dates from year to year. A histogram giving the dates on which the freezing nucleus counts were high is given in Fig. 1, indicating that for the three years 1954,

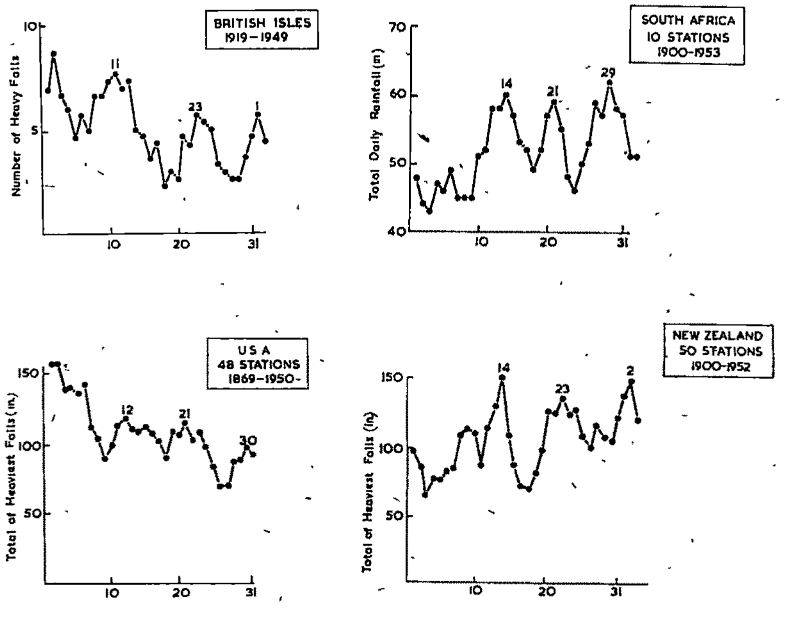

Fig. 2. The January rainfall of four countries in widely separated parts of the world

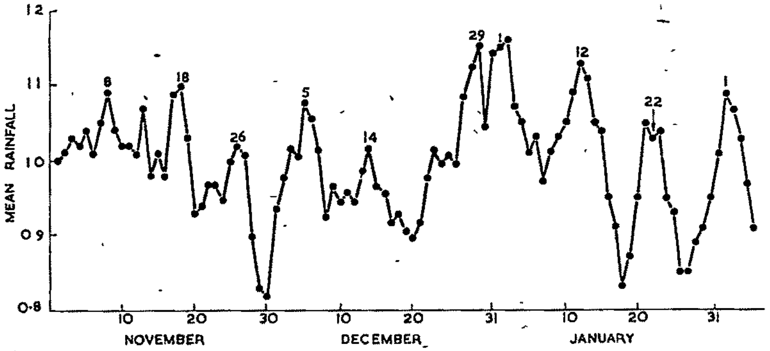

Fig 3. The mean rainfall of November, December and January for three hundred stations distributed over the globe

1955 and 1956 the maxima occurred on January 13, 22 and 30.

This behaviour is strikingly similar to that of the rainfall in many parts of the world. As reported in a recent publication[2], if the records of a large number of stations are examined, there appears to be a preference for heavy falls of rain to occur on certain dates. In Fig. 2 is given the number of falls of rain exceeding 2½ in. in 24 hours in January in the rain-gauge network of Great Britain for the period 1919–49. It shows distinct variations from one day to the next. In the remaining curves are corresponding observations for three other regions of the globe, namely, forty-eight stations in the United States, ten in South Africa and fifty in New Zealand. In each case the stations were chosen by officers of the respective weather bureaux to be representative of the whole country. There appears to be a remarkable agreement between them, in spite of the widely different climatic regimes which exist in these areas, and the fact that they refer to winter-time in one hemisphere and summer-time in the other. There are three rainfall peaks which appear within a few days of each other on all four curves and, furthermore, they are grouped around the dates January 13, 22 and 30, on which the concentration of freezing nuclei in the atmosphere has been observed to have high values.

The close relationship between the January rainfall of widely separated regions which is exhibited in Fig. 2 is not in accord with conventional meteorological ideas. As it is so difficult to explain the present effect on ordinary climatological grounds, let us look outside the immediate boundaries of meteorology for the explanation. The clues are clear-cut—the effect appears to be one which occurs almost simultaneously over the globe, which suggests an extra-terrestrial phenomenon; and it takes place on particular calendar dates, which suggests an association with meteor showers.

Table 2. Comparison of Dates of Meteor Streams and Rainfall Peaks

Date of rainfall peak	Meteor stream	Date	Time difference (days)
Nov. 8	Giacobinids	Oct. 9	30
18	Orionids	Oct 20–23	29
26	Not known with certainty		—
Dec. 5	Taurids	Nov. 3–10	32
14	Leonids	Nov. 16	28
29	Bielids I	Nov. 27→15	—
Jan. 1	Bielids II	Dec. 2	30
12	Geminids	Dec. 13	30
22	Ursids	Dec. 22	31
Feb. 1	Quadrantids	Jan. 3	29

Relation to meteor showers. The Earth in its orbit is known to pass through streams of dust which exist in vast elliptical orbits around the Sun. The dust includes a wide range of particle sizes. The large ones burn up on entering the atmosphere and appear as visible meteors; the smaller particles do not have enough energy to be consumed and fall slowly into the lower atmosphere. Svestka[3] has shown that meteoritic dust takes between thirty and forty days to fall from the top of the atmosphere to the troposphere. It may be significant that there are three prominent meteor showers about thirty days before the rainfall peaks, namely, the Geminids of December 13, the Ursids of December 22 and the Quadrantids of January 3.

It appears, therefore, that the rainfall peaks might occur about a month after the meteor showers. This possibility can be tested in an elementary way by examining the rainfall of a somewhat longer period than that given in Fig. 2. In Fig. 3 is a curve of the mean rainfall for the three months November, December and January for a period of about sixty years. The curve is for approximately three hundred stations distributed over the globe, and includes those already referred to in the United States, Great Britain, South Africa and New Zealand, together with fifty stations from Australia, thirty-two from Japan and five from the Netherlands. The dates of ten of the most prominent peaks are listed in the first column of Table 2, together with a list of the meteor showers which appear to correspond. The only rainfall peak which is not associated with a well-known meteor shower is that of November 26; nevertheless, Ellyett and Roth[4] have reported previously unsuspected meteor activity in the southern hemisphere approximately a month before this date. In the interests of brevity, the results in this table are only given in the barest outline, and a full treatment is in course of publication in the meteorological literature.

In the final column of Table 2 is the difference in time between the meteor showers and rainfall peaks, and it is seen to have a mean value of 30 days, with greatest departures from this value of ± 2 days. The hypothesis has therefore been advanced that dust from meteor streams falls into the cloud systems of the lower atmosphere, nucleates them and causes exceptionally heavy falls of rain thirty days after the dust first entered the atmosphere.

There are several aspects of this hypothesis which are difficult to accept, and many questions arise. Why should meteoritic dust be so active as a nucleating agent? Why does the time of fall appear to be so consistent from one shower to the next? And why is the effect on rainfall confined to such a few days? As yet these are without answer; but there is already enough evidence about the reality of the effect to call for a thorough investigation of the physics of the phenomenon and a careful assessment of its impact on the day-to-day problems of meteorology.

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LETTERS TO THE EDITORS

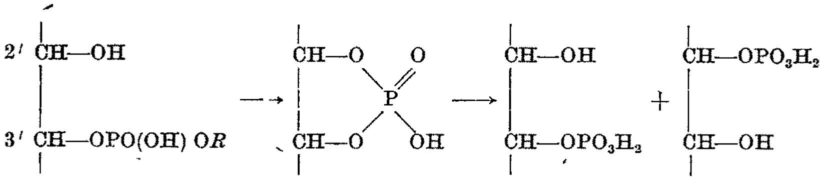
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Hydrolysis of Esters of Monoribonucleotides

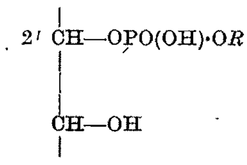
CONSIDERABLE attention has been paid in recent years to the hydrolysis of ribonucleic acids to mononucleotides. It was shown[1,2] that alkyl esters of the 2′- and 3′-monoribonucleotides (partial formula I ; R = alkyl) provided simple model substances which could be used for a more precise study of the mechanism of hydrolysis. The overall process, effected by acid or by alkali, results in a conversion of (I) to a mixture of (III) and (IV). Both procedures involve the unstable cyclic ester intermediate (II), which is then hydrolysed to the isomeric mononucleotides (III) and (V). Since the conversion of (I) → (II) is formally a trans-esterification[3], it seemed possible that the analogous process (I) → (V), that is, migration of the alkyl phosphate residue without loss of R, might also occur simultaneously.

When cytidine-3′ benzyl phosphate (I ; $R = CH_2.C_6H_5$) is partially hydrolysed by 0·5 N sodium hydroxide solution, the ester recovered can be shown by ion-exchange chromatography to contain none of the corresponding 2′-ester (V). Other experiments show that no observable conversion of a 2′-methyl ester (V ; R = Me) to the 3′-ester (I) occurs under similar conditions. Thus under alkaline hydrolytic conditions, no migration of the alkyl phosphate group occurs. This result appears to imply that the step (I) → (II) involves a transition state which may be represented by (VI), and not a discrete molecule such as (VII) analogous to that involved in the alkaline hydrolysis of carboxylic esters[4].

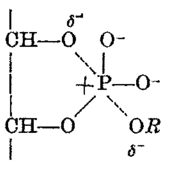
After partial acid hydrolysis, however, analysis of the remaining ester reveals that migration of the alkyl phosphate group occurs to a significant extent. Thus when hydrolysis of (I ; $R = CH_2Ph$) is carried to 53 per cent of completion; (V) accounts for 25 per cent of the remaining ester. Of direct significance for ribonucleic acid chemistry is the finding that the dinucleoside phosphate adenosine-2′ uridine-5 phosphate[5] (V ; R = uridine-5′ residue) yields a proportion of the rearranged product adenosine-3′ uridine-5′ phosphate. Qualitative observations on the rate of hydrolysis indicate that the reaction is catalysed by acid. The results are accommodated if protonated species derived from intermediates of type (VIII) or (IX) are postulated, the latter arising directly or *via* (VIII). These could then lead by P—O fission either to (I), (II) or rearranged ester (V). The mechanism of the rearrangement (I) → (V) is presumably essentially similar to that of the acid-catalysed migration of phosphate in the mononucleotides (III) and (IV).



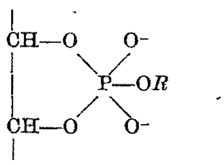
(I) (II) (III) (IV)



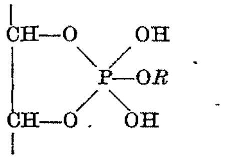
(V)



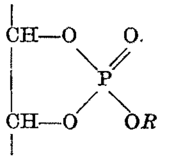
(VI)



(VII)



(VIII)



(IX)

Baer and Kates[6] have suggested a similar migration during the acid hydrolysis of α-glycerophosphorylcholine and -ethanolamine to account for optical rotation changes. They, and Long and Maguire[7], also conclude that alkylphosphoryl migration occurs during alkaline hydrolysis ; but the present observations appear to invalidate this.

It is intended to discuss our experiments in more detail elsewhere in relation to other work on phosphate ester hydrolysis. The purpose of the present communication is to indicate their relevance to ribonucleic acid hydrolysis. Partial acid hydrolysis has been used for preparing a variety of oligonucleotides[8]. The internucleotidic linkage in ribonucleic acids is at present considered to involve a phosphodiester bridge exclusively between the 3′- and 5′-positions in adjacent ribonucleoside residues[2]. On the above evidence, however, partial acid hydrolysis of such a structure must be expected to give rise to oligonucleotides, a proportion of which will have a 2′ : 5′-internucleotidic linkage. The isolation of such a substance will, in itself, afford no evidence for a 2′ : 5′-linkage in the ribonucleic acid structure. Furthermore, present enzymic methods for polynucleotide structure analysis, if applied without realization of the possibility of isomerization of the internucleotidic linkage, may lead to erroneous conclusions. This follows from the fact that the nuclease-type enzymes (for example, ribonuclease) have differing specificities for purine and pyrimidine nucleoside sites in the molecule, but all those studied have shown a specific requirement for a 3′ : 5′-internucleotidic linkage[9]. The validity of the use of such nucleases for sequence determination in oligonucleotides rests on the assumption that the 3′ : 5′-internucleotide linkage is preserved unchanged during the hydrolysis of the nucleic acid ; it loses its validity if a change from 3′ : 5′- to 2′ : 5′- can occur. Such methods should be supplemented by the known hemical degradation, which can distinguish between $3' : 5'$- and $2' : 5'$-phosphodiester linkage[10].

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Ionophoresis of Oligosaccharides as N-Benzylglycosylammonium Ions

Filter-paper ionophoresis is now being widely used for separations of mixtures of neutral sugars, which are converted into charged molecules by the formation of borate complexes[1]. This excellent method provides a far more rapid separation of isomeric components which possess appropriate structural differences than does filter-paper chromatography; and at the same time, deductions can be made about the probable structure of an unknown sugar from its rate of migration. It does, however, suffer from a disadvantage when compared with filter-paper chromatography, inasmuch as it does not give any indication of the molecular size of an unknown oligosaccharide. We now report a different method of filter-paper ionophoresis which readily yields this information; it is to be regarded as complementary to the borate process. When both methods are used in conjunction, much information about a new product can be gained very rapidly.

This alternative method of ionophoresis is a development of the technique of filter-paper chromatography in which reducing sugars are converted on the paper into N-benzylglycosylamines[2]; in this case a charge is afterwards placed on the nitrogenous derivative by using a strongly acid solution as the medium during electrolysis. In the general method the reducing sugar is spotted on to a strip of Whatman No. 3 filter-paper, and a spot of a solution of benzylamine (1 c.c.) in methanol (9 c.c.) and 10 *N* formic acid (5 c.c.) is superimposed. The paper is heated at 95° for 5 min. and then subjected to ionophoresis at 600 V./55 cm. for 6 hr. in an electrolyte (*p*H 1·8) composed of a mixture of 5 per cent aqueous sodium hydroxide (600 c.c.) and 90 per cent formic acid (400 c.c.). The paper is dried to remove all formic acid, and the spots are detected with alkaline silver nitrate[3] or periodate[4]. The mobility is expressed as the ratio between the distance which separates the N-benzylglycosylammonium ion from the unchanged sugar and the distance which separates the N-benzylglucosylammonium ion from unchanged glucose. It is quite convenient to measure these distances because the reaction between the sugar and the benzylamine is not complete (cf. ref. 2). Typical results are given in Table 1.

Table 1

Sugar	Mobility*
Pentose	1·09–1 15
Hexose	1 00
Heptose	0 91
Hexose disaccharide	0 71–0·78
Hexose trisaccharide	0·59–0 63
Hexose tetrasaccharide	0 49–0·51
Hexose pentasaccharide	0·42
Hexose hexasaccharide	0·33

* Defined in text

It will be seen that the mobility bears an inverse relationship to the molecular weight of the ion; to the first approximation, it is independent of the stereochemistry of the sugar and also of the positions of the linkages in a higher saccharide. Full details of this work, including the experiments which led to the development of the general method and studies with amines other than benzylamine, will be reported later. The work was supported by a grant from the Nuffield Foundation.

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Ion-Exchange Preparation of Low-Silica Hydroxide Solutions for Colorimetric Determinations of Total Silica

Attempts to determine small concentrations of total silica colorimetrically by applying the method of Straub and Grabowski[1], following solubilization of the silica by boiling with hydroxide, have been frustrated by the interference of the silica present in either the sodium or potassium hydroxide used as the solubilizing agent. In studying this problem, the possibility of preparing a hydroxide solution by passing a salt solution through the hydroxide-form of a quaternary-base ion-exchange resin was investigated. The fact that complete conversion from the salt to the hydroxide is not required for the analytical method is a recommendation of this approach; a salt solution more concentrated than is normally amenable to ion-exchange treatment may be used as the starting material in order to produce a moderately concentrated hydroxide solution.

A quaternary ammonium-type anion-exchange resin ('Amberlite *IRA*-400') was used in the preparation of the caustic solutions. A small column of the resin was prepared in a 1- or 2-in. diameter polyethylene pipe. The resin was converted to the hydroxide-form by treating it with six volumes/volume resin of 4 per cent sodium bicarbonate solution followed by six volumes/volume resin of 4 per cent sodium hydroxide solution both at a rate of 0·15 ml./ml. of resin/min. The column of resin was then rinsed to a *p*H of 9·5 with deionized water.

Solutions of *N* potassium chloride and of *N* potassium sulphate have been used as starting materials for the preparation of caustic solutions. The potassium salts were selected in preference to the corresponding sodium salts because they contained smaller amounts of silica. The salt solutions were passed through the resin at the rate of 0·15 volume/volume resin/min. A total of one volume of salt solution per volume of resin was treated in each cycle. Regeneration of the column between cycles was carried out with sodium bicarbonate and sodium hydroxide by the same method as the original regeneration. In each cycle the hydroxide effluent was collected in five equal fractions and analysed for silica content and for their hydroxide content. Typical results are given in Table 1.

Table 1. CHARACTERISTICS OF HYDROXIDE SOLUTIONS PREPARED VIA ION EXCHANGE

Cycle	1	2	3	4
Column size	2 in.*	2 in.†	2 in.	2 in.
Influent	1 *N* pot. chloride	1 *N* pot. chloride	1 *N* pot. sulphate	1 *N* pot. sulphate
N Hydroxide				
Cut 1	—	0·369	—	0·413
Cut 2	—	0·501	—	0·505
Cut 3	0·106	0·501	—	0·455
Cut 4	0·311	0·437	—	0·405
Cut 5	0·451	0·379	—	0·343
p.p.m. Silica				
Cut 1	5	—	0·78	0·20
Cut 2	5	2·2	0·67	0·12
Cut 3	5	2·0	0·31	0·11
Cut 4	5	—	0·29	0·10
Cut 5	5	—	0·24	0·10

* Glass column.
† Only sodium hydroxide used as regenerant.

It may be seen that the quality of the effluent hydroxide increases with increasing number of regeneration cycles. The solution prepared in cycle 4, when used for solubilizing silica at a ratio of 1 ml./50 ml. of water sample, contributes only 0·002 p.p.m. to the final solution being analysed. This is below the present limits of detection of silica by colorimetric methods.

The above procedure is now being employed in a study of the concentration of soluble and total silica in ion-exchange resin deionization systems, and the results of this study will be submitted for publication in the near future.

SALLIE FISHER
ROBERT KUNIN

Rohm and Haas Co.,
Philadelphia, Penn. Jan. 11.

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Use of the Orcinol - Sulphuric Acid Reaction in the Positive Identification of Certain Monosaccharides from a Salivary Mucoid

AN approximate identification of sugars separated from hydrolysates of biological material can usually be made by paper chromatography. Positive identification is usually achieved by the measurement of some specific physical property such as optical rotation, or the preparation of derivatives possessing characteristic melting points. It frequently happens that sugars separated from hydrolysates are present in insufficient amounts to enable such methods of identification to be used.

The modified orcinol – sulphuric acid reaction described by Bruckner[1] is eminently suitable for the identification of small amounts of various hexose which give characteristic absorption spectra readil distinguishable from one another. The differen aldopentoses exhibit the same absorption curv which, however, is different from those of th individual hexoses. As little as 0·1 mgm. of th sugar is necessary to obtain a satisfactory absorptio curve.

In the course of our investigations into the composition of mucoids occurring in human saliva, fraction was obtained which was thought to b identical with the 'blood group A substance' describe by Aminoff, Morgan and Watkins[2]. Less tha 100 mgm. of the substance was hydrolysed by refluxing with water in the presence of 1 gm. of 'Amberlit *IR*120' ion-exchange resin at 100° C. for 16 hr. Th resin was filtered off and washed with water. Th combined filtrate and washings were evaporated t dryness *in vacuo* and the residue taken up in 2 ml of water.

One-dimensional chromatograms were run o Whatman No. 1 paper in methyl ethyl ketone/aceti acid/water (6 : 1 : 1), a very rapidly running solvent introduced in this laboratory (Leaver, A. G., an Irwin, M., unpublished work). Two of these gave R_F values approximating to those found for galactose and fucose. When the hydrolysate was again run with spots of these two sugars run adjacently, the tentative identification was confirmed.

The total hydrolysate was applied to three wider strips of the very thick paper Whatman No. 3 *MM*, application being in the 'ribbon' form across the width of each paper. Development was continued for 18 hr., after which the chromatograms were dried, narrow strips cut from each edge and sprayed with aniline hydrogen phthalate. The areas corresponding to the two principal bands obtained were cut out of the main strips and eluted with distilled water. The two eluates were evaporated to dryness *in vacuo*, the solids being weighed and taken up in distilled water to give a concentration of 0·1 mgm. per ml. Both solutions were then treated with orcinol and sulphuric acid, according to the method of Bruckner[1], absorption curves being measured on the 'Unicam' S.P.600 spectrophotometer. The first solution gave the typical absorption curve for galactose, whereas the latter exhibited the highly characteristic spectrum of fucose, which shows maxima at 390 mμ and 500 mμ and is totally different from all other spectra examined (Bruckner, private communication).

Thus galactose and fucose were identified as neutral sugars present in the hydrolysate of the salivary mucoid. It is of interest that Aminoff, Morgan and Watkins[2] found these two sugars in hydrolysates of human 'blood group A substance'.

Use of the orcinol – sulphuric acid reaction for the positive identification of monosaccharides affords a rapid and simple way of making definite confirmation of results obtained by paper chromatography.

We are indebted to Dr. J. Bruckner for his valuable assistance and for making available the unpublished absorption curve for fucose.

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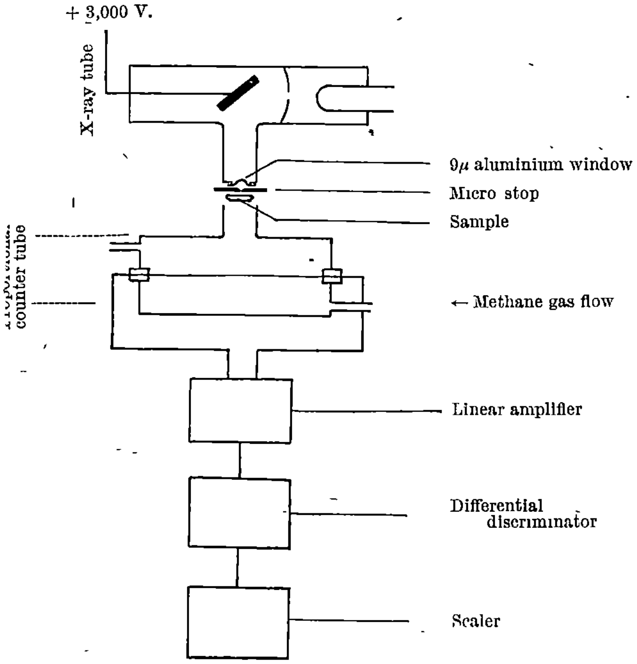
X-Ray Mass Determination in Cells by Scanning

In 1949–50 Engström and Lindstrom published a ethod for determining the cell mass by means of sorption measurements in soft X-radiation. In e wave-length range 6–12 A., the absorption of e X-radiation is proportional to the mass of carbon, trogen and oxygen substances. The cells are photo-aphed together with a reference system in which e absorption – wave-length relationship is the me. The photographic emulsion and process are the ain limit to accuracy and resolving power.

The photographic process can be evaded by anning the section of the cell with a very thin pencil f X-rays, and then measuring the transmission irect. The possibilities of obtaining a measurable nount of X-radiation through a small stop of 1·8μ as first been examined. The wave-lengths must be ithin the limits 6–12 A., and to prevent getting too eat a geometrical unsharpness the pencil of rays ust be almost parallel.

A sealed-off X-ray tube has been constructed hich has a thin window through which the rays ass. The window is of aluminium foil 9μ thick, hich at the same time serves as a filter. The diameter f the focus is 1·5 mm. and the focus-window distance 70 mm. The anode voltage is 3 kV. and the anode urrent 1 m.amp. A gold micro-stop is placed nmediately in front of the window. The rays pass hrough the stop and enter a windowless proportional ounter through which methane is flowing.

The possibility of obtaining measurable quantities f rays through the micro-stop is a problem of ntensity; but it is further complicated by the atural radiation giving a background, the irregular ariations of which can be expected to be greater han the radiation passing through the micro-stop. his problem has been solved in the following way. he height of impulses from the proportional tube epends on the energy of the radiation. The soft, ow-energy radiation which is used here gives very much smaller impulses than the high-energy natural radiation. The high impulses are blocked in a differential discriminator, and only impulses below a certain height reach the impulse counter. Consequently, the disturbing background becomes insignificant. By using this form of X-ray tube and these conditions of operation (Fig. 1), a micro-stop with a diameter of 1·3μ resulted in a mean of 145 impulses/min. being obtained; the background was found to be 15 impulses/min. Quite measurable quantities were thus passing the stop.



Proportional tubes in connexion with the differential discriminator, however, give still another possibility. Impulses below a certain level can also be excluded, and thus only impulses between two levels will be counted. If these levels are set close to each other, it will be possible to measure within a very narrow range of wave-lengths. This means that absorption measurements in cells of various substances can be carried out at their maximum absorption. Further quantitative examination of the chemical components in the cells should thus be possible.

Preliminary investigations have shown that mass determination in cells is possible by scanning with X-rays. Further investigations will be published later on.

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Some New Stereochemical Arrangements of Divalent Palladium and Platinum

The usual stereochemistry of divalent palladium and platinum is that of a square-planar arrangement, associated with $(n-1)dnsnp^2$ bonding. A number of structures of this type have been reported[1]. The stereochemistry of square complexes has been discussed in considerable detail by Mellor[2]. With the exception of a few compounds such as the pyrromethene[3] and triaminotrimethylamine[4] complexes, where the bonds must be forced out of a plane, the four bonds to a bivalent platinum atom are invariably planar.

A few compounds have been reported in which the divalent platinum atom has been said to be six-covalent. For example, *bis*-(acetonitrile) tetrammine platinous chloride, $[Pt(NH_3)_4(CH_3CN)_2]Cl_2$, has been prepared in what are claimed to be *cis*- and *trans*-forms[5]. An octahedral arrangement has also been suggested for the *bis*(α,β,γ-triaminopropane) platinous ion[6]. The evidence for the proposed octahedral arrangements is, however, purely chemical.

While investigating recently the complexes of the chelate group *o*-phenylene*bis*(dimethylarsine) (denoted by diarsine) the reaction

$$[M(\text{diarsine})_2]^{++} + X^- \rightarrow [M(\text{diarsine})_2X]^+$$

where X = Cl, Br and I, and M = Pd and Ni, was observed to occur in non-aqueous ionizing solvents such as nitrobenzene, and complexes of the general formula $[M(\text{diarsine})_2X]^+ClO_4^-$ (M = Pd and Ni) have been isolated from acetone solutions[7]. These metals apparently exist as five-covalent ions $[M(\text{diarsine})_2X]^+$ in nitrobenzene solution[7], for the perchlorates function as uni-univalent electrolytes in this solvent. It is to be expected that compounds of the type $[M(\text{diarsine})_2X]^+\text{ClO}_4$ would involve a five-covalent metal ion in the solid state. Special interest is attached to the structure of the series $M(\text{diarsine})_2\text{I}_2$, where $M = \text{Ni}^{\text{II}}$, Pd^{II} and Pt^{II}. These iodides also behave as uni-univalent electrolytes in nitrobenzene solution, presumably forming the ions $[M(\text{diarsine})_2\text{I}]^+$ and I^-, bearing in mind that a molecule of the solvent may be co-ordinated to the cation, thus making the metal six-covalent. The structure of these di-iodides has now been investigated to determine if five- or six-covalency occurs in the solid state.

Single crystals, from nitrobenzene, of the above platinum and palladium compounds have been examined in detail using the Buerger precession camera and molybdenum $K\alpha_{1,2}$ radiation. Apart from small visual variations in spot intensities, the reciprocal lattice nets are identical. The space group is $P2_1/c$ and the unit cell has the dimensions: $a = 9 \cdot 68$ A.; $b = 9 \cdot 27$ A.; $c = 17 \cdot 27$ A.; $\beta = 114° 30'$. It contains two molecules, which must therefore be at centres of symmetry. A satisfactory trial model was obtained using $h0l$ and $0kl$ Patterson maps, and the isomorphous replacement method, using the nickel, platinum and palladium complexes, agreed with these results. The refinement of atomic co-ordinates has proceeded using successive $\{|F(\text{obs.})| - |F(\text{calc.})|\}$ difference syntheses computed along the a- and b-axes. The reliability indexes

$$R = \frac{\Sigma\{|F(\text{obs.})| - |F(\text{calc.})|\}}{\Sigma|F(\text{obs.})|}$$ at present have

the values $R(h0l) = 0 \cdot 13$ and $R(0kl) = 0 \cdot 14$. These values of R include contributions from carbon atoms as well as the heavy palladium, arsenic and iodine atoms. The light carbon atoms showed up quite well despite the presence of the heavier metal and arsenic atoms.

The structure consists of discrete molecules of $M(\text{diarsine})_2\text{I}_2$. The central atom is surrounded by four arsenic atoms in a square plane and at distances of approximately $2 \cdot 38$ A. The two iodine atoms complete a distorted octahedral arrangement with elongated metal iodine bonds of $3 \cdot 52$ A. The calculated Pd—I bond distance in square palladium complexes is only $2 \cdot 65$ A. These preliminary results are in complete accord with bond-lengths expected from the crystal (ligand) field theory. The palladium (II) atom in an octahedral $\text{Pd}(\text{diarsine})_2\text{I}_2$ molecule has eight non-bonding $4d$ electrons. Six of these form a symmetrical closed sub-shell of d_ε orbitals, whereas the remaining two are almost certainly in a $4d_{z^2}$ orbital. The vacant $4d_{(x^2-y^2)}$ orbital points in the direction of the four arsenic atoms and, together with a $5s$ and two $5p$ orbitals, forms four square $4d_{(x^2-y^2)}5s5p^2$ bonds. Pointing along the axis of the two Pd—I bonds is the filled $4d_{z^2}$ orbital, which must exert a strong repulsion upon the two iodine atoms, leading to a considerable increase in bond-lengths. The two iodine atoms might be conveniently regarded as bound by linear hybrid $5p5d$ bonds—an interpretation in accord with the length of the bonds, with ligand field-theory, and with their covalent character.

Compounds of the formula $[M(\text{diarsine})_2X]\text{ClO}_4$, where $M = \text{Pd}, \text{Ni}$, and $X = \text{I}, \text{Cl}$, also form an isomorphous series. The unit cells are body-centred tetragonal and have the dimensions $a = 13 \cdot 33$ A.; $c = 32 \cdot 44$ A. There are eight molecules per cell. The space group is probably $I4_1$. Systematic absences occur when $h + k + l = 2n + 1$ and $001 \neq 4n$.

The structures of these compounds are at presen being examined with the view of determining the presence or otherwise of an asymmetrical five covalent ion in these non-centric cells. A more detailed account of these investigations will b reported in due course.

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Cation-Exchange Properties of Zirconium (IV) – Tungsten (VI) Precipitates

IN an investigation of adsorptive properties o inorganic materials, precipitates of tungstate brough down by addition of zirconium (IV) solutions wer found to have cation-exchange properties. Th adsorbent may be prepared by mixing a solution of zirconium oxychloride with a large excess o sodium tungstate solution (adjusted to pH c. 1· with hydrochloric acid). The precipitate (mole ratio tungsten/zirconium of about 3/1) is dried at 25 without washing, ground and screened. The conditions of preparation are not critical, so long as the acidity is not too high. Drying the precipitates for 24 hr. at temperatures above 80° C. sharply decreases both uptake of cations and the values o distribution coefficients D (amount adsorbed per kgm. adsorber/amount per litre of solution); at 150° C. the exchange properties of the solid are essentially destroyed.

Although cations in general can apparently be adsorbed on and eluted from the materials in characteristic cation-exchange manner, most work so far has concerned the alkali metals. For these, adsorption is rapid and reversible, essential equilibrium being attained in a matter of minutes. Under some conditions, at least, the materials show essentially idea ion-exchange behaviour. Thus, in adsorption o tracer cæsium from ammonium chloride solutions, a plot of log D versus log M ammonium chloride gave a straight line of slope minus one in the range studied ($0 \cdot 1$–1 M ammonium chloride). Apparent capacities are relatively high ($0 \cdot 5$ mole cæsium uptake per kgm from $0 \cdot 1$ M cæsium chloride) and selectivities appear good. Thus, distribution coefficients D for cæsium and rubidium were 65 and 21 respectively, in $0 \cdot 1$ M ammonium chloride, and similarly large ratios of D were found for the other alkali metals.

These results suggested that the materials could be used for separations with small columns. As an example, separation of the elements sodium to cæsium on material dried at room temperature is given in Fig. 1; conditions are summarized in the figure.

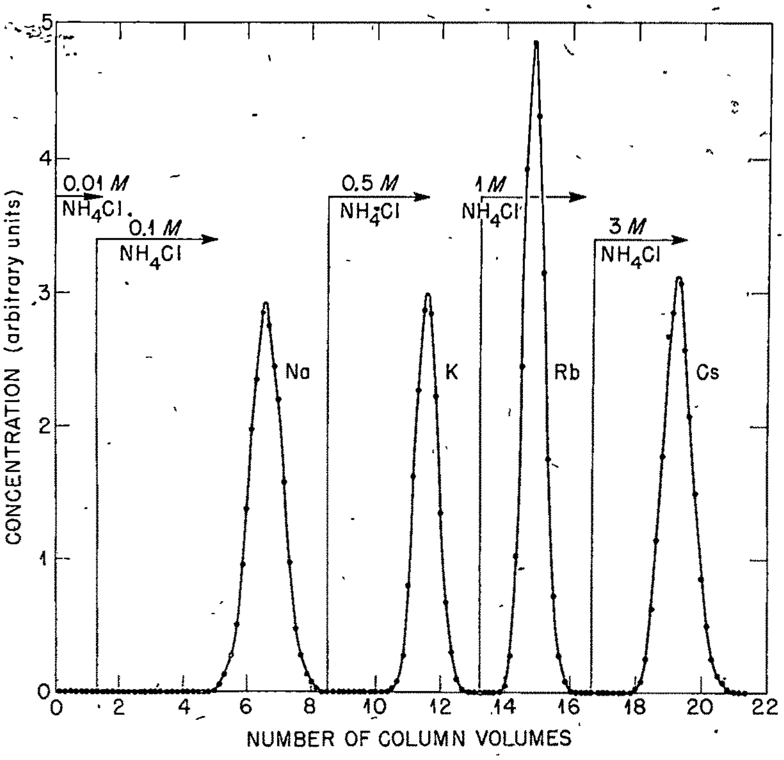

Fig. 1. Zirconium tungstate, 25° C.; column, 11·3 cm. × 0·13 cm.^{2}; flow-rate, 1 cm./min.

While Fig. 1 represents separations of alkali metal tracers, similar separations can be achieved at macro concentrations.

This work was carried out for the U.S. Atomic Energy Commission at the Oak Ridge National Laboratory.

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Composition of Egg Phospholipids

THE fatty-acid composition of egg lecithin prepared by the cadmium chloride method has been determined by Riemenschneider *et al.*[1] and of total egg phospholipids by Shorland[2]. Their results agree in finding about 30 per cent of C_{16}, 55 per cent of C_{18} and 15 per cent of C_{20} and C_{22} acids; approximately 39 and 45 per cent, respectively, of the total acids were saturated.

It has been known for some years that the fatty acids split off from lecithin by the phospholipase *A* of snake venom are unsaturated, and more recently it has been proved that the enzyme removes these acids from the α′-position. Hanahan[3] has further shown that the fatty acids of the liver lecithins from various animals are not distributed at random between the two positions available, but that the α′-position is occupied by unsaturated acids only and the β-position exclusively by saturated. The same structure was found in egg lecithin (prepared by an alumina column method), where, moreover, the constituent acids were found to be entirely C_{18}[4]. This permitted the preparation of pure L-α-distearoyl lecithin by the hydrogenation of the natural material and then, by hydrolysis with lecithinase *A* or *C*, of pure L-α-monostearoyl lecithin[4] and of αβ-distearin[5].

Our work, however, suggests that the composition of egg lecithin is appreciably more complicated than that found by Hanahan for his alumina-column preparations.

In the first place, lysolecithins were prepared either by the action of snake venom on egg yolk followed by separation of the resulting lysophospholipids on a silica column, or by hydrolysis with venom of lecithins prepared on a silica column. In both cases they were found to possess a residual unsaturation of about 0·15 double bond per molecule, indicating the presence of a small proportion of lecithins containing two unsaturated residues in the molecule. This is in agreement with a failure to find more than 45 per cent of saturated acids in the total acids of egg lecithin.

Secondly, the fatty-acids recovered from lysolecithin (which had been prepared by the action of venom on the intact yolk and represented 90 per cent of the original lecithin) have been examined, after hydrogenation, by partition chromatography according to Nijkamp[6] and found to consist of 33 per cent stearic and 67 per cent palmitic acid. This corresponds to a content of 33 per cent C_{16} acids in the egg lecithin, a figure similar to that found by the earlier workers.

Thirdly, acids with an average unsaturation of 5 (unconjugated) double bonds per molecule have been recovered from the α′-position of highly unsaturated lecithin fractions obtained from silica columns[7], and spectrophotometric examination after alkali isomerization has confirmed the presence of hexaene and tetraene acids. After hydrogenation the presence of C_{22} and C_{20} acids was demonstrated by the partition chromatogram.

It would appear on the basis of these results that not more than one-third, and possibly considerably less, of the lecithin of the egg yolks examined by us can have the simple di-C_{18} structure found by Hanahan for his alumina-column preparations, and that hydrogenation of lecithin obtained from eggs cannot therefore be relied upon to yield an individual distearoyl lecithin or its hydrolysis products by enzymic treatments.

It is well established that the fatty-acid composition of egg phospholipids is markedly dependent upon that of the dietary fats; but it seems unlikely that such a factor would account for the complete absence of C_{16}, C_{20} and C_{22} acids in the lecithin described by Hanahan.

Examination of the lysophosphatidylethanolamine obtained from venom-treated yolk has shown that its constituent acids also have a small unsaturation of the same order as that of the lysolecithins. In this case the hydrogenated acids consisted of 47 per cent stearic and 53 per cent palmitic. Assuming that the action of the venom phospholipase is at the α′-position, as in the case of the lecithinase *A*, it may be concluded that the phosphatidylethanolamine of egg yolk has the same type of fatty-acid distribution as the lecithin.

A detailed account of this work, which forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research, will be published elsewhere.

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Characterization of an Enzyme reducing Pyrroline-5-Carboxylate to Proline

SEVERAL lines of evidence serve to establish glutamic-γ-semialdehyde as the key intermediate in the pathway of the biosynthesis of proline from either glutamic acid or ornithine[1,2]. Since glutamic-γ-semialdehyde spontaneously cyclizes nearly completely to Δ^1-pyrroline-5-carboxylic acid[2], hydrogenation of the latter becomes a key reaction in the biogenesis of proline.

An enzyme catalysing this reaction has been observed in extracts of mycelial pods of *N. crassa* and named pyrroline-5-carboxylate reductase[3]. Extracts of rat liver mitochondria have been shown to convert glutamic semialdehyde to proline; but efforts to increase the activity failed[4].

We have determined that pyrroline-5-carboxylate reductase occurs in the soluble proteins of liver. The enzyme has now been partially purified by ammonium sulphate fractionation and the hydrogen donor has been shown to be reduced diphosphopyridine nucleotide. The enzyme has also been characterized with respect to a number of its properties.

Assays of the enzyme are carried out by measuring the fall of absorption of reduced diphosphopyridine nucleotide at 340 mμ in the Beckman spectrophotometer as the reduction proceeds (see Table 1).

Table 1

	Experiment	Change in optical density per 10 min.
1.	Pyrroline-5-carboxylate + enzyme (0·8 mgm.) + DPNH	0·300
2.	DPNH + enzyme (no pyrroline-5-carboxylate)	0·01
3.	DPNH + pyrroline-5-carboxylate	0

The enzyme is prepared from rat liver homogenized in a Potter–Elvehjem homogenizer with 1·5 volumes of 0·025 *M* phosphate buffer at *p*H 8 and centrifuged at 100,000 *g* for 30 min. Neutral saturated ammonium sulphate is stirred into the supernatant fluid at 4° to obtain the fraction precipitating between 40 and 60 per cent saturation. This is reprecipitated, dissolved, then reprecipitated and subjected to successive elutions with 50, 45, 40 and 35 per cent saturated ammonium sulphate respectively. The solution resulting from elution with 35 per cent saturated ammonium sulphate is usually most active. This is dialysed for 18 hr. at 4° against four changes of 0·05 *M* phosphate buffer, *p*H 8.

The cuvette for assay contains 3 ml. of 0·05 *M* triethanolamine, 0·04 ml. of pyrroline-5-carboxylate, 0·1 ml. of enzyme solution, containing approximately 1 mgm., and 0·2 ml. reduced diphosphopyridine nucleotide (∼0·5 mgm.). The total mixture is adjusted to *p*H 6·8.

The crude supernatant fluid contains an inhibitor fraction which is eliminated as the enzyme is purified. A doubling of the total enzyme activity is obtained in the first precipitation of the 40–60 per cent saturated ammonium sulphate fraction. This inhibitor seems to be precipitated at less than 40 per cent saturated ammonium sulphate.

A preliminary determination of the properties of pyrroline-5-carboxylate reductase has shown that it is unstable in acid and has an optimum *p*H at 6·8 in 0·05 *M* triethanol amine.

The enzyme is inhibited by *p*-chloromercuribenzoic acid, mercuric and silver ions at a concentration of 10^{-5} *M*. *BAL* (1-hydroxy-2,3-dithiolpropane) protects the enzyme from this inhibition, indicating the participation of an active SH group in the reaction. Ethylenediaminetetraacetic acid does not affect the enzyme activity, but adenosine triphosphate, at a level of 10^{-4} *M*, inhibits the reaction.

Studies are now in progress to characterize still further the properties of the enzyme and the inhibitor fraction.

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Effect of Reserpine on Serotonin in Rabbit Serum

IT is generally accepted that the effect of clinical doses of reserpine on the circulation is central in origin and that such doses have no peripheral effect of any significance. It has recently been shown that reserpine and serotonin have similar effects on the central nervous system, and that relatively large doses of reserpine in dogs markedly increase the urinary secretion of a metabolite of serotonin[1]. It has therefore been suggested that certain actions of reserpine are mediated through the liberation of serotonin from the intestine[2].

We have shown that, in rabbits, relatively small doses of reserpine reduce the concentration of serotonin in the serum. In our experiments rabbit serum was tested on the rat œstrous uterus, and compared with known concentrations of 5-hydroxytryptamine creatinine sulphate. The accuracy of this method is about ± 10 per cent. The effect of the serum was presumed to be due to the serotonin content, as histamine does not affect the rat uterus and acetylcholine is not found in serum. As further proof of this presumption, it was shown that similar contractions, produced by the serum, and by

able 1. Effect of Various Intravenous Doses of Reserpine
n the Concentration of Serotonin in Serum from Four Rabbits
(*a*) Before the Injections, (*b*) 17 hr. Later

Weight of rabbit (gm.)	3,010	2,870	2,770	2,870
Dose of reserpine (mgm.)	0 4	0 2	0·1	0 05
Serum conc. of serotonin (μgm./ml.) (*a*) (*b*)	4 35 0 07	4 35 0·52	4·35 0·87	4·35 1·08

-hydroxytryptamine, were antagonized to the same xtent by ergot alkaloids.

We have not been able to demonstrate any ntagonism between reserpine and serotonin *in vitro*. ven high concentrations of reserpine (10 μgm./ml.) ave no effect on the sensitivity of the rat uterus to erotonin. Uteri from rats pretreated for several ays with toxic doses of reserpine showed no change sensitivity to serotonin as compared with normal reparations.

Fig. 1 and Table 1 demonstrate some of the results btained after intravenous injection of reserpine. he serum content of serotonin falls rather rapidly; or example, it is reduced to half its original value wo hours after a dose of 1 mgm. reserpine to a abbit.

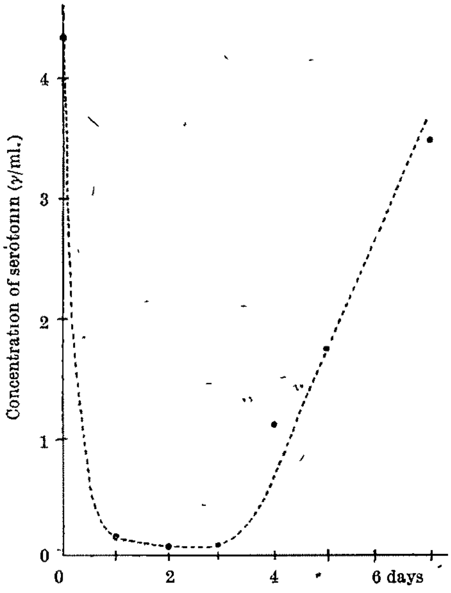

Fig. 1. Effect of three intravenous doses of 0·2 mgm. reserpine (at zero time and on each of the first two days) on the concentration of serotonin in serum. Rabbit weight: 3,350 gm.

We think that this effect can best be explained by a disappearance of serotonin from the platelets, these being the accepted source of the serotonin released during coagulation. The delayed disappearance of serotonin from the serum probably indicates an effect of a metabolite of reserpine rather than a direct effect of reserpine itself.

The possibility of a direct effect of reserpine on the platelets *in vitro* is now under investigation.

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Oxidation of Octanoic Acid by Cell-free Bacterial Extracts

Studies with extracts from the anaerobic organism *Clostridium kluyveri* have shown that certain fatty acids are oxidized to acetate by processes similar in essentials to those in mammalian systems[1]; but the mechanisms employed by aerobic bacteria have remained obscure. Thus, although results with whole cells of *Serratia marcescens*[2] did not apparently accord with β-oxidation, it has been shown more recently that extracts from *Pseudomonas fluorescens*[3] catalyse the formation of acetate from decanoate with the uptake of one micromole of oxygen per micromole of substrate. In experiments with cell-free extracts prepared from a vibrio[4], we have now been able to show that octanoic acid is oxidized by molecular oxygen to 2C units; that diphosphopyridine nucleotide, coenzyme A and magnesium ions are co-factors in this process; and that subsequent oxidation is by way of the tricarboxylic acid cycle.

After growth with forced aeration in a mineral-salt medium supplying octanoic acid as sole source of carbon[5], each 10 gm. (wet weight) of cells was crushed in a Hughes press[6] at − 14° C.; and while still frozen, the cells were ground in a mortar to a smooth paste with 10 gm. of alumina and 25 ml. of phosphate buffer. Centrifuging to remove alumina and cell debris gave clear extracts which contained about 18 mgm. protein per ml. and catalysed the oxidation of octanoate (Fig. 1). The rate of oxidation decreased with time, and the volume of oxygen utilized approached that for complete oxidation, namely, 11 moles oxygen per mole octanoate, when fumarate was added: thus four moles oxygen had been utilized in excess of the control after 40 min. and eight moles after 150 min.

The high rate of oxygen uptake in the absence of added substrate was largely abolished by dialysis against water or ethylenediamine tetraacetate, as shown in Fig. 2; and after this treatment, only

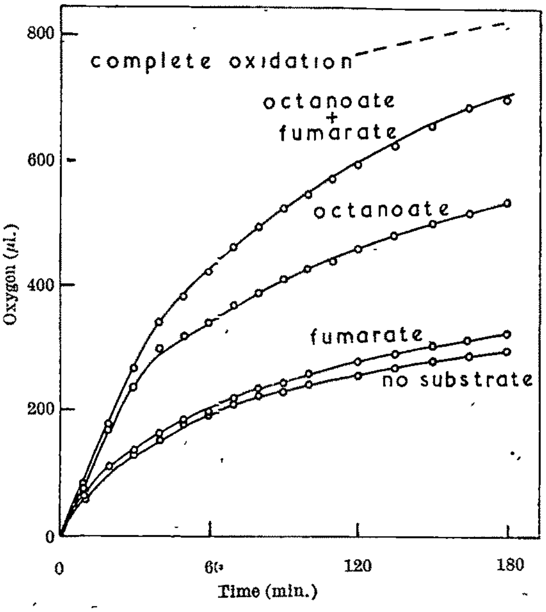

Fig. 1. Aerobic oxidation of octanoic acid by an undialysed extract. 2 μmoles of the substrates indicated were present with 1 ml. of extract in a total volume of 3 ml. Co-factors at concentrations given in Fig. 2 were also present

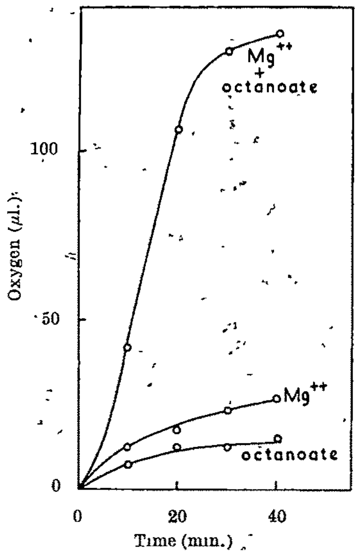

Fig. 2. Oxidation of octanoic acid by an extract dialysed for 3 hr. against ethylenediamine tetraacetate (0·02 *M*; *p*H 7·2). Reaction vessels contained, per 3 ml., 1 ml. of extract, 5 µmoles reduced glutathione, 0·1 µmole coenzyme A and 0·3 µmole diphosphopyridine nucleotide. Additions were as indicated: octanoate (2 µmoles) and magnesium sulphate to a final concentration of $1 \cdot 3 \times 10^{-2}$ *M*

2·5–3 moles oxygen was then utilized when diphosphopyridine nucleotide and magnesium ions were added. In an experiment similar to that of Fig. 2, overnight dialysis against distilled water gave a preparation which oxidized 2 µmoles of octanoate, present in 3 ml. of reaction mixture, at the rate of 60 µl. oxygen per hr. when diphosphopyridine nucleotide was absent, and at 90 µl. oxygen per hr. on addition of 0·3 µmole of diphosphopyridine nucleotide. In these experiments, in addition to $1 \cdot 3 \times 10^{-2}$ *M* magnesium sulphate, 0·1 µmole of coenzyme-A and 5 µmoles of reduced glutathione were also present. Subsequent experiments showed that the latter was not essential; but after treatment of extracts with 'Dowex-1' a stimulation of oxygen utilization by octanoate from 50 µl. per hr. in the absence of added coenzyme-A to 90 µl. per hr. in the presence of 0·1 µmole of coenzyme-A was obtained.

Oxidation of octanoic acid by dialysed extracts in the presence of added co-factors was accompanied by an increase in volatile fatty acid. After deproteinization with metaphosphoric acid, flask contents were distilled in an apparatus and approximately 6 µmoles of volatile acid were obtained from 2 µmoles of octanoate compared with the 8 µmoles of acetate required by the reaction $C_8H_{16}O_2 + 3O_2 \rightarrow 4CH_3COOH$. Further experiments, however, showed that addition of 5 µmoles of acetate caused a marked reduction in rate of oxidation, and it appeared that accumulation of acetate in the reaction mixture might inhibit the breakdown of a small fraction of the octanoate; this was also indicated by total oxygen uptakes rather less than the three molecules required. When volatile acid production was related to oxygen consumed, yields 90 per cent of theoretical were obtained. No keto-acid was detected; and examination of flask contents on extraction with ether, using gas–liquid partition chromatography, revealed acetic acid only.

Previous work has shown that, in the presence of fluoroacetate, this organism accumulates citrate during octanoate oxidation[7]; and cell-free extracts are able to oxidize citrate[8]. When this is considered with the present findings, it appears probable that octanoate is broken down to 2C units which ar then oxidized by the reactions of the tricarboxyl acid cycle. Dialysis probably prevents the operatio of the latter by removal of 4C compounds present i extracts; this observation points to the necessity o a mechanism for 4C replenishment by cells growin at the expense of fatty acids[5]. The tendency of fre acetate to inhibit octanoate breakdown suggests th existence of a regulatory mechanism maintaining balance between the rates of operation of the fatt acid[9] and tricarboxylic acid cycles.

I wish to thank Mr. J. R. L. Walker for his assistance in the determination and identification of acet acid; Mr. T. J. Bowen, who constructed the apparatu for vapour-phase chromatography; Mrs. M. Lee for skilful technical assistance; and the Agricultural Research Council for a grant.

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Bacterial Variation to Sensitivity: an Example of Individuality in Micro-organism

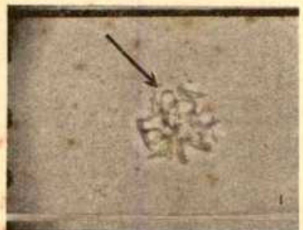
IT is now a commonplace that, in culture, resistan organisms may be already present before there ha been any contact between them and an antibiotic[1] I demonstrated[1a] that this was true even in youn cultures derived from single cells.

While it has been relatively easy to demonstrat that there is a regular distribution of resistanc through these populations, there has not so far bee any published evidence that increased sensitivity wa similarly distributed. There is evidence of the production of true-breeding mutants which are man times more sensitive than the parent strain[2]; bu this is a different order of phenomenon from th graduated series of variants here being considered.

If phase-contrast microscopy be supplemented b time-lapse ciné-micrography, it is possible to demonstrate that organisms more sensitive than the paren cell are produced in micro-colonies in 'sub-inhibitory concentrations of antibiotic. These cells are no normally noticed since they are eliminated by lysis leaving nothing to indicate that selection has bee at work. The alternative method, which involve the testing of individual organisms by transferrin them singly to antibiotic agar or other unfavourabl environment, is so laborious that only a few generations can be studied[3].

The results shown by ciné films have been s instructive that it seems justifiable to report a typica preliminary finding here.

Fig. 1 shows a young colony derived from a singl cell and growing on one-fifth of the normal inhibitor dose for the strain. Of the individual cells present only one, marked with an arrow, is sensitive at thi level of penicillin. Fig. 2 is of the same colon 230 min. later; it shows that this cell alone has faile to divide. Fig. 3 is the next frame in the film, onl



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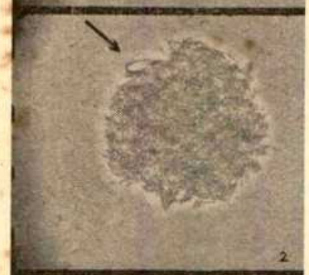

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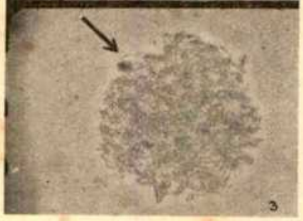
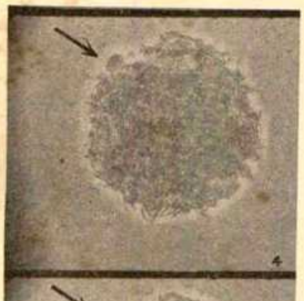


3

20 sec. later, and records the bursting of this cell. Its contents flow out and are visible for 23 min., but then disappear between one frame and the next (Figs. 4 and 5), leaving nothing that can be resolved by the light microscope.

At higher concentrations of antibiotic, this individuality of reaction in cells derived from a single parent can also be seen. In a field of three or four organisms, all inhibited for division but able to grow in size, it is usual to find at least one that is obviously more sensitive and is destroyed while its fellows survive to give rise to fresh generations many hours later. Some sensitive cells appear in the cultures no matter how often the strain has been exposed to the antibiotic.

I therefore feel justified in advancing the hypothesis that, whenever a microbe divides, the daughter cells will differ from one another and from the parent cell from which they came. The so-called 'clone' of organisms is a population of separate individuals normally distributed for any measurable character and subjected to continuous re-selection by an unfavourable environment. Selected populations are not soon permanently altered, as they would be by mutation proper, but will show similar reactions at each fresh contact with the unfavourable environment.



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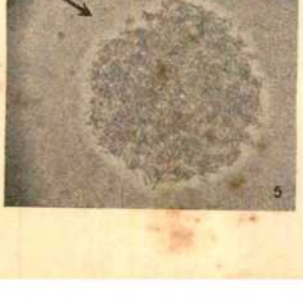

5

In reviewing the records made during the eight years in which phase-contrast microscopy has been available, I have never observed anything that might throw doubt on this hypothesis. Photographs and films published by others also support this view. Vadasz and Juhasz[4] although primarily interested in the origin of resistance, show pictures of *Salmonella enteritidis* similar to ours with *Proteus vulgaris*. Further evidence is available from such divers fields as Lwoff and Gutmann's[5] studies on phage production in *Megatherium* and Crawley and Jevons's[6] recent publication on the synthesis of carbohydrate by streptococci.

The supervision of the ciné-micrographic technique used was in the hands of Dr. Peter N. Cardew, of the Photographic Department, St. Mary's Hospital Medical School, and the apparatus was designed and largely built by him.

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Free Amino-acid Content of the Lymph

We have been studying the free amino-acids of the blood and urine by quantitative paper chromatography[1]. This method also offered the possibility of extending our researches on lymph and of comparing the free amino-acid content of lymph and blood obtained from different areas.

Our experiments were carried out on six dogs. Under 'evipan'-anæsthesia we isolated the thoracic duct, the cervical lymph ducts and the lymph duct running along the vena portæ, and gathered lymph through cannulæ. At the same time, we drew blood from the jugular vein and from the portal vein too.

In these samples the free amino-acids were determined in the following way. The deproteinization of the blood or lymph was carried out by alcoholic precipitation and the removal of lipids by shaking with ether. Desalting was done by the method of Consden and Gordon. The amino-acids were separated by two-dimensional ascending paper chromatography in a phenol/*n*-propanol/water, or in some cases in a phenol/*n*-butanol/acetic acid/water solvent system. The principle of the method of determination was to make the amino-acids visible by spraying the paper with diluted ninhydrin solution, removing the ammonia-like impurities of the paper by spraying it with alcoholic potash solution. The spots were cut out and their amino-acid content determined by our previously published method[2] with recent modifications (unpublished). The ninhydrin reagent used in

Table 1. AMINO-ACID CONCENTRATIONS (μgm./ml.)

	Jugular vein		Portal vein		Thoracic duct		Cervical trunk		Liver lymphatic	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
Alanine	19–52	32·8	27–53	35·6	17–47	30·7	28–44	35·2	22–43	29·6
Arginine	7–16	12·3	9–18	14·0	8–19	11·6	7–14	10·8	7–10	8·8
Aspartic acid	2–6	3·8	3–4	3·2	2–6	4·2	3–4	3·3	2–3	2·7
Cystine	6–21	12·2	5–16	8·8	5–16	10·2	5–19	12·3	4–7	6·0
Glutamine	38–88	58·2	34–72	50·7	32–80	55·3	42–85	63·0	33–70	46·2
Glycine	8–20	11·8	9–17	13·8	6–14	10·3	6–21	12·5	8–18	11·6
Histidine	7–12	10·0	5–17	8·6	4–15	11·0	9–11	10·0	8–12	9·5
Leucine + *iso*leucine	13–24	19·3	13–26	19·0	14–30	19·2	6–18	13·2	12–27	19·8
Lysine	7–16	11·2	5–17	10·0	4–19	8·5	7–12	9·0	3–10	6·6
Phenylalanine	6–12	8·5	7–14	10·2	6–21	12·7	7–10	7·8	8–19	11·6
Proline	17–22	19·0	16–23	19·5	12–20	15·0	10–20	15·0	12–18	15·0
Serine	6–12	9·0	5–11	7·4	5–14	9·6	8–13	10·7	6–14	8·5
Threonine	9–28	20·7	16–28	19·8	12–31	20·0	12–25	18·8	11–21	18·4
Tyrosine	8–15	12·4	8–17	12·2	7–18	12·3	8–15	10·0	7–18	12·6
Tryptophan	6–13	8·5	8–11	9·3	11–17	14·7	6–8	6·7	11–15	14·7
Valine	10–18	14·0	11–21	15·2	9–22	14·8	7–17	12·0	12–19	15·4

this method is similar to that of Moore and Stein[3]. The determination of proline was made by our modification of Schweet's method[4]. In accordance with Stein and Moore's results[5] we also observed that glutamine may be slightly decomposed during the procedure. To minimize this error, the standard glutamine solution was submitted to the same procedure before determination. The relative limit of our method is about ± 10 per cent. The results are given in Table 1.

Summing up our observations: (1) the amino-acid pattern of lymph is similar to that of the serum; (2) in some experiments we have found striking differences in the concentration of individual amino-acids of different samples, certainly exceeding the error of our method (see detailed publication in *Acta Med. Hung.*, in the press), but systematic, unidirectional differences were not to be found; (3) the amino-acid in the highest concentration in all materials was glutamine, that in lowest concentration aspartic acid.

The concentration of individual amino-acids in the systemic blood and portal vein in dogs was investigated recently by Denton and Elvehjem[6]. Comparing our results with theirs, the values for arginine, histidine, leucine, phenylalanine, threonine, tryptophan and valine correspond, despite the diversity of the methods. Our determinations of histidine, phenylalanine, tryptophan and tyrosine agree also with the results of Hier and Bergeim[7]. In disagreement with the available data on dog plasma, the concentration of lysine is comparatively low. This may be connected with the loss of this amino-acid arising from the method of preparation (for example, desalting). This problem has not been dealt with in detail.

Our investigations will be published fully in *Acta Med. Hung.*

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Reciprocal Egg Transplantations to study the Embryo–Uterine Relationship in Heat-induced Failure of Pregnancy in Rabbits

PREGNANCY in rats[1], mice[2] and ewes[3] is adversely affected by high ambient temperature. Experiments described here were undertaken to see if rabbits, too fall in this category; and if so, whether the heat acts directly on the embryos, the uterus, or both.

In the first experiment, the course of pregnancy was studied in eight rabbits, following continuous exposure to high temperature for six days following copulation. The heat-treatment was carried out in a thermostatically controlled chamber. The average air temperature was 95·9° F. dry-bulb and 78·8° F. wet-bulb. This raised the rectal temperature of the rabbits from an average of 102·5° F. in the normal environment to 105·1° F. during the six-day period of heat-treatment. Before and after heat-treatment the rabbits were kept in the normal environment. The course of pregnancy was followed by laparotomy between the tenth and fifteenth day post-coitum, by abdominal palpation of conceptuses, and by autopsy in cases of pregnancy interruption. Prenatal losses were estimated by the method of Allen, Brambell and Mills[4]. Entire litters were resorbed in seven of the eight heat-treated rabbits, and a partial resorption occurred in the eighth doe, in which two out of five conceptuses, observed at laparotomy, were carried to term. Observation of corpora lutea, implantations and resorptions of embryos in the eight heat-treated rabbits revealed that, on the basis of ovulations, prenatal losses were 96·2 per cent, of which 75·6 per cent occurred by way of resorptions following implantation. Pre-implantation losses were unaffected. Thus a continuous exposure of rabbits to high air-temperature during the pre-implantation period of pregnancy (six days post-coitum) resulted in severe prenatal mortality through resorption of embryos, following normal implantation. The resorptions occurred mainly between the tenth and fifteenth day of pregnancy and to a smaller extent after the twenty-first day. Control experiments showed that the interruption of pregnancy was unrelated to a lowered food intake during heat-treatment, or to laparotomy.

In the second experiment the technique of egg transplantation was employed to study the embryo–uterine relationship in this interruption of pregnancy. Normally, transplantation of six-day rabbit eggs would involve incision of the uterus of a pseudo-pregnant recipient for transfer of eggs[5]. However, in the transplantations reported here uterine incision was avoided by transferring eggs to the uterus via the cervix through an incision in the vaginal canal of laparotomized recipient females. Pyometra, usually encountered following transplants in the presence of active corpora lutea in rabbits[6], was obviated by the local use of aureomycin and intramuscular injections of penicillin. Using this technique, thirty-two six-day eggs from unheated donor rabbits were transferred to the uteri of five unheated six-day pseudopregnant recipients. In all, twelve normal young were born to four of five recipients, representing a normal development to term of 37·5 per cent of transferred blastocysts. These transplantations, in which both donors and recipients were kept in the normal environment, formed the controls for experiments three and four, involving heat-treatment of either donors or recipients.

In the third experiment, thirteen donor rabbits were subjected to heat-treatment for six days (144 hr.) following copulation with fertile bucks. At the end of heat-treatment they were killed and seventy-four blastocysts were collected, which represented 72·5 per cent of 102 ovulations (on the basis of corpora lutea). This figure compares favourably with a 74·4 per cent recovery of six-day blastocysts from normal unheated donors[7]. Forty-two six-day eggs from the heated donors were transferred to the uteri of eight unheated six-day pseudopregnant recipients. Seven of the eight recipients produced fifteen normal young, representing a development to term of 35·7 per cent of eggs transplanted against 37·5 per cent in control transplantations. Thus, embryos recovered from donors heat-treated for a period of six days post-coitum undergo normal development to term in the uteri of unheated pseudopregnant recipients. This shows that embryos up to six days of age are unaffected by heat—a finding which is substantiated by the fact that a similar number of blastocysts may be recovered at six days from either heated or unheated donors.

In the fourth experiment, all donors were kept in the normal environment, but recipient rabbits were subjected to continuous heat-treatment for 144 hr. following mating to vasectomized bucks. Sixty-six six-day blastocysts from unheated donors were transferred to the uteri of nine heat-treated six-day pseudopregnant recipients. Recipients were left in the normal environment following transplantation, and pregnancy was diagnosed by abdominal palpation at regular intervals. Recipients were autopsied if and when their pregnancies were diagnosed as regressing. Implantation of transferred embryos occurred in all nine heat-treated recipients; but at stages subsequent to implantation entire litters were resorbed in eight of them. In these eight recipients, resorption of embryos occurred mainly between the twelfth and fourteenth day post-coitum, and to a smaller extent after the twentieth day. The ninth doe, which was killed on the tenth day post-coitum, appeared to have normal conceptuses at that time; but these perhaps would have resorbed had the animal not been autopsied prematurely. From this experiment it is clear that when six-day blastocysts from unheated donors are transplanted to heat-treated pseudopregnant recipients, embryos become implanted, but most of them afterwards undergo resorption. This shows that continuous heat-treatment for six days renders the uterus unsuitable for the normal development of embryos.

These experiments have shown that normal pregnancy in the rabbit was interrupted by high temperature during the first six days of gestation. This was caused by heat acting adversely on the maternal tissues rather than directly on the embryos themselves.

My thanks are due to the Government of the Commonwealth of Australia for the award of a junior fellowship under the Technical Co-operation Scheme of the Colombo Plan enabling me to carry out this work; to the Government of India for sponsoring my application; to the University of Queensland for extending research facilities; to Dr. N. T. M. Yeates, of the Commonwealth Scientific and Industrial Research Organization of Australia, for his continued guidance; and to Prof. W. V. Macfarlane and the staff of the Physiology School, University of Queensland, for their help.

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Determination of Sex in Early Human Embryos

The presence of sex-chromatin in cell nuclei is being noted in an ever-increasing number of tissues from human and animal females[1-9]. Popular interest was roused recently by a report in *Nature*[10] describing a method of antenatal sex determination. The method depends on the presence or absence of sex-chromatin in desquamated cells isolated from amniotic fluid.

An examination has now been carried out of the human embryos and fœtuses in this Department. The collection comprised twenty-two male and twelve female fœtuses, ranging in size from 18 to 150 mm. crown-rump length. All the specimens have been stained with hæmatoxylin and eosin. Most of the specimens were sufficiently well fixed and stained for nuclear details to be observable.

The presence of a dark-staining plano-convex particle in contact with the nuclear membrane of vesicular, 'open-faced' nuclei was taken as indicating the presence of sex-chromatin. Shrunken, pyknotic, too densely stained nuclei, or those overlapped by other structures, were unsuitable for study. Using these criteria, the presence or absence of sex-chromatin corresponded in each case with the sex of the fœtus as determined by the histological appearances of the gonads. Sex-chromatin particles were identified in 30–50 per cent of nuclei examined in the tissues of the female fœtuses. Although sex-chromatin could be identified in many tissues, the nuclei most suitable for examination were found in the liver, suprarenals mesonephric tubules, surface epithelium, cardiac muscle, undifferentiated mesenchyme, notochord and cartilage. However, the latter was often insufficiently well preserved to be reliable. It should also be noted that the morphological sex differences described above are also demonstrable in both layers of the trophoblast.

In male fœtuses doubtful nuclei were occasionally encountered but they never exceeded 10 per cent of the nuclei counted. A closer examination of these nuclei usually revealed a degree of irregularity of the nuclear membrane. As there appears to be a concurrence between the incidence of sex-chromatin in fœtal cells and the presence of ovarian characters in the gonad, young embryos in which the gonad had not yet differentiated into a testis or ovary were examined. Thirteen embryos were suitable for this examination, and six were found to possess a sufficient number of nuclei containing sex-chromatin to warrant their classification as females. The youngest specimen showing this feature was a 1·7 mm. pre-somite embryo. In addition, the syncytiotrophoblast cells of an implanting blastocyst were seen to contain the sex-chromatin particles, although the cells of the embryonic disk and the cytotrophoblast were not suitable for the test.

These results are presented as they appear to be significant, and the method may prove useful in the determination of sex in early embryos. It is realized, however, that more specimens will have to be examined and more experience gained before the test can be said to be entirely reliable.

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Effect of Electric Shock and Cardiazol Shock on Morphine Tolerance

During my investigation of the tolerance for morphine and codeine using 'coughing dogs'[1], I noted that acquired tolerance for these drugs by which their antitussive effects were completely lost was reduced or eliminated by an electric shock or a cardiazol shock. Morphine (2–6 mgm./kgm.) given intravenously completely depressed coughing for 1–6 hr. in such dogs on the first day of administration. By continued daily application of the drug, the dogs acquired tolerance in five to ten days; but the same drug failed to depress coughing afterwards. Similar tolerance for codeine developed in eight to fourteen days. The dogs thus made tolerant for morphine or codeine were subjected to an electric shock (a.c. 90–100 V., 2 sec.) or cardiazol shock (30–50 mgm./kgm.). On the following day, each antitussive drug was one-fourth to three-fourths as potent, or in a few cases, quite as potent, as on the first day of administration, indicating that the shock had reduced or eliminated the tolerance.

The effect of the first shock persisted for three to four days, after which another shock was required to eliminate the redeveloped tolerance. Neither of the shock therapies affected the antitussive action of morphine in any non-tolerant dogs, and the combined application of morphine and electric shock for many consecutive days failed to prevent the animals from acquiring tolerance for morphine. Excepting the rare cases, the effect of an electric shock or cardiazol shock was proportional to the severity of the resulting convulsion and excitement.

From the following observations it is presumed that the effect of shock may in part be ascribed to the increased permeability of cerebral blood vessels and brain tissue. (1) Intravenously administered trypan blue, which left brain and spinal tissue unstained in normal dogs[2], stained brain tissue blue when accompanied by an electric shock (however, the nerve cells contained none of the dyestuff). (2) Hyaluronidase (10,000 v.r.u./kgm.) mixed with morphine reduced tolerance without causing convulsions, though the effect was far weaker than that of an electric shock. Brain tissue was also stained with trypan blue during hypertension produced with adrenaline; but the hypertension itself did not reduce the tolerance for morphine.

These facts suggest that the staining of brain tissue with trypan blue after application of an electric shock is mainly attributable to enhanced permeability of cerebral blood vessels due to the hypertension induced by convulsion, and that the effect of the shock on morphine tolerance may be based on its action of enhancing the permeability of brain tissue (especially the nerve cells themselves). Possibly the effect of shock therapy on a narcotic addict is in part based on the reduction of drug tolerance described above.

Further investigations have shown that: (1) tolerance can be acquired only when morphine reaches the central nervous system via blood vessels, and not via the cisterna cerebellomedullaris, for the tolerance developed in five to fourteen days by intravenous or intra-arterial injection (common carotid artery), but never developed by daily intracisternal injection for six months; (2) when complete tolerance was obtained by daily intravenous administration of such a dose of morphine that would give much longer duration of antitussive effect than that given intracisternally, the same dose as that administered intracisternally before was given into the cisterna again; however, tolerance did not affect the intracisternal effect, that is, the intracisternal effect was almost equal to that before tolerance had been acquired.

Y. Kasé

Chemico-Pharmacological Department,
Faculty of Pharmacy,
University of Kumamoto,
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[1] Kasé, Y., *Jap. J. Pharmacol.*, **4**, 130 (1955).

[2] Goldman, E. E., "Vitalfarbung am Zentralnervensystem" (Georg Reimer, Berlin, 1913).

Hair-line Cracks in Low-alloy Steels

The cause of hair-line cracks in low-alloy steels has been debated for many years. The main hypotheses now current can be reduced to the following: the hydrogen-pressure hypothesis and the residual stress hypothesis. It follows from the former that hydrogen alone can induce hair-line cracks to form; and from the latter that, in the absence of residual stress, no hair-line cracks will form even if hydrogen is present.

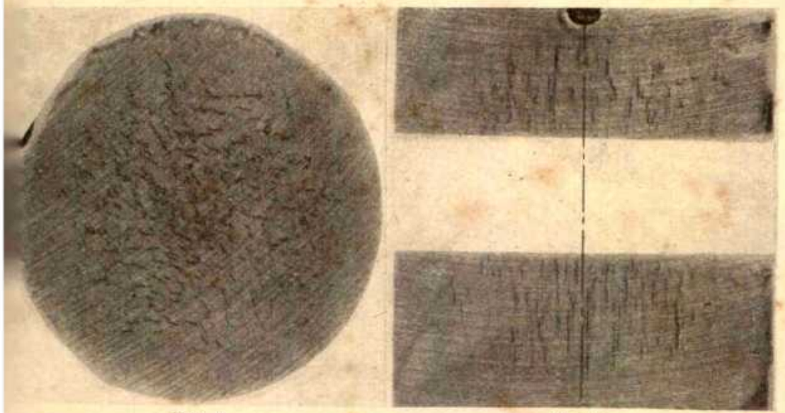
Fig. 1 Fig. 2

(1) Transverse section at mid-length. (2) Longitudinal section. The centre line is vertical. The missing centre portion is where the section shown in Fig. 1 was taken. Magnetic etch. Diameter of the section, 4 in.

Dana, Shortsleeve and Troiano[1] have recently studied the effect of transformations and hydrogen content on the formation of hair-line cracks. One of the conclusions reached was that transformation stresses must be present for cracks to form. Petch[2] also concludes that the hydrogen-pressure hypothesis is not likely to explain hair-line cracking.

We have carried out experiments in which cylinders of steel 4 in. in diameter × 4 in. long have been saturated with hydrogen at 100 atmospheres pressure at subcritical temperatures (between 600° and 650° C.), the specimens afterwards being air-cooled. Under these conditions, no transformation takes place and the residual stress after treatment at 600° C. and air cooling will be small.

By this means, hydrogen contents of between 12 ml. and 14 ml./100 gm. have been obtained in several steels. Plain carbon steels with 0·1 per cent carbon did not contain hair-line cracks after this treatment. With steels of the following composition :

	C	Si	Mn	Ni	Cr	Mo
Steel *A* :	0·28	0·26	0·62	2·76	0·77	0·54 per cent
Steel *B* :	0·30	0·19	0·42	4·22	1·27	0·16 per cent

typical hair-line cracks have been found to form.

An example is shown of steel *A* (Fig. 1), originally oil-quenched and tempered at 630° C. followed by hydrogen treatment at between 570° C. and 620° C. for 20 hr. Supersonic examination showed small hair-line cracks on cooling to room temperature, which gradually increased in size and number with time. The sections shown were obtained 120 hr. after air cooling. The hardness was 280 V.D.H. after treatment. In all cases, supersonic examination showed that the specimens were free from hair-line cracks before the hydrogen treatment.

Houdremont and Schrader[3] have described an experiment in which 2½-in. diameter specimens of a nickel chromium steel of similar composition to steel *B* (Fig. 2) were exposed to hydrogen at 1,000 atmospheres pressure and 550° C. and then either water-quenched or furnace-cooled. Many hair-line cracks were present after water quenching, but only a few in the furnace-cooled specimen. Although about three times the hydrogen content would be present at a temperature compared with the experiments described above, the relatively small size of the specimen would result in much more hydrogen being lost from the centre of the specimen in the slow-cooling treatment than would be the case with the 4-in. cylinders in our experiments.

These experiments indicate that hair-line cracks can form when residual stresses are very low. The local stresses caused by hydrogen pressure are insufficient to crack the softer mild steels, but are sufficient to cause brittle fracture in the nickel steels. Residual stresses due to both transformation and cooling effects would be expected to be additive to the basic hydrogen pressure-induced stresses. In most practical cases the macro residual stresses will be low ; but the micro transformation stresses are likely to be of considerable importance.

We wish to thank the directors of Thos. Firth and John Brown, Ltd., for permission to publish this communication.

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A. Wainwright

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Jan. 6.

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[1] Dana, A. W., Shortsleeve, F. J., and Troiano, A. R., *J. Metals*, **7**, 895 (1955).

[2] Petch, N. J., "Residual Stresses in Metals and Metal Construction" (Reinhold, 1954).

[3] Houdremont, E., and Schrader, H., *Stahl u. Eisen*, **27**, 653 (1941).

Dependence of Snowfall on Temperature

D'Ooge has reported[1] a correlation between amount of snowfall in inches and temperature at the time of snowfall. His data showed that maximum depth of snowfall occurred at a daily mean temperature of − 11° C. ; Bossolasco[2] correlated frequency of occurrence of snowfall with temperature and found maximum occurrence at approximately the same temperature. These observers assumed that the mean daily temperature recorded at the level of observation was a reasonable estimate of the temperature at the level of formation of the snow. From the data presented, conclusions were drawn concerning nucleation of snow crystals.

The dependence observed by D'Ooge was checked by analysing, on a monthly basis, data collected by the Canadian Meteorological Service at Old Glory Mountain (elevation 7,700 ft.) over the period 1947–55. The observed dependence of inches of snowfall on the mean daily temperature is shown in Fig. 1. Assuming that the distributions are due to a real dependence of the amount of snowfall on the temperature at which the snow is forming, Fig. 1 indicates that only during the midwinter months are the temperatures measured at the level of observation likely to be a reasonable estimate of the temperature at the level of formation. The distributions for the remaining months are shifted to higher temperatures, as would be expected when the effect of the annual variation in mean temperature at the ground is taken into account.

It was pointed out to us by members of the Canadian Meteorological Service that these distributions do not necessarily show a true correlation of amount of snowfall on temperature. Other possible explanations exist ; for example, the observed

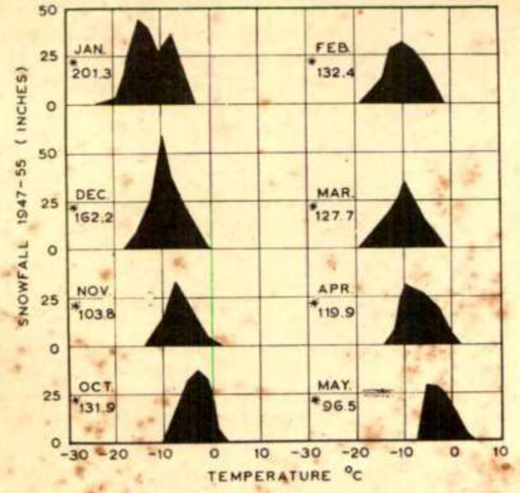

Fig. 1. Dependence of monthly snowfall on temperature at Old Glory Mountain for period 1947–55
• Total snowfall in inches, 1947–55

distribution may be a reflexion of the frequency distribution of the temperatures at the fixed level of observation. Data were available from observations taken at Montreal during the winter of 1951–52 [3] which gave the depth of snowfall and the temperature at the level of formation as estimated from the meteorological records. The distribution obtained from these data is shown in Fig. 2. The area enclosed in the distribution corresponds to 89 in. of the winter total of 124 in. Assuming that air masses in which the snow forms will not produce precipitation until conditions are favourable, Fig. 2 should be a true correlation between amount of snowfall and the temperature at the level of formation. From this distribution it is seen that the greatest amount of snow is likely to come from cloud between − 10° C. and − 20° C. One interesting feature of the Montreal observations was that the majority of snow crystals were irregular assemblages of columns and plates[4]. The distribution in inches for the snowfalls observed was: 59·0 in., irregular crystals (usually associated with frontal storms); 15 in., dendrites; and the remainder, columns and needles. According to Nakaya, irregular assemblages of columns and plates form over the temperature ranges − 9° C. to − 14° C. and − 17° C. to − 20° C.; dendrites form in the temperature range − 14° C. to − 17° C.

Since it is very difficult to estimate the temperature of formation of the snow, and since this temperature is not likely to remain constant throughout a snowfall, any conclusions drawn based on details in the observe distributions must indeed be speculative.

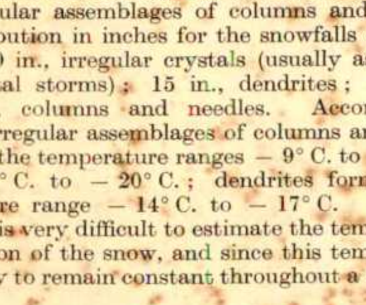

Fig. 2. Dependence of snowfall on temperature from observations made at Montreal

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Dec. 20.

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[1] D'Ooge, C. L., *Nature*, **175**, 465 (1955).

[2] Bossolasco, M., *Geofisica Pura e Applicata*, **28**, 208 (1954).

[3] Gold, L. W., and Power, B. A., *J. Meteor.*, **11**, No. 1, 35 (1954).

[4] Nakaya, U., "Snow Crystals: Natural and Artificial" (Harvar Univ. Press, 1954).

Results of Gravitational Significance in Riemannian Geometry

IT is well known that by contraction one can deduce from the Bianchi identities in Riemannian geometry the following result:

$$R^h{}_{ijk\,;\,h} = R_{ij\,;\,k} - R_{ik\,;\,j} \qquad (1$$

From this it follows that if:

$$R_{ij} = \lambda g_{ij} \qquad (2$$

which is the usual condition for an Einstein space then:

$$R^h{}_{ijk\,;\,h} = 0 \qquad (3)$$

This implies:

$$\text{(i)}\quad C^h{}_{ijk\,;\,h} = 0, \quad \text{(ii)}\quad W^h{}_{ijk\,;\,h} = 0 \qquad (4)$$

for the conformal and projective curvature tensors in Eisenhart's[1] notation. The gravitational significance of (3) and (4) does not appear to have been examined so far, although (4i) has received some attention in a particular context[2].

For an arbitrary contravariant vector field a^m we have:

$$a^m{}_{;\,ln} - a^m{}_{;\,nl} = a^p R^m{}_{pnl} \qquad (5)$$

Hence, by contraction ($m = l$), we get:

$$a^m{}_{;\,mn} - a^m{}_{;\,nm} = a^p R_{pn} \qquad (6)$$

If now (2) is used, (6) is reduced to:

$$a^m{}_{;\,mn} - a^m{}_{;\,nm} = \lambda a_n \qquad (7)$$

The cosmological constant λ is now given by:

$$\lambda = a^n(a^m{}_{;\,mn} - a^m{}_{;\,nm})/a^l a_l \qquad (8)$$

which shows how the constant can be interpreted in terms of operations on an arbitrary non-null vector field a^n. From (7) we can also deduce that:

$$a^m{}_{;\,nml} - a^m{}_{;\,lmn} = \lambda(a_{l\,;\,n} - a_{n\,;\,l}) \qquad (9)$$

If the gravitational field is given by $R_{ij} = 0$, the essence of the equations is contained in the fact that an arbitrary vector field a^n satisfies the condition:

$$a^m{}_{;\,mn} - a^m{}_{;\,nm} = 0 \qquad (10)$$

It is believed that the gravitational significance of (8) and (10) has not been noticed so far.

V. V. NARLIKAR

Department of Mathematics,
Banaras Hindu University.
Dec. 31.

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[1] Eisenhart, L. P., "Riemannian Geometry", 82, 91 and 135 (Princeton, 1926).

[2] Narlikar, V. V., and Singh, K. P., *Phil. Mag.*, **41**, 152 (1950).

FORTHCOMING EVENTS

Monday, June 18

RITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF NCE GROUP (in the Joint Staff Common Room, University College, er Street, London, W.C.1), at 5.30 p.m.—Dr. A. W. Stonier: e Influence of Philosophy in Economics".

Wednesday, June 20

STITUTE OF NAVIGATION (at the Geographical Society, 1 Kensing Gore, London, S.W.7), at 5 p.m.—Mr. George Lowe. "Crossing tarctica".

OYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, .7), at 5 p.m.—Special General Meeting to elect Officers and ncil for 1956–57. Mr. N. A. Phillips: "The General Circulation of Atmosphere—a Numerical Experiment".

Wednesday, June 20—Thursday, June 21

OLAROGRAPHIC SOCIETY (in the Chemistry Lecture Theatre, tersea Polytechnic, Battersea Park Road, London, S.W.11), at .m. daily—Symposium on "Polarography and Medicine".

Thursday, June 21

OYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson use, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual eral Meeting; followed by Prof. P. C. C. Garnham: "Looking Parasites in Brazil—an Illustrated Account of a Journey".

APPOINTMENTS VACANT

PPLICATIONS are invited for the following appointments on or ore the dates mentioned:

ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, The Queen's iversity, Belfast (June 20).

LECTURER (with a good degree and suitable teaching experience) MATHEMATICS—The Principal, Leeds College of Technology, okridge Street, Leeds 2 (June 20).

SENIOR ENTOMOLOGIST, and an ENTOMOLOGIST, IN THE DEPARTMENT RESEARCH AND SPECIALIST SERVICES, Federal Ministry of Agri-ture, Federation of Rhodesia and Nyasaland—The Secretary, odesia House, 429 Strand, London, W.C.2 (June 20).

ASSISTANT, Grade B (with teaching and research experience) IN OLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa ad, London, S.W.3 (June 23).

BIOCHEMIST (honours science graduate) for research duties in the riatric Department of the Sunderland Hospital Group—The Senior ministrative Medical Officer, Newcastle Regional Hospital Board, lker Gate Hospital, Benfield Road, Newcastle-upon-Tyne 6 (June).

CHEMIST (with a first- or good second-class honours degree or equiv-nt qualification and at least three years experience, and preferably nowledge of liquid fuels and lubricants) at the Central Laboratory, iswick—The Recruitment and Training Officer (F/EV.587), London nsport, 55 Broadway, London, S.W.1 (June 23).

RESEARCH ASSISTANT (with a good honours degree in physics and ferably some research experience) IN THE PHYSICS DEPARTMENT—e Head of the Physics Department, Imperial College of Science and chnology, London, S.W.7 (June 27).

STATISTICIAN or MATHEMATICIAN (preferably with a university gree in mathematics or statistics or equivalent qualifications) at adquarters, London, S.E.1, to assist in a section devoted to system eration research, and will be expected to apply original mathematical as to the short-term and long-term planning of the system—The rector of Establishments, Central Electricity Authority, Winsley eet, London, W.1, quoting Ref. AE 832 (June 29).

ASSISTANT FORESTERS and FORESTERS (graduates of a recognized estry school), to assist in the management of large-scale softwood ntations, including establishment maintenance, protection and lization, or assist in research—The Agent General for South Aus-lia, South Australia House, Marble Arch, London, W.1 (June 30).

ASSISTANT LECTURER (graduate in physics, chemistry, metallurgy, logy or engineering) IN DENTAL MATERIALS—The Registrar, The iversity, Manchester 13 (June 30).

ASSISTANT LECTURER (with special qualifications either in mycology d soil microbiology or in plant physiology) IN THE DEPARTMENT BOTANY—The Registrar, The University, Bristol (June 30).

DIRECTOR OF THE COMPUTING LABORATORY, situated in Newcastle-on-Tyne—The Registrar, University Office, 46 North Bailey, rham (June 30).

LECTURER IN ENGINEERING (Civil)—The Registrar, The University, anchester 13 (June 30).

LECTURER IN GEOGRAPHY, and a LECTURER IN CHEMISTRY, at the gerian College of Arts, Science and Technology—The Secretary, visory Committee on Colonial Colleges, 1 Woburn Square, London, .C.1 (June 30).

RESEARCH ASSISTANT (with a degree in agriculture, with special erence to animal husbandry or production), for investigations on ccase quality of beef—The Secretary, School of Agriculture, The iversity, Cambridge (June 30).

TECHNICAL ASSISTANT (Display) IN THE DEPARTMENT OF ARCHÆO-GY AND ETHNOLOGY; and a TECHNICAL ASSISTANT IN THE DE-RTMENT OF NATURAL HISTORY—The Director, Liverpool Public useums, Carnatic Hall, Elmswood Road, Liverpool 18 (June 30).

RESEARCH STUDENTS (with a degree of Bachelor or Master of a British university, other than Manchester) IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

LECTURER or ASSISTANT LECTURER (with special interest in inorganic chemistry) IN CHEMISTRY—The Registrar, The University, Sheffield (July 2).

SENIOR LECTURER, LECTURER, and ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (July 4).

ASSISTANT LECTURER (with an honours degree) IN PSYCHOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (July 6).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 6).

READER IN ELECTRICAL ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 6).

SOIL ANALYST (with a degree or equivalent qualification in chemistry, and at least two years subsequent experience), at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 6).

SOIL MICROBIOLOGIST (with a good honours degree and practical experience)—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (July 6).

ASSISTANT (male, with a degree in horticulture, agriculture or botany, together with a keen interest in the scientific aspects of practical fruit culture, and ability to convey the results of research to scientists, advisory officers and growers) IN THE SCIENTIFIC LIAISON SECTION—The Secretary, East Malling Research Station, near Maidstone, Kent (July 7).

PRINCIPAL (male, graduate of a British university, with teaching and, if possible, some administrative and industrial experience) OF THE BRADFORD TECHNICAL COLLEGE—The Director of Education, Town Hall, Bradford 1 (July 7).

SENIOR LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Sheffield (July 7).

DEMONSTRATOR or ASSISTANT LECTURER (with a medical qualification registrable in this country) IN PHYSIOLOGY—The Registrar, The University, Manchester 13 (July 9).

ASSISTANT (preferably with qualifications in psychology) IN THE DEPARTMENT OF LOGIC AND METAPHYSICS in St. Salvator's College, St. Andrews—The Joint Clerk to the University Court, College Gate, St. Andrews (July 14).

LECTURER or ASSISTANT LECTURER (with qualifications in physical or inorganic chemistry, and preferably with experience in radiochemistry) IN CHEMISTRY—The Registrar, The University, Hull (July 16).

FELLOW AND TUTOR IN PHYSICS—The Warden, Merton College, Oxford (July 23).

CHAIR OF CHEMISTRY at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER IN THE DEPARTMENT OF PHILOSOPHY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (September 5).

ASSISTANT REGIONAL TRIALS OFFICER (graduate in botany or agriculture, and preferably practical experience in crop production), at Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

CHEMIST (with a first- or good second-class honours degree in chemistry) with the Geological Survey of Uganda, for the analysis of ores, rocks and minerals with particular reference to the ores of tungsten, beryl, niobium and tantalum and analyses of limestones, and to work in close co-operation with the department's ore-dressing laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD 105/9/06.

DEPUTY DIRECTOR OF RESEARCH—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22.

MASTER TO TEACH PHYSICS including advanced and scholarship levels—The Headmaster, Bishop's Stortford College, Herts.

PHYSICISTS (with, or obtaining, a first- or second-class honours degree or equivalent qualifications) at Ministry of Supply Research and Development Establishments, in the South Midlands and the South of England, for work directed towards the solution of problems and the development of new ideas in the fields of radio communications, radar, guided missiles, aircraft and aircraft equipment, gas turbines, instrumentation, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.214/6A.

PHYSICS LABORATORY TECHNICIAN, for duties concerned with the application of physics to medical problems, maintenance and service of electrical equipment, including high-voltage X-ray sets and electronic equipment used with radioactive isotope work—The Group Secretary, War Memorial Hospital, Scunthorpe.

RESEARCH ASSISTANT (honours science graduate), to work on the chemical and biochemical aspects of cancer research—The Director of Cancer Research, Department of Pathology, Medical School, The University, Birmingham 15.

RESEARCH OFFICERS (preferably with an honours degree in mining, metallurgy or chemical engineering and/or postgraduate experience) IN THE MINES DEPARTMENT, Federation of Malaya, for research into mining and mineral dressing problems and the application of results, through pilot stages, to utilization in the field—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.99/23/01.

SENIOR LABORATORY TECHNICIAN IN THE CLINICAL PATHOLOGICAL LABORATORY, for duties which will be mainly biochemical—The Secretary, The National Hospital, Queen Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry: Meteorological Office. Professional Notes. No. 120: Distribution of Wet-Bulb Temperature at Aberdeen and Eskdalemuir. By A. B. Thomson. Pp. 26. (M.O. 524t.) (London: H.M. Stationery Office, 1956.) 1*s*. net. [64

Royal Technical College, Glasgow. Annual Report on the One Hundred and Fifty-Ninth Session. Pp. 64. Report on Research Session, 1954–55. Pp. 40. Department of Civil and Mechanical Engineering. Postgraduate Course in Environmental Control Engineering and Resource Utilization. Pp. 13. (Glasgow: Royal Technical College, 1955 and 1956.) [64

Aero Research Technical Notes. Bulletin No. 157 (January 1956): "Araldite" for Glass Cloth Laminates. Pp. 6. (Duxford: Aero Research Limited, 1956.) [64

National Institute of Oceanography. Collected Reprints, Vol. 3. (Reprints Nos. 96–124.) (Wormley, near Godalming: National Institute of Oceanography, 1955.) [64

Nuclear Engineering. Vol. 1, No. 1 (April, 1956). Published monthly. Subscription rates for 1 year: 42*s*; U.S.A. and Canada, 7 dollars. Pp. 48+72. (London: Temple Press, Ltd., 1956.) [64

Admiralty Bulletin No. 75: The Hydrographic Department of the Admiralty. Part 1: Functions, History and Organisation. By G. B. Stigant. Pp. 6. (London: Admiralty, 1956.) [64

1956–57 Civil Estimates for the year ending 31st March 1957. Class 8: Agriculture and Food. Pp. 154–xvi. (London: H.M. Stationery Office, 1956.) 5*s*. 6*d*. net. [64

Planning. Vol. 22, No. 395: Britain's Iron Ore Supplies. Pp. 53–68. (London: Political and Economic Planning, 1956.) 2*s*. 6*d*. [64

Forestry Commission. Leaflet No. 10: Oak Leaf Roller Moth. Pp. 7. 6*d*. net. Leaflet No. 37: The Capercailzie. Pp. 10. 9*d*. net. Forest Record No. 30: Growth and Yield of Sweet Chestnut Coppice. By C. D. Begley. Pp. 25+8 plates. 2*s*. 6*d*. net. Report of the Committee of Hedgerow and Farm Timber, 1955. Pp. 64+8 plates. 3*s*. 6*d*. net. Report on Forest Research for the year ended March, 1955. Pp. viii+140+12 plates. 5*s*. 6*d*. net. (London: H.M. Stationery Office, 1955 and 1956.) [64

Annual Report on the Progress of Rubber Technology. Vol. 19, 1955. Pp. vii+158. (Cambridge: W. Heffer and Sons, Ltd., 1956. Published for the Institution of the Rubber Industry.) 21*s*. [124

Wool Industries Research Association. Publication No. 202: Report of the Director of Research for 1955–56. Pp. 32. (Leeds: Wool Industries Research Association, 1956.) [124

Iron and Steel Institute. Special Report No. 55: Physical Aspects of Absorptiometric Analysis—a Consideration of the Principles Involved in and Factors Affecting the Performance of the Hilger Photoelectric Absorptiometer. By the Methods of Analysis Committee, Metallurgy (General) Division. Pp. ii+37+4 plates. (London: Iron and Steel Institute, 1956.) 25*s*. (Members, 15*s*.) [124

Stability Functions for Structural Frameworks. By Dr. R. K. Livesley and Dr. D. B. Chandler. Pp. v+33. (Manchester: Manchester University Press, 1956.) 6*s*. net. [124

British Broadcasting Corporation: Engineering Division. Monograph No. 6: A V.H.F./U.H.F. Field-Strength Recording Receiver Using Post-Detector Selectivity. By R. V. Harvey, G. F. Newell and J. G. Spencer. Pp. 26. (London: British Broadcasting Corporation, 1956.) 5*s*. [124

Physical Society. Handbook of Scientific Instruments and Apparatus, 1956 Exhibition. Pp. xvi+257+88. (London: Physical Society, 1956.) 6*s*. [174

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AUTOMATION AND MANAGEMENT

THE report on the technical trends of automation and their impact on management and labour ich the Department of Scientific and Industrial search has prepared*, and on which the two major litical parties in the House of Commons con- atulated the Department on May 17, does not add nificantly to our technical knowledge of auto- tion. It is important, nevertheless, first as helping minimize the dangers which attend the misunder- andings of the nature and implications of auto- ation and which have already led to its becoming mething of a bogey word; and secondly, it gives convenient summary of the present position of our owledge of the expansion of the scope of mechan- tion, of the development of techniques of auto- atic control and especially of the application of e electronic digital computer to the automatic ocessing of technical information and more par- ularly of the social and human problems which are volved both for managers and for the trade unions. this context, the Duke of Edinburgh's Study onference on Human Problems of Industrial Com- unities within the Commonwealth and Empire to held in Oxford during July 9–27 assumes additional portance.

All these meanings are popularly given to auto- ation, and the report accordingly covers all technical evelopments that make automatic production more ssible. Although the confusion between these fferent meanings has been responsible for mis- derstandings and for some opposition to what is sentially a development that has been in progress r centuries, the report should clarify some at least the confusion and help to abate tension. Auto- ation is put into its proper historical perspective. so far as, like the Minister of Labour in his broad- st on May 4, we restrict its meaning to "machines oking after machines", it only represents the third three continuous and overlapping phases in the evelopment of modern industry. The electronic gital computer, by facilitating the rapid and auto- atic processing of business information, has tended automatic control to complex manufac- uring operations and commercial offices. The pace development has been accelerated; but the principle d techniques of automatic control were already eing developed and applied to manufacturing pro- esses over a widening range of industries. In its urn, such automatic control both followed and roceeded simultaneously with the earlier phase of ne production in which advanced techniques of andling materials and products and assembling omponents had extended the scope of the earlier hase of mechanization.

It is the scale of future developments that has ade automation something of a bogey. It is already ossible to envisage a large and complex, yet fully automatic, factory in which a computer integrates and controls the separate automatic production lines, and almost certainly striking developments in automatic control will come from units incorporating computers. The potential scale of such developments and the economy in labour they seem to offer are reasons for the present concern; the fact that they affect primarily those industries which are turning to mass production and, in thus offering mass consumption, are most sensitive to fiscal and economic policy, is another. The third and most important reason is psychological, arising in part from the shadow cast upon full employment and in part from inherited prejudices and imperfectly understood events of the past.

The report begins by looking at automation in historical perspective, and briefly outlining the conception of automatic production with two examples, one a piston factory in the U.S.S.R., and the other a building-board factory in the United Kingdom. These examples represent the converging of two or more developments; but current progress is mainly in separate streams—transfer machines, mechanical handling and assembly, automatic control of machinery and processes, and clerical work by electronic computers. These all help to make more processes automatic, but do not integrate them and thus do not fulfil the concept of fully automatic production. The present position is accordingly indicated in a chapter on the technical trends, which examines separately developments in automatic machinery, including the control of machine tools by electronic methods in automatic process control, and in the automatic processing of data.

In this chapter some of the future possibilities are discussed; but they are considered more fully in the succeeding chapter on the extent and rate of development. Control equipment in a new chemical plant or petroleum refinery may represent as much as 20 per cent of the entire capital equipment in terms of cost, and in future it should be possible on an electronic computer to integrate with the direct control of all variables in the process and plant the time-consuming calculations needed to assess the effects of deliberate changes in operating conditions, raw materials and plant characteristics. Moreover, if the present trend is followed, much process control of the future will be based on the measurement of quality in the final product, though not until techniques of instrumentation are much further advanced. While computers will almost certainly be introduced gradually in offices, it can already be assumed that there is much scope for them; but their use will call for careful re-examination of office routines and may change them in many ways, not only replacing clerical staff but also permitting the production of data that could not be obtained in time to be useful before, if obtainable at all.

The report suggests that, while it is uncertain how far and how fast automation will proceed, many industries will adopt automatic techniques of production in one form or another. Neither size of firm nor availability of capital appears to be a principal restriction, though progress is likely to be most rapid in the bigger firms with the advantages of larger-scale production and bigger financial resources. The most decisive factor is likely to be the shortage of trained managers, engineers and technicians, partly because of the increasing technical complexity of industrial production and partly because of the existing shortage of scientists and technologists. Indeed, the report goes so far as to suggest that a major re-appraisal of university and vocational training in Britain may be needed.

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* Department of Scientific and Industrial Research. Automation: Report on the Technical Trends and Their Impact on Management nd Labour. Pp. viii+106 (London: H.M. Stationery Office, 1956.) s. net.

That conclusion emerges equally clearly in the chapter which considers the impact on management. This chapter and the succeeding one, which discusses the impact on labour, may well be the two most important in the book. They both point to the imperfections of present knowledge of the economic and social aspects of automation when compared with knowledge of the technical possibilities, and to the vital need of extending knowledge of these aspects by research and exchange of experience. Here, particularly, however, the report is not entirely uninhibited, and it is difficult to believe that its authors have been so lacking in discernment as might be suggested by the absence of comment or suggestions for inquiry into, for example, the problems of trade union demarcation that any wide programme of re-training adult workers is bound to encounter, or the new flexibility in union rules and in some employers' recruitment policies that will be required. Such lacunæ are the more obvious when the list of suggested subjects for research into the social and economic aspects is examined. The recent work of B. C. Roberts, J. A. Mack, H. A. Clegg and A. Flanders, and of others like N. S. Ross and R. Harle, writing in the recent special issue of *The Political Quarterly*, has shown how, if the trade unions are to adapt themselves to fulfil more effectively their new role in the Welfare State, it must be as a result of inquiry and reform from within. It will not be secured, however, by ignoring necessity for change and inquiry, or by failing to point out the directions in which they are required; and the report is notably weak in throwing on management the whole responsibility for difficulties attendant on the introduction of automation, and also in its reluctance to point out directions in which the co-operation and support of the workers are no less essential.

Except in relation to the new skills required, the chapter on labour does not draw any general conclusion pointing to responsibilities on the part of trade unions or workers. Operators on present-day automatic processes need no advanced technical training; but they must learn to understand their processes and machines. They may need more or less skill than formerly; but there is rarely a sharp break with existing skills. The evidence suggests that the new operative skills can be acquired through a moderate degree of training on the job. On the need for flexibility the report is silent; but it suggests that automation is likely to provide real substitutes for satisfactions which have already di appeared from jobs that it is likely to eliminate. Th operator will often see more of the process, receive wider range of technical information, because h must understand how his own job fits in with othe on the same process, and in these and other way his work is likely to be more interesting. This ma be the more important in that by calling for educa tional qualifications in a great proportion of job automation may make it more difficult to advan merely through experience gained on the job.

The new technical and managerial skills—includin those of programmers, 'systems' engineers, mai tenance craftsmen and more highly trained manage —are less easily acquired. If they are taken int account, the general level of skill will tend to rise the sectors of industry affected by automatio especially where routine clerical work is taken ove by electronic digital computers. In some industri even supervisors may require qualifications that ca only be obtained at educational institutes, and th report emphasizes the importance of firms seeking t train and promote the potential managers and technicians of all grades who are still in the ranks. Moreover, co-operation among technical specialists, an between them and managers, on one hand, an maintenance craftsmen and operatives on the othe becomes increasingly important; technical co-operation with maintenance men and technica management may provide a new social satisfactio for the operatives on automatic processes, who ar often spread thinly over a big area and may find i keeping the machine-line or process running a satisfaction they might formerly have found in membership of an operative team.

The bearing of all this on the expansion of technica education is obvious. The implications for educational policy are no less important, and the report a a whole emphasizes the vital importance of plannin educational expansion as a unity. If qualities lik versatility, adaptability and the capacity for understanding other points of view look like bein increasingly valued in managers and professiona staff, in a lesser degree they are called for in other also. Consultation with the trade unions in advanc of each step and the most careful attention to th needs, feelings and problems of the workers concerne will not ease the transition to automation if th workers are unwilling or unable to respond and ar incapable of seeing the problem against the perspective of the position of the industry and the need of the nation as a whole rather than of any on section of it.

So far as factory management is concerned, automation greatly increases the need for planning in order to minimize the technical inflexibility of highl integrated plant, to establish maintenance aimin at preventing faults, thus minimizing stoppages an achieving a high and constant rate of output, an providing for continuous running of machinery Existing techniques of management may need t give way to new techniques that suit automati processes, as, for example, in the systematic stud of operations, the use of computers and the contro f costs. Again, the necessary changes in operative ills will be made more smoothly if they are care- lly planned, if proper provision is made for training the job, and if workers are consulted and kept ell informed of likely developments. Moreover, ise management offers the best hope of surmounting ifficulties in persuading workers to accept the shift- ork essential for continuous running and in main- aining the workers' interest in the job without the egular social contact which the traditional operative eams afford.

These aspects of the tasks of management under e impact of automatic techniques of production ow how important it is that technological education ould be broadly based, and associated so far as ossible with those types of courses which in the ast have proved so successful in developing adminis- ative ability and the capacity for initiative, the cceptance of responsibility and powers of leadership. f the need for communication and co-operation in dustry is greatly increased, as this report suggests, xcessive specialization in order to provide technical nowledge may be a danger rather than a help unless hese qualities are safeguarded. Vision and imag- ation as well as versatility and adaptability will be equired, if management is to soften the impact of utomation on labour. All grades of management ill indeed require fuller knowledge of the technical actors that influence their decisions; and while it will e more important than ever to plan the construction f a new plant well in advance, such planning must ake account not merely of the technical com- lexities and aspects of production, but equally of he problems of organization of labour, including the lanning of man-power requirements and the avoid- nce of redundancies where possible by utilizing, for xample, natural wastage and labour turnover.

A number of the suggestions for research appended o the report are relevant to problems of management. or example, there is research into the economics nd social implications of shift-working, on which a tart has already been made at the Universities of heffield and Cambridge. At the South-East Essex echnical College and at the University of Edinburgh, ork has already been started into the forms of anagement structure and organization most effective ith automatic processes; but other work is sug- ested into the new techniques of management equired by automation and into methods of planning an-power requirements, for example, the planning f innovations to coincide with natural fluctuations n the labour force.

Like other developments that increase the com- lexity of techniques of production, automation akes it essential that scientists and technologists hould be given their right place in management, ecause technical considerations affect an increasing umber of policy decisions on investment and on the outine operation of plant. Managements require a road understanding of the new principles emerging rom scientific and technical developments, and echnologists and scientists require a clearer under- tanding of the economic and other managerial factors involved in implementing technical views. The report itself suggests that scientists and technologists are likely to be found at board-level more frequently than in the past, and some functional departments will increase in importance. It also queries the suitability in automation of the 'line-and-staff' principle of responsibility, though more by way of a matter for inquiry.

Much of this has been urged by Dr. P. V. R. Venables, by Sir John Cockcroft in his address to the Institute of Physics last April on "Science and Technology in Industry" and by others; both the Rector of the Imperial College of Science and Technology and the Principal of the Manchester College of Technology have indicated that the projected expansion at both Colleges is planned to provide technologists of the outlook and calibre demanded. Lord Heyworth again, at the annual meeting of Unilever, Ltd., on May 24, specially stressed the importance of good managers in industry, devoting most of his speech to their selection, background and training. If the Department of Scientific and Industrial Research's report on automation in the first place points to the urgent need for inquiry into the human and social aspects of automation, it equally presents the problem of finding managers of to-morrow of the requisite competence as one of the leading questions of the day. The report will have served its purpose if it brings the Government to a belated appreciation of the critical importance of that question.

As already emphasized, the report, however, also demonstrates the importance of looking at the expansion of education as a whole. It shows how vitally important to the economic and industrial future of Britain is the expansion not merely of technological education but also of technical education, and as a corollary the public understanding of technological change and what it involves. The Government has done well, as indicated in the reply of the Parliamentary Secretary to the Ministry of Labour and National Service to a question in the House of Commons on May 29, to promote the publication of a simplified version of the report for wide circulation, and there is much more needed to remove misunderstandings and fears of redundancy while the National Joint Advisory Council is considering the implications of the report itself. But the Government cannot rest there. It should be implementing, on an adequate scale, from our own resources and not merely from funds provided by American generosity, the researches into the economic and social aspects of automation which the report suggests. Even more important, it should be handling the educational issues with real determination and imagination, and no longer allow prejudice and tradition to impede the formulation and execution of a national policy adequate alike in scope, in content and in the resources with which it is provided. Lastly, the Government should be facing the issues involved in re-training and mobility of labour, so that its assistance policies do not subsidize under-employment and resistance to change but afford real help to those affected in the difficult period of transition from one job to another.

GEORGIUS AGRICOLA

Georgius Agricola 1494–1555 zu seinem 400 Todestag, 21 November 1955

(Deutsche Akademie der Wissenschaften zu Berlin.) Pp. 376+23 plates. (Berlin: Akademie-Verlag, 1955.) 38 D. marks.

De Natura Fossilium (Textbook of Mineralogy)

By Georgius Agricola. Translated from the First Latin Edition of 1546 by Mark Chance Bandy and Jean A. Bandy. (Geological Society of America Special Paper 63.) Pp. xiii+240. (New York: Geological Society of America, 1955.) 3 dollars.

THE four hundredth anniversary of the death of Georgius Agricola[1] (1494–1555) has been marked in Eastern Germany by the publication, under the auspices of the German Academy of Sciences at Berlin, of a commemorative volume containing twenty-five essays concerning various aspects of his life, work and times. Agricola was a man of varied accomplishments—one of the great scientists of the sixteenth century and also physician, scholar and diplomat—and these essays should have a wide appeal.

It is impossible, within the limits of a short review, to do more than refer briefly to the subject-matter of individual essays. The first, by Prof. Leo Stern, of Halle, is of an introductory character, dealing generally with Agricola's life and mentioning the many contemporary scholars whose work in some way impinged on his. Other essays cover particular periods in his life, and one which calls for special mention is the account, by Dr. Helmut Wilsdorf, of Freiberg, of Agricola's *Wanderjahre* in Italy and some of the English scholars whom he may have met there. The contemporary background is also discussed in articles on mineral collectors and collections of the sixteenth century, and on the songs of the miners; and a brief account of the miner and his work as delineated in contemporary art is accompanied by a number of attractive plates. One of these illustrates the beautiful frontispiece of the famous "Kuttenberger Kanzionale" (a manuscript volume of old songs in the possession of the Vienna National Library), depicting the whole gamut of mining activities, from the miner deep in the mine to the eager shareholders receiving their profits. Both this plate and that of the miners' altar at Annaberg would have gained immensely by reproduction in colour.

Many of the contributions are reviews, by experts, of different chapters in Agricola's most famous book, the "De Re Metallica". These deal with subjects such as mining law, mine machinery, ore-dressing, metallurgy and surveying in the sixteenth century. Among them is a valuable contribution by Dr.-Ing. P. Beyersdorfer, a glass technologist, comparing the account of glass manufacture given by Biringuccio in his "Pirotechnia" (1540) with that given by Agricola. A well-illustrated article on the woodcuts in the "De Re Metallica", by Dr.-Ing. W. Pieper, includes a reference to the suggestion, recently made by Dr. H. Prescher, that Agricola himself is represented in one of the woodcuts depicting tin-smelting, by a figure industriously writing in a note-book (p. 415 in the Hoover (1912) translation).

There are several essays on the influence exerted by the work of Agricola on mining in neighbouring countries, including one on the development of mining in Russia from the sixteenth to eighteenth centuries. This stresses the value attached to Agr cola's writings by the great Russian scientis Lomonossov.

Agricola published all his specifically geological an mineralogical writings together in one volume, in 1546 the work being generally known by the title of the firs part, "De Ortu et Causis Subterraneorum". The contents of this volume have unfortunately received muc less attention than they deserve. Dr.-Ing. Walthe Fischer, in an essay entitled "Agricola, Father o Mineralogy", discusses the valuable contributions t mineral science found in "De Natura Fossilium", th third section of this volume, and also mentions som of Agricola's opinions on such subjects as volcanoes earthquakes and ore-genesis; but one could hav wished for a fuller treatment of these subjects Another section in the same volume, with the titl "De Veteribus et Novis Metallis", a valuable historica account of mines, is discussed in a second essay b Dr. Wilsdorf, who advances the claim that Agricol laid the foundation for a history of mining.

Other aspects of Agricola's life are described in articles on his work as physician, on his books on money and on weights and measures, and on hi services as burgomaster of Chemnitz (now known a Karl-Marx-Stadt). The volume also includes an annotated record of Agricola's known correspondence published and unpublished, with a reproduction o his handwriting. There is no index, and the volume ends with a somewhat over-elaborate table of the various editions of Agricola's numerous publications This is useful, but its value would have been greatly enhanced if more bibliographical details had been given.

This commemorative volume is of especial value as a detailed study of mining and related activities in central Europe during the sixteenth century, but it should also have a considerable appeal to all interested in the development of science during that period.

In America, an appreciation of early mining and metallurgical classics has been manifest for a number of years. This interest was first stimulated by the publication of the well-known translation of Agricola's "De Re Metallica" by the Hoovers in 1912 Since then there have come in succession from the United States scholarly translations of A. A. Barba's "Arte de los Metales", of Biringuccio's "Pirotechnia", of early sixteenth-century editions of the mining and assaying works known as the "Bergbüchlein" and "Probierbüchlein", respectively, and of Lazarus Ercker's "Treatise on Ores and Assaying". Now the Geological Society of America has entered this field by publishing a translation, by M. C. and J. A. Bandy, of Agricola's "De Natura Fossilium". The translation has been made from the first edition, published in 1546, and not from the second edition, which was enlarged by Agricola himself, although not published until 1558, three years after his death. This treatise on minerals forms the third section in the volume of Agricola's geological and mineralogical writings mentioned above, and in it the term "fossilia" is used to include anything inorganic dug out of the earth. We find, therefore, not only accounts of minerals, but also of clays, and their use by potters and sculptors, of marls, and their use by farmers, of bricks, marbles, and even of incinerary urns. Although Agricola frequently quotes Pliny and other early authors, he adds many interesting comments of his own, such as "Within the year thirty-five buildings in Magdeburg have had lead roofs put on them", a statement which iggests this book might be of interest to economic istorians.

While this translation is most welcome, one misses e many scholarly notes that form so valuable a rt of the Hoovers' work. Many of their notes do, fact, refer to the "De Natura Fossilium", and some oss-reference to them would have been useful to e reader. However, a number of explanatory foot- otes have been included with this translation, as ell as indexes of mineral names in English, Latin d Greek. There is, unfortunately, no index of ace-names. A few misprints and errors have been oticed, such as "agate" on p. 18, line 33, for aetites".

This little volume should have a wide circulation, nd it is to be hoped it will be followed by translations to English of other works by Agricola, particularly e "Bermannus" of 1530, of which a new German anslation, by Dr. Wilsdorf, appeared as recently as 955.

JOAN M. EYLES

See *Nature*, 176, 949 (1955).

WISCONSIN SYMPOSIUM ON SOLAR ENERGY, 1953

olar Energy Research

dited by Farrington Daniels and John A. Duffie. p. xv+290+11 plates. (London: Thames and udson, Ltd., 1955.) 30*s*. net.

RESEARCH on the utilization of solar energy has received a very great impetus as a result of onferences that have been recently held in Arizona ee *Nature*, Jan. 21, p. 110). This book is a record f the proceedings of an earlier conference organized y Prof. Farrington Daniels at the University of Visconsin, Madison, in September 1953. Though ess ambitious than the Arizona meetings, the adison conference offered the first opportunity for any of those actively engaged in solar research to ome together and discuss their problems. The book onsists of a series of chapters written by those ttending the conference or invited to contribute, nd covers most of the aspects of the utilization of olar energy. These may be summarized briefly nder the following headings: collection of solar adiation in the form of low-grade heat (that is, below he normal boiling point of water, as used for water nd house heating, and water distillation); concen- ation of the radiation by mirrors to produce high emperatures for melting metals and refractory aterials; conversion of radiation to electricity, ither by thermoelectric methods with heat as an itermediate stage, or by photovoltaic effects; hotochemical effects in which the equilibrium f a chemical system is changed by the action of ght; and photosynthetic processes through living lants.

An introduction by Prof. Farrington Daniels xplains the object of the conference and is followed y a section on probable world energy demands in e future, in which P. C. Putnam predicts that in a undred years time solar heat collectors might supply early 10 per cent of the world's demand in the form f low-grade heat, though only 0·1 per cent in the rm of power. Incidentally, 60 per cent is quoted r nuclear fuels and 25 per cent for fossil fuels. nowledge of the influence of meteorology on solar adiation and measurement of solar radiation are essential for a study of applications, and these factors are discussed in the succeeding chapters.

The nine chapters which follow collate papers on space heating and domestic uses of solar energy; solar power, solar evaporation and distillation, atmospheric phenomena and conversion of solar to electrical energy, solar furnaces, photosynthetic and photochemical utilization of solar energy, the British point of view, and miscellaneous applications and suggestions for further work. An appendix by Dr. John A. Duffie, of the University of Wisconsin, contains a survey of United States patents on the subject and a bibliography. Most of the sections consist of three or four papers by well-known research workers on the subject, and describe in a clear and lucid manner the present state of knowledge and the future possibilities.

The object of the symposium was to summarize the situation regarding the utilization of solar energy, and it is possible that the recent world conference in Arizona was, in some respects, promoted by the interest aroused at this earlier meeting. Many people with thoughts on the future development of world energy resources are inquiring about the possibilities of utilizing solar energy directly. The contents of this book appear to have been arranged for the express purpose of explaining these, and are written in an easily readable style with adequate illustrations. The complete volume gives the best outline at present available of activities in the utilization of solar energy.

THERMODYNAMICS FOR CHEMISTS AND CHEMICAL ENGINEERS

The Principles of Chemical Equilibrium, with Applications in Chemistry and Chemical Engineering

By Prof. Kenneth Denbigh. Pp. xxi+491. (Cambridge: At the University Press, 1955.) 42*s*. net.

AN understanding of thermodynamics is essential for all who are concerned with quantitative aspects of chemical processes, and yet most students find its concepts too abstract for rapid assimilation. A major difficulty is that the link between thermodynamics and the familiar and easily comprehended molecular theory is statistical mechanics, and most teachers, and apparently most authors, are of the opinion that the student is even less receptive to this subject. The order of presentation of most courses of physical chemistry is therefore molecular theory, thermodynamics and, finally, statistical mechanics. One wonders whether the problem of presentation is not the root of the vast number of books on thermodynamics and whether this spate of texts, each one of which may have a different emphasis, approach and nomenclature, is not a further barrier to the understanding of the often benumbed student. Every teacher of this fascinating and fundamental subject must be assailed by doubts of this kind when he opens the pages of yet another volume.

None the less, Prof. Kenneth Denbigh's book is a welcome addition to the multitude. It is intended for students in their final year of a chemistry or a chemical-engineering degree course, who have already had some acquaintance with the elementary parts of the subject. The first part (100 pages) introduces the first and second laws, the usual thermodynamic functions and conditions of equilibrium, while the second (214 pages) is concerned with the application to gases, gaseous equilibria, phase equilibria and solutions. The approach throughout is properly based on the chemical potential, and the treatment, always adequate, is at times illuminating. The student who works through these chapters will be amply rewarded; but work he will have to, for although care has been taken to ensure clarity, the style is at times ponderous and he may well get the impression that the subject is more difficult than it really is. He will be helped, however, by the illustrations in the text and by the graded problems at the end of each chapter—a very valuable feature of the book. Only by submitting himself to the rigid discipline of working examples does the student begin to appreciate the value and versatility of the thermodynamic tool and to acquire the confidence to use it in attacking practical problems. The chemistry student will find the treatment of cells and electrolytes too brief and will regret the exclusion of surface phenomena. The third part (150 pages), devoted to statistical mechanics, contains interesting chapters on the statistical analogues of entropy and free energy, the partition functions of gases, and crystals and the third law, but the beginner may find them above his head. The two final chapters, one giving a brief treatment of regular solutions and adsorption, and the other on some aspects of chemical kinetics, might well have been replaced by a statistical treatment of chemical equilibrium, which receives only scant attention. There is even no mention of the functions $(G^0-H^0_0)/T$ and $(H^0-H^0_0)$ and of their use.

Prof. Denbigh's book will be useful to the brighter students and to teachers of the subject; but those applied chemists and chemical engineers who wish to be led gently up the thermodynamic slope may seek a less strenuous guide.

TOWARDS THE NEW CYTOLOGY

Physiologie der Zelle

Von Dr. Johannes Haas. Pp. 474. (Berlin-Nikolassee: Gebrüder Borntraeger, 1955.) 48 D.M.

THE need for a text-book presenting an integrated account of cell organization in the light of developments of the past twenty-five years has for some time been evident, and Dr. J. Haas's book goes a long way towards satisfying this need. The modernity of its approach is indicated by an initial section on molecular morphology, accounting for about one-third of the volume. There is to this extent a certain parallel with Frey-Wyssling's book, "Submicroscopic Morphology of Protoplasm and its Derivatives"; but there is a wealth of difference between the two, for the emphasis in Dr. Haas's book is primarily biochemical. Within the compass of a hundred and sixty pages he examines the structure and properties of proteins, nucleic acids, enzymes and lipoids, and then proceeds to a consideration of cell organelles: cytoplasm, cell surface, mitochondria, nucleus and interphase-chromosomes (119 pp.). In a third section he discusses selected cell functions: respiration, exchanges with the environment, cell division, growth and differentiation (155 pp.).

The extent to which the author has succeeded in integrating a work of this scope is highly commendable; but he has not managed to avoid repetition It would be easy to draw up a list of reference missed, and for British and American readers ther will be some shocks; but these omissions do no impair the over-all achievement. They are mor than offset by the number of references which will be new to many readers.

On a different plane of criticism, one may perhap regret that Dr. Haas seems not entirely conscious o the revolution in ideas which has occurred and o which he displays the results. He states (p. 17) tha the object of physiology is the study of function in its dependence on organic structure prevailing at given time. It is to be doubted whether any physiologist of thirty years ago would have so expressed hi aim; and there are probably many physiologist to-day who will be surprised by such a definition For cell physiology, the definition is a concise statement of present aims; but Dr. Haas allows it to pass as if it were a commonplace. Related to thi lack of historical awareness is a more serious criticism—the more serious since this book is clearly a text book—namely, that he frequently introduces a nev topic by a statement derived from classical cytological views, but made as if those views still retained their original force. Thus he quotes without commen (p. 170) Wilson's view that the structureless hyaloplasm is the most constant and active component o the cell, even though he is well aware of the exten to which this opinion requires modification in the light of the role of the mitochondria. Again, he repeats—and does so as if the generalization admitted of no exceptions—that "the living nucleus appear optically empty, both in normal light and dark ground". If students are to be spared the necessity of leaping old hurdles, it is the limited value of the light-microscopic image which requires emphasis and what is important is that the nucleus is *no* optically homogeneous when viewed by phase contrast. The reason for such statements is the difficulty we all experience of escaping from the somewhat mystical concepts of classical cytology the twin man-made ghosts, *the* nucleus and *th* cytoplasm, both homogeneous in the light-microscope—and by implication homogeneous in every other respect as well.

Not only in cytological matters, but also in the exposition of biochemical topics, Dr. Haas sometime modifies his initial position profoundly and disconcertingly at a later stage. Thus, the discussion o molecular shapes (p. 28 *et seq.*) proceeds as if chain molecules of the linear polypeptide or polysaccharide type were the only type of linear macromolecule known. Not until the discussion of cytoplasmic structure (p. 194) do we learn of polymerization o globular molecules to form fibrils.

Dr. Haas writes a simple German style of somewha unusually short sentences. Particularly successful sections are those on mitochondria, nucleus, cell respiration, growth and differentiation. It is eviden that considerations of cost have influenced both layout and the extreme economy of illustration. The latter is regrettable; for Dr. Haas's book, in spite o its title of 'cell physiology', is a 'cytology'. That i one indication of the distance travelled during the past twenty-five years; another is this, that the name of Boveri occurs but once, and without reference.

LAURENCE PICKEN

LEARNING IN MAN AND ANIMALS

THE discussion on "Learning in Man and Animals" on May 16, initiated by the Section of Comparative Medicine of the Royal Society of Medicine, fell into two relatively clearly differentiated parts. One of these might be called naturalistic-empirical; concern here is with field-observations and the direct assessment of certain experimental modifications. Dr. W. H. Thorpe's discussion of "Key Problems in Animals" is characteristic of this approach.

Dealing with the problem of instinct in animal learning, Dr. Thorpe pointed out the value of studying the songs of birds in this connexion, particularly in view of technical advances made in recent years (he instanced tape recordings and electronic methods of analysis). Some birds apparently have their song patterns determined completely by heredity, so that the self-same patterns are produced even when they are brought up in complete isolation. Other birds, such as chaffinches, react to such 'Kaspar Hauser' experiments in rather a different manner. The song pattern resembles that of birds brought up normally, in its broadest outline, but lacks all the finer modulations and modifications. If such birds are brought up in groups, they do learn to modify the original pattern until, finally, all the birds in the group produce patterns which are virtually indistinguishable from each other. These patterns do not change even when later on the birds are exposed to song patterns of free animals, and thus 'group learning' may account for the well-known facts of local dialects in chaffinches. Chaffinches do not learn the songs of other birds like, for example, bullfinches, who will learn almost any kind of pattern quite easily.

Regarding the learning ability of animals and particularly birds, Dr. Thorpe mentioned the recent work of Otto Köhler in Austria, who has studied the counting ability of birds and squirrels. Much of the previous work in this connexion has been vitiated because of accidental clues, and this recent work is notable because of its experimental rigour. In one group of experiments, jackdaws were taught to open a box having on it a number of dots corresponding with a number of dots on a key card presented to the animal. Great care was taken to vary the positions of cards and boxes, to randomize the size, shape and position of the dots, and in fact to eliminate all possible clues except that of number. Under these conditions it was proved conclusively that birds can compare groups of units and act in accordance with this information. The limit of this ability appeared to be in the neighbourhood of six or seven. This is an interesting finding in view of the fact that in human beings also the process of number estimation shows a definite break roughly at this number. Below it human beings appear to employ a process of what has been called 'subitizing', which is characterized by immediate, errorless, apprehension of number. Apparently birds possess this ability to the same extent as man; what they do not apparently possess is the additional ability to count. Learning along these lines appears to be quite reliable and accurate in birds. The interesting point was raised that there appears to be no obvious biological function which this ability serves, as the birds cannot be assumed ever to use number estimation in their natural habitat.

Mr. B. B. Boycott's paper on "The Neural Basis of Learning in *Octopus vulgaris*" dealt mainly with the abilities of octopus to learn to discriminate between different stimuli, and the effects on memory of the removal of parts of the vertical lobe. Discrimination learning was established by associating rewards (crabs) with one figure, and electric shock with another. Apparently the animals have no difficulty in establishing differential responses to black as opposed to white, to large as opposed to small, and to differences of position. They tend to fail in shape differentiation, as, for example, in discriminating between a square and a diamond, or a square and a circle.

Memory was studied after the removal of various parts of the vertical lobe, an important aspect of the experiment being that operations were carried out both before and after the original learning had taken place. The results indicated that the proportion of brain tissue removed had an important effect on the decrease in efficiency of performance, very much as had been found by Lashley, many years ago, in the case of rats. The results are difficult to interpret, however, because the experimenters failed to differentiate between learning and performance, using the latter as an index of the former. That this is inadmissible was shown quite clearly in one of the experiments described, in which it was found that an octopus after operation apparently lost all power of discrimination when the positive and negative stimuli were presented with the bait actually on them, but showed almost perfect discrimination when the stimuli were presented without the bait. In fact, there appears to be a close similarity between leucotomized humans and brain-operated octopus in terms of greater impulsiveness and lessened inhibition. These temperamental effects of brain damage are important and might be worthy of closer study.

The next two papers dealt rather with theoretical models in terms of which results of learning experiments can be analysed. While also concerned with experiments, it should be noted that adherence to this approach implies a rather different attitude compared with the naturalistic field-study type of approach, which in its extreme form appears to study facts for their own sake. To the theoretical psychologist the experimental demonstration or the empirical fact is important in so far as it contributes to a theoretical formulation or decides between several deductions from different theories. At the present stage of research on learning, both types of approaches are of obvious interest and value and serve mutually to complement each other.

In his discussion of "What Do We Learn ?", Dr. H. Kay was concerned with putting forward a version of what is sometimes called the probabilistic theory of learning. According to this way of looking at the learning process, past experience establishes certain expectancies according to which an individual judges the most probable sequel of any given stimulus. Such a model has obvious relevance to conditioning experiments, and Dr. Kay demonstrated for many everyday situations that an explanation of learning in terms of the dependent probabilities within a series of events can be made to appear reasonable. He extended this type of analysis to the learning of simple skills, showing how the learning of such simple acts as that of catching a ball can be interpreted in probabilistic terms.

The strength of such an approach lies in the ease with which quantitative analysis becomes possible; we can obviously measure probability of occurrence of a given act in terms of the relative frequency with which the act is in fact performed. The obvious weakness of the approach is two-fold. In the first place, the probability of an act changes with its performance, so that it is difficult to attribute any operational meaning to the probabilistic analysis in the case of the individual person. We can do so only in terms of groups of people, and it is doubtful to what extent the averaging of responses is permissible. It has been suggested that, as a general rule, averaging of response-rates is permissible only when the formula according to which growth takes place can be expanded by Taylor's theorem; this sets severe limits to this form of analysis. Another, and probably more fundamental, objection to this model is that it seems to leave psychology behind altogether by its complete failure to analyse the different components (drives, habits, etc.) which enter into the learning process.

As the last of the four papers, Prof. H. J. Eysenck's discussion of "Modern Learning Theory" presented a more orthodox type of model which has become widely accepted among psychologists. This model, which is due largely to the work of C. L. Hull, is a combination and formalization of two streams of thought, both of which are of considerable antiquity. One component is that of hedonism, or motivation by pain and pleasure; this was formalized and subjected to experimental study by Thorndike as the 'law of effect', and now emerges under the name of 'reinforcement' or 'drive reduction'. The other component is that of associationism; this was brought under experimental control by Pavlov and Beckterev, in the form of conditioning or habit formation. Hull joined these components in an impressive theoretical structure the formal character of which makes possible large numbers of experimental predictions, many of which have been verified. This approach, it should be stressed, is a purely molar one; the concepts are what psychologists call 'intervening variables' or 'hypothetical constructs' for which no neurological or physiological equivalent is necessaril postulated.

The most important concept in the theory is dissociation of performance (symbolized by Hull a ${}_SE_R$) from habit (symbolized as ${}_SH_R$). Habit i conceived as a relatively permanent modification o the nervous system which mediates all learning performance can only be used as an index of thi modification under certain conditions. To equate th two, as is often done by experimenters lackin psychological sophistication, is to invite disaster Much experimental work has been done on th conditions determining the growth of ${}_SH_R$, an among those found are: the number of reinforcements given, the nature and amount of the reinforcin agent, and the delay in reinforcement.

The fundamental formula linking performance an habit introduces the concept of drive which acts a a multiplicative variable according to the followin formula:

$${}_SE_R = {}_SH_R \times D$$

Further concepts are necessary to make this formul applicable to the majority of experimental studies In particular, we must add the concepts of reactiv inhibition (I_R) and of conditioned inhibition (${}_SI_R$). According to the theory, all learning, that is, al formation of stimulus–response connexions, produce some degree of inhibition or fatigue in the mediatin structures; this fatigue acts as a negative drive and tends to dissipate with time during periods of rest. Such dissipation acts as a reinforcement for the prevailing state of affairs, namely, the state of rest, so that we obtain a concept of conditioned inhibition which is essentially a negative habit, that is, a habit of not responding to the stimulus.

There is strong evidence to support this type of analysis, and the fact that many predictions can be made from the general theory, which can be experimentally verified, has led to its adoption by large numbers of students of the theory of learning. One such prediction was discussed in some detail, namely, that linking the predominance of inhibitory potential with extraverted and hysterical-psychopathic personality types, while linking the predominance of excitatory potential with introverted, anxious, depressive personality types. Experimental evidence from conditioning and other studies employed bears out this linkage.

METEOROLOGICAL RESEARCH AT PORTON

By Dr. F. PASQUILL

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FROM its beginnings in 1921, research in meteorology at Porton has been primarily concerned with the study of atmospheric diffusion, and the current programme of observations, which was formally incorporated in the research programme of the Meteorological Research Committee of the Air Ministry early in 1955, involves no departure from tradition in any fundamental sense. It does, however, contain new items which significantly reflect the broadening of interest from small-scale processes such as those involved in smoke screening, to larger-scale processes such as those which determine the dissemination of 'cloud-seeding' agents from generators operated on the ground.

In considering the new lines of investigation, it will be useful first to note briefly the position reached in the earlier work. Shortly after the end of the Second World War, the now well-known pre-war studies of eddy motion and diffusion in the atmosphere near the ground were consolidated and extended, and it is especially noteworthy that by appealing ultimately to the experimentally established laws for the drag exerted by a rough surface on fluid motion over it, the *vertical* diffusion of airborne matter was quite accurately related to the observed vertical profile of wind speed over the particular surface. This important result has two limitations, first, in being restricted to the height-range over which the horizontal turbulent shearing stress may be assumed constant (usually taken to be of the order of 100 ft.), and secondly, in being applicable only in the absence of buoyancy effects, that is, in the absence of marked temperature gradients which so frequently occur vertically in the lower atmosphere. Some extension to these conditions was attempted on the basis of the observed diminution of the influence of buoyancy as the boundary is approached; but the device has only been partially justified in unstable conditions and it appears not to be acceptable at all in stable conditions. No really satisfactory progress has recently been made in the case of *horizontal* diffusion, and for the time being reliance must continue to be placed on some form of analogy with vertical diffusion.

The point to be emphasized at the present stage is that, although it is not uncommon for the prevous results to be extrapolated, there is nothing in the observations and the theoretical understanding which justifies this procedure beyond about 1,000 yd. in distance and 100 ft. in height. It is clear, therefore, that the first requirement imposed by the present extension of interest is for the accumulation of reliable observational data on the distribution of airborne material at distances of at least tens of miles from a known source. It is also necessary to examine the eddy structure which leads to this distribution; and since experience quickly shows that in tens of miles material released at the ground may diffuse vertically to thousands of feet, this examination must accordingly be made at heights considerably greater than those usually adequate in micrometeorological investigations. These last few features determine the form of the new experimental studies which are at present being carried out at Porton by the Meteorological Office in conjunction with the Ministry of Supply.

Observations of the distribution of airborne material at 'medium' range from a point source are being made with the aid of a tracer technique originally developed in the United States. A fluorescent pigment, zinc cadmium sulphide, is dispensed into the atmosphere at a controlled rate of the order of 100 gm. per min., and samples of the particles, which are mainly in the size-range 1–5 microns in diameter, are afterwards collected by drawing air through an impactor which contains an adhesive receiving surface on a drum. This drum may be rotated by small amounts at predetermined intervals, so that over a period of time a large number of separate samples may be stored on a single drum. Under ultra-violet light, the particles fluoresce with a characteristic yellow-orange colour and so may be distinguished from naturally occurring fluorescent substances and counted with confidence. As 1 gm. of the pigment disperses into something like 10^{10} particles, it can be seen that the method is remarkably sensitive.

In practice, the impactor is carried across the plume of particles by an aircraft operating at various heights in succession, or by a motor-vehicle travelling along conveniently situated roads. In this way the distribution in a cross-wind section of the cloud is obtained at various distances. Preliminary experiments during the first part of 1955 provided encouraging experience in using the technique at distances up to 40 miles and heights up to 4,000 ft., and at the same time gave a useful rough indication of the distributions to be expected in point-source clouds in certain conditions. The plan is now to conduct the experiments systematically in a number of well-defined synoptic conditions. The experiments are quite difficult operationally, requiring to start with a coincidence of predictable suitable weather conditions and the availability of an aircraft. They also bring new technical problems, such as the quantitative sampling of an aerosol cloud at the high speed of an aircraft and—a problem now receiving attention—the collection of samples in the presence of a cloud of water droplets, when the usual impactor technique becomes unsuitable. Also it is clear that the diffusive properties which are being examined exhibit a great degree of inhomogeneity, and can be described adequately only in a statistical sense from a large number of experiments. For such reasons the progress in this investigation will probably be slow.

The study of eddy structure and its effect on diffusion may be made along two lines: first in terms of the eddy velocities and their variation in space and time, and secondly in terms of the statistical behaviour of identifiable particles which may be assumed to follow the local air movement. The second line is, of course, being followed in the tracer experiments just referred to; but it is exploited there only in a broad fashion, and the resulting knowledge of the final distribution in a field of turbulence which frequently varies in space and time may itself be of limited value. It seems most necessary to support these observations with more penetrating experiments on the diffusion of particles; and for the design of these experiments and the provision of a framework to hold the results the most encouraging prospect seems to be offered by the statistical theories of turbulence. These theories recognize two ways of describing the diffusive motion of particles, one referring to the statistical displacement of a single particle with respect to its origin, and the other to the separation of a pair of particles with respect to some initial separation. There are important fundamental issues involved in distinguishing between these two systems of description; but the choice is usually affected to some extent by convenience in interpreting the observations in a practical sense and to a large extent by the feasibility of the experiments which would be appropriate. On these grounds choice has initially fallen on the former system, though experiments involving the latter system are now under consideration.

A good deal may be gained by designing the experiments on dispersion of particles for sites well above the surface, for then not only is attention directly paid to the higher levels, which must control diffusion ultimately, but also the avoidance of the marked shear in the airflow near the surface should ensure a simpler form of diffusion more amenable to treatment by theories which for tractability require the assumption of steady homogeneous turbulence. The present experiments have accordingly been planned to use dispersing and collecting equipment carried on the cables of tethered balloons, and for obvious reasons vertical diffusion rather than horizontal is investigated. Unfortunately, the conventional filtering or impacting equipment normally used for collecting particles is far too elaborate and heavy for extensive use in this fashion. This difficulty has been overcome by merely allowing the particles to impact naturally on adhesive cylinders held into the wind by light vanes spaced out along the balloon cable. Spores of *Lycopodium* are used as these are big enough (30 micron diameter) to impact with reasonable efficiency (near 50 per cent in normal wind speeds for a cylinder of diameter 0·25 in.), relatively easy to recognize and count under a microscope of moderate magnification, and yet possess a free falling velocity (2 cm./sec.) which will normally be much less than one-tenth of the vertical eddy velocities.

A first series of experiments has been carried out using the above technique, the particles being released for half an hour at a time at a height of 500 ft. and sampled at distances of a few hundred yards downwind. At the same time the fluctuating inclination of the wind at the position of release of the particles was measured by a light responsive vane, the movements of which were recorded electrically at ground-level. This instrument was designed especially for use on a balloon cable and includes automatic compensation for the varying inclination of the cable. The few results analysed so far indicate that even after a travel of 500 metres, the vertical distribution of particles may still be very closely in accordance with the distribution of the inclination of the wind. This implies the existence of a Lagrangian type of correlation, that is, one which is concerned with the velocities of the same sample of air at successive intervals of time, with a coefficient maintained close to unity for as long as one minute or more. On the other hand, from the 'instantaneous' values of wind inclination, it was found that the Eulerian correlation coefficient, namely, that between the inclination at a fixed point at a given time and the inclination at the same point some time later, had fallen to near zero in about 10 sec. This much greater persistence of velocity in a Lagrangian than in a Eulerian sense is a known feature of wind-tunnel turbulence, and evidence is now accumulating for a similar feature in atmospheric turbulence. If it is confirmed, this would mean that the convenient substitution of the measurable Eulerian coefficient for the almost unmeasurable Lagrangian coefficient is unacceptable even as a rough approximation. However, experiments of the present type may then reveal systematic connexions between the Lagrangian and Eulerian characteristics, as in fact has already been done in wind-tunnel experiments, and so provide some real physical insight into the fundamental features of atmospheric diffusion.

In addition to studying the relation between diffusion and the measurable aspects of eddy structure, it will also be important to have a more general description of the space-time variations of eddy structure than is available from the conventional micrometeorological investigations near the surface. The instrument for measuring the fluctuations of wind inclination from a mounting on a balloon cable has already been operated with some success at heights up to 5,000 ft. and has provided some interesting indications of the variations of turbulence with height and time. Plans are now in hand to increase the instrumental equipment and to use it more extensively. Such measurements should provide further knowledge of the nature, growth and decay of mechanical turbulence and convective motion over a substantial depth of the troposphere.

REVISION OF THE POLICY ON BREAD IN GREAT BRITAIN

TOWARDS the end of the Second World War, consideration was given in Britain to the desirability of specifying the type of flour to be used for bread-making once the period of war-time restrictions was over. The Conference on the Post-War Loaf[1] recommended that an 80 per cent extraction-level should be the minimum permitted and that more refined flours enriched with two or three nutrients should not be considered equally acceptable. A report by the panel on Composition and Nutritive Value of Flour has now been published* which, while agreeing that a plain flour of less than 80 per cent extraction would constitute a nutritional hazard, nevertheless concludes that the addition of thiamine, nicotinic acid and iron would provide sufficient safeguard. This is the point of view favoured by the millers, and it was chiefly pressure from them that caused the present Panel to be set up.

When, in 1953, the Government found it possible to relax controls on cereals, the trade obtained permission to prepare flour of 70 per cent extraction provided thiamine, nicotinic acid and iron were added to it ; but such flour did not qualify for subsidy when used in bread-making. To the surprise of the millers, the public showed remarkably little interest in this new flour, and sales of bread made from it never reached a higher proportion than 4·4 per cent of total bread sales ; by the middle of 1955 this proportion had dropped to 0·8 per cent. The millers claim that the public really prefers such bread but cannot afford to buy it. It would seem equally arguable that people were quite satisfied with the National loaf.

In pressing for permission to mill a low-extraction flour, the millers also sought (and obtained) permission to make up National flour by blending as well as by the straight-run process. This completely undermined the safeguards which the Conference on the Post-War Loaf sought to provide, and the value of National flour steadily deteriorated. The present report refers to "the acknowledged infringement of the spirit of the Flour Order" and states that "The Panel believes that the immediate drop in the vitamin B_1 and nicotinic acid content of National flour after decontrol and the continuing fall since, have resulted primarily from deliberate disregard of the intention of the Flour Order rather than from such factors as variations in the character of the wheat from which the flour was milled, although these factors may have played a secondary role". The report argues that a policy of adding specified nutrients would give greater assurance of their presence, since "if the miller is free to sell enriched white flour of any technical quality which he desired

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* Report of the Panel on Composition and Nutritive Value of Flour. Pp. vii+34. (Cmd. 9757) (London: H.M.S.O.) 1s. 6d. net.

Table 1. NUTRIENTS PRESENT IN WHEAT FLOUR (REPRESENTATIVE VALUES)

Nutrients (per 100 gm. flour)	Wholemeal	Flour of 70 per cent extraction
Proteins (gm.)	12·2	11·0
Fat (gm.)	2·3	1·1
Calcium (mgm.)	45	18
Potassium (mgm.)	376	144
Magnesium (mgm.)	127	24
Phosphorus (mgm.)	287	102
Sulphur (mgm.)	165	108
Chlorine (mgm.)	62	53
Iron (mgm.)	4·2	0·8
Copper (mgm.)	0·8	0·2
Manganese (mgm.)	4·5	0·4
Tocopherol (μgm.)	910	30
Thiamine (μgm.)	500	70
Riboflavin (μgm.)	100	35
Pyridoxine (μgm.)	460	220
Choline (mgm.)	90	50
Folic acid (μgm.)	50	12
Biotin (μgm.)	8	0·5
Nicotinic acid (mgm.)	7	1·2
Pantothenic acid (mgm.)	1·3	0·6

A full set of values is not available for flour of 80 per cent extraction, but in general the higher the extraction-rate the greater the retention

there would not appear to be much temptation to add less than the specified quantities of nutrients".

The recommendations of the Conference on the Post-War Loaf, however, were intended to safeguard health by assuring that the flour used for bread-making contained not only thiamine, nicotinic acid and iron, but also a fair measure of the numerous other nutrients which wheat can supply. Since exact requirements for many of these other nutrients have not yet been established, it cannot be said for certain that the differences between 80 per cent flour and enriched 70 per cent would prove of nutritional significance, but equally it cannot be said that they would not. The matter still awaits investigation (the so-called 70 per cent extraction flour used in the much discussed Widdowson and McCance experiments[2] contained thiamine, riboflavin and nicotinic acid in quantities greater than is usual at that level and must be assumed to have provided more of the remaining nutrients also). Table 1 sets out some of the nutrients which are present in wheat and shows what a severe reduction occurs in milling to a 70 per cent extraction level. Only a few of these nutrients were given consideration by the Panel, yet the others may be of equal—or even greater—importance.

In this report the Panel gives the warning that "The history of nutrition reveals many instances where the refinement or over-purification of food has led to ill-health and there is no reason to believe that this chapter of knowledge is closed". The Panel, however, seems to assume that the National Food Survey would give adequate warning of any need for further revision of bread policy. But research workers already feel[3] that over-sophistication of food may provide the explanation of many of the diseases which beset 'civilized' man despite his extensive medical services, and the present time seems inauspicious for a reduction of the dietary supply of some fifteen or more minor nutrients merely to suit trade interests. Moreover, the proposed change would require nearly a quarter of a million extra tons of wheat a year.

M. W. GRANT

[1] Rep. Conf. Post-War Loaf. (Cmd. 6701.) (London: H.M.S.O., 1945.)

[2] Widdowson, E. M., and McCance, R. A., Med. Res. Counc. Spec. Rep., Ser. 287. (London: H.M.S.O., 1954.)

[3] Platt, B. S., *Brit. Med. J.*, i, 179 (1955). Sinclair, H. M., *Lancet*, i, 381 (1956).

NATIONAL PHYSICAL LABORATORY

OPEN DAY

'OPEN Day' at the National Physical Laboratory, Teddington, serves a dual function: it gives representatives of industry, universities, government departments and the technical and daily Press an insight into the work of one of the largest national research laboratories in Britain and, no less useful, serves to indicate the direction of national research effort in many branches of science and engineering. About three thousand visitors attended this year and 225 exhibits were on view. During the afternoon, the General Board of the Laboratory met to consider the Executive Committee's annual report[1].

The Metallurgy Division celebrates this year its fiftieth anniversary, and it was appropriate that its exhibits provided evidence of its continued interest in the constitution and structure of metals and alloys in relation to their physical and mechanical properties, work for which the Division has gained an international reputation. An investigation of the constitution of a uranium–palladium system undertaken for the Atomic Energy Research Establishment revealed the interesting feature of a considerable solid solubility of uranium in palladium; since the electronic structure of palladium is known, measurement of certain physical properties such as electrical resistivity, paramagnetic susceptibility, thermoelectric power and lattice parameter suggested that uranium dissolves in dilute solution with an effective valency of 6, but at higher concentrations the valency is probably 4.

The study of high-purity iron with particular reference to elucidating the embrittling effect of traces of impurities in amounts as low as 0·001 per cent has led to the development of an electrolytic process with the view of producing sulphur-free iron; a commercial cation exchange membrane was used for dividing the electrolytic cell and preventing the transfer of the sulphur-containing anions. Tensile tests on single crystals of iron at −196° C. indicated that orientation had a marked effect on brittle fracture[2], and further investigations of rolled Swedish iron bar using the National Physical Laboratory X-ray diffractometer confirmed that texture had a marked effect on brittle properties. The tracer laboratory is now in full operation, and equipment has been designed to measure the rate of diffusion of antimony in copper, and to study the self-diffusion of silver under fatigue stress.

The steadily increasing use of radioactive materials has necessitated a simplified calibration procedure for checking their activities. For this purpose and to ease the demand on standard samples of radioactive substances, the National Physical Laboratory's Advisory Committee on Radioactive Standards and the Atomic Energy Research Establishment, Harwell, have jointly arranged for the commercial production of a combined beta–gamma ionization chamber for the measurement of β-ray and γ-ray sources in the range 1 microcurie to a few millicuries. This equipment was shown in the Physics Division, which also demonstrated the principle of a possible alternative to the fundamental method of determining temperature by the so-called 'gas thermometer'. In this case use was made of the fact that the spontaneous fluctuations in voltage in a metallic conductor, or 'Johnson noise', have a statistical variance which is proportional to the absolute temperature; modern electronic amplifiers have made it possible to measure with the required precision the electrical energy generated, which at the melting point of gold is about a hundred-millionth of a microwatt. Such a method will be useful in permitting the absolute measurement of temperature in circumstances where a gas thermometer could not be used.

Work in the field of high-pressure physics includes the establishment of standards for the measurement of high pressures up to 3,000 atmospheres and beyond. The new National Physical Laboratory 'similarity' method for the precise calibration of pressure balances[3] was demonstrated and indicated how the hitherto limiting factor of accuracy, namely, the difficulty of measuring the effective area of piston–cylinder assemblies due to distortion, was overcome by using two assemblies of the same dimension but made in materials (hard tool steel and high tensile bronze) having different elastic constants. This Division also showed the results of tests and equipment used for determining the effective biaxial mean stress on fatigue failure, a problem of considerable importance in aircraft design; the biaxial stressing is obtained by applying gas or oil pressure to a hollow test-piece, and the results confirmed that the energy needed to propagate fast fracture is that resident in the compressed gas. Among other interesting exhibits was an ultrasonic viscometer using the National Physical Laboratory split-tube type of barium titanate torsional transducer which, in a high-intensity form, can be made capable of measuring the effects of large particles in hydrosols; and new equipment for investigating thermal and electrical conductivities to well above 1,000° C.

A notable event in the standards field was the completion in the Electricity Division of a cæsium atomic beam standard of frequency and time interval. The cæsium beam chamber on view incorporated a number of changes suggested by investigations of its performance during the past eight months[4]. The present experimental model provides a unit of time which is accurate to ± 3 in 10^{10} (one-hundredth of a second in one year). By comparison with this primary reference standard, quartz clocks, still the most convenient working standard, can now be calibrated over a period less than one second with a precision of one part in 10^9. This improved accuracy in calibration will be made generally available by the *MSF* standard frequency transmissions which are continuously monitored at the Laboratory.

In the High-Voltage Laboratory of this Division equipment is being set up to investigate the breakdown strength of a wide range of organic liquid dielectrics. It will allow the measurement at atmospheric or reduced pressure, at ambient or higher temperatures, after fractional distillation, fine filtration, drying and degassing, or any combination of these; the effect of the shape and duration of the voltage wave, as well as electrode material, will also be investigated. At the rear of this building a new million-volt 700-kVA. oil-immersed transformer is being installed to replace the bank of air-insulated transformers which have given useful service over the past thirty years. Supporting towers, and rain-spray equipment will also be provided for outdoor power-frequency tests.

A number of exhibits indicated the valuable assistance that the Divisions can give to each other in the course of their work. A good example is the new techniques used by the Metrology Division in the preparation of fused quartz cylinders for the construction in the Electricity Division of a new primary standard of inductance, from which the ohm is derived. With the aid of special lapping blocks, the variations in effective diameter of the helix have been reduced from 15μ to 5μ.

The Metrology Division also showed, in its final form, a microwave interferometer, the only equipment of its kind in existence, for the precise determination of the free-space vacuum velocity of electromagnetic waves. The fairly recent introduction of the geodimeter, which uses the speed of light for measuring distances of the order of 10 km., emphasizes the need for a value accurate to at least one part in a million. This interferometer uses two opposing microwave transmitters fed from a common source and, between them, a movable carriage supporting two receiving apertures, each facing a transmitter. The received signals are mixed to produce interference, and an accurately measured bar, two metres long, is used for determining the displacement corresponding to about 1,000 half-waves with great precision; the operating frequency is high (72 kMc./s.), and is measured by comparison with high harmonics of a quartz-crystal frequency standard.

The close contact which this Division maintains with industry was evident in the two methods demonstrated for measuring the camber of large rolls, one using an autocollimator and the other an interferometric technique. A number of exhibits, demonstrating the application of pneumatic gauging, were of special interest. The thickness of thin sheet material was shown being measured continuously by this method as it passed over a roller beneath a number of air jets. This apparatus, as at present designed, will measure to a lower thickness limit of 0·002 in. and an accuracy of ±·1 per cent. By means of a selector switch, variation in thickness of the sheet beneath any one of the jets can be continuously plotted by a pen recorder. A similar technique was demonstrated for testing the flatness of unexposed photographic plates.

Two thin-film type bolometers are being developed in the Light Division to meet the industrial need for sensitive non-selective detectors of infra-red radiation. Thin films of gold or antimony, less than two-millionths of an inch thick, supported on a plastic pellicle, are used. The blackened gold film bolometer is quite as effective as the best thermal detectors at present available and is robust enough for monochromators used in chemical process control; the amorphous antimony bolometer also shows promise in that it is highly sensitive to voltage and has an impedance so large that it can be connected directly to a valve amplifier, thus saving the expense of a step-up transformer.

Among other interesting exhibits in this Division were a photo-electric polarimeter which was contructed to investigate inaccuracies in the calibration of quartz plates used as standards of optical rotation ; and a gas refractometer developed for testing trichloroethylene inhalers, with which the oncentration of trichloroethylene in air is determined y comparing the refractive index of the vapour mixture with that of air in a Jamin-type interferometer. New methods have been developed for producing replica diffraction gratings in plastic ; hey make it possible to join several lengths to form ontinuous accurate gratings several feet in length. t was shown how these gratings can be used for the accurate measurement of movement or displacement by counting the moiré fringes produced when a short ndex grating is moved over a length of fixed grating of the same pitch. The possibilities of this technique of indicating position is being actively investigated and has been adopted in one instance for the automatic control of machine tools.

Work on the design of electronic digital computers continues in the Control Mechanisms and Electronics Division, which exhibited units of the new Automatic Computing Engine (ACE), that was seen in the process of construction. This will be a more powerful tool than its predecessors, the ACE Pilot Model and its engineered version DEUCE, as made by the English Electric Co., Ltd. The new computer will have a larger storage capacity or 'memory' and have an overall speed four times greater than DEUCE ; n a typical working day it will average 20,000 'three address' operations per second and its mercury delay ines and magnetic drums will store a total of $1\frac{1}{2}$ million binary digits. With its other special facilities this machine will allow the solution of very complex problems which have hitherto not been possible with existing computers. A simplified flow diagram for wage accounting directed attention to the possible use of a high-speed computer, with magnetic tape equipment, in office work. This was based on the work done for a study group formed in 1954, consisting of representatives of the Organization and Methods Division of the Treasury, the Ministry of Pensions and National Insurance and the National Physical Laboratory, the first report of which has ust been published[5]. This Division is also concentrating on the design of data-processing equipment and exhibited an automatic graph-plotter which enables information in punched card form to be plotted automatically at a rate of one point every two seconds for points lying fairly close together. Information is read from the cards serially and supplied through a relay distributor to the relay stores, the outputs of which are voltages proportional to the number held ; these voltages are then supplied to the plotting table, which traverses the carriage to the corresponding point, and the plotting head is operated.

The Mathematics Division is now using DEUCE for solving large-scale numerical calculations arising n scientific research and industrial design. This machine was seen in operation and is being used for solving problems in mathematical physics, linear algebra, ballistics and aircraft flutter.

The facilities of the Ship Division are being extended, and a model was shown of the new Ship Hydrodynamics Laboratory now being built at Feltham, Middlesex. This will provide a ship model-testing tank 1,300 ft. in length, 45 ft. wide and 25 ft. deep, and its carriage will have a maximum speed of 50 ft. per sec. There will also be a new water tunnel 40 in. in diameter for research on propellers ; work on 'cavitation' will be facilitated by a resorber circuit which will go 200 ft. below ground-level. A problem associated with the arrangement for supporting and driving the propeller model in this new water tunnel was demonstrated. A mechanical model indicated the method of investigating the different modes of whirling of an overhung shaft and the effects of alteration in the shafting or bearings at critical whirling speeds, with the view of determining the best supporting system. In the Yarrow Tank a lightship was seen undergoing tests in rough water. These experiments are on behalf of the Corporation of Trinity House and the Commissioners of the Port of Calcutta, and are being made under conditions simulating the effect of tide, wind and waves on the riding behaviour of an anchored lightship. The high cable tensions are affected by the hull form, and methods of reducing the cable tension have been suggested.

Of special interest to visitors to the Aerodynamics Division were the wind tunnel exhibits demonstrating methods for improving the efficiency of lifting surfaces by preventing flow separation. Such studies are of vital importance for improving the landing and take-off performance of high-speed civil and military aircraft, where the trend towards highly swept wing-forms has necessitated relatively high landing and take-off speeds. High lift was demonstrated in the 13 ft. × 9 ft. wind tunnel by blowing high-velocity air over a trailing-edge flap of a half-model delta wing to re-energize the boundary layer. In the 9 ft. × 7 ft. wind tunnel experiments were in progress to ascertain the usefulness of boundary-layer control at the wing nose when combined with jet flaps at the wing trailing-edge.

In high-speed flight, shock-induced boundary layer separation from a wing or other component of an aircraft seriously affects stability and control of the aircraft. This formed the subject of a film, in colour, which was shown to visitors. An interesting exhibit concerned experiments on a thin half-aerofoil section designed to be free from boundary-layer separation for an appreciable range of lift coefficients at all speeds, thus enabling the formation of a shock wave to be studied independently of boundary-layer interaction and a check to be made on theoretical results. The influence of the shape of the leading edge on change in the type of separation that occurs as the Mach number is raised for a wing at high incidence was also being studied.

Equipment specially designed for the measurement of aerodynamic forces on oscillating wings was exhibited in this Division. It is intended to provide fundamental data relating to oscillating forces at high speeds and frequencies, and will be used for checking the theoretical methods at present used when designing aircraft to guard against oscillatory instability in flight. An electro-mechanical feed-back system is used, incorporating a torsion bar linking two inertias, one carrying the model and a displacement pickup, and the other being electromagnetically excited at its natural frequency.

The Laboratory's testing facilities are constantly being extended to meet new demands. Three new water-baths have been installed in the Test House to facilitate testing and avoid fatigue of observers testing clinical thermometers, of which more than half a million were tested last year. With the increasing use of viscometers in various industrial applications, and by the oil industry in particular, there has been an increasing demand for the calibration of a range and variety of these instruments ;

temperature control has been installed in rooms used for this work. The testing of trichloroethylene inhalers intended for use by registered midwives has been facilitated by the use of the new gas refractometer referred to previously. Two prototypes have been approved, and about 110 inhalers have been tested. 'Trouble-shooting', the theme of an interesting exhibit, stressed the assistance given by the Test House to enable manufacturers to overcome their production difficulties and to improve the quality and accuracy of their output.

E. I. Brimelow

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OBITUARIES

Prof. Carl Ramsauer

Carl Ramsauer, who died in Berlin on December 24, 1955, was an outstanding character as well as an outstanding physicist. As a young man, he made his way by his toughness and purpose. Born on February 6, 1879, in Osterburg, a little place in Oldenburg where his father was the Lutheran parson, in his early twenties he occupied a diversity of positions, including those of schoolmaster and assistant in the torpedo laboratory at Kiel, at which University he took his doctorate with an interesting and original thesis on the mechanism of ricochet from water. He was twenty-eight when Lenard, who had been professor at Kiel, enabled him to take up an academic career by appointing him to a post in the Physics Institute at Heidelberg. Here he worked, except for the war period, during which he was an artillery officer, until 1921, when he was appointed professor of physics at the Technische Hochschule at Danzig. With Lenard he carried out a series of significant researches on the ionization produced by ultra-violet light; but the work that brought his name into prominence was his discovery, in 1921, that slow electrons pass much more easily than swifter ones through the atoms of the rare gases, the so-called Ramsauer effect. In this connexion he introduced the term Wirkungsquerschnitt (effective cross-section), which has been so widely used.

At Danzig, Ramsauer proceeded to transform the small and comparatively unimportant department into a first-class institute for teaching and research in physics. He was by inclination and training an outstanding teacher, taking the greatest pains and pleasure to devise effective lecture experiments and to make clear the fundamentals of the subject. The research school, which was occupied mainly, but by no means exclusively, with the passage of electrons through matter, was known for the precision and clarity of its work. By 1928 his reputation was such that when the Allgemeine Elektricitätsgesellschaft decided to found a research institute, Ramsauer was appointed to direct it. His gifts as an organizer and controller of research found full expression in this extremely responsible post. Under him work proceeded not only in physical, but also in chemical, electrotechnical, metallurgical and other departments of the great institute. He installed 'technical-physical workshops', which were of great value. He continued his personal research on effective atomic and molecular cross-sections, and the work which he carried out with Kollath on the scattering of protons is classical. In 1931 he became joint editor of the *Zeitschrift für technische Physik*, and many other responsibilities of this nature accrued to him.

During the Second World War, Ramsauer was elected president of the Deutsche Physikalische Gesellschaft, a very difficult position at that time With characteristic courage he spoke out against the many abuses and shameful personalities which were ruining German physics, his letter, sent in 1942, to Rust, then Minister for Education, being particularly uncompromising. It had no result; but if Ramsauer had been a less valuable and less respected man it might have been fatal for him.

After the War, Ramsauer occupied himself with reorganizing the teaching of physics at the Technische Hochschule at Charlottenburg, a task for which his gifts and experience particularly fitted him In 1953 he published a remarkable little book dealing with the history of certain fundamental experiments in physics. He did not give up his post until he reached the age of seventy-five, and died shortly after his resignation.

Ramsauer was a quite exceptional personality. He disliked any parade of sentiment, but he was a staunch friend and a man of firm principles, who never truckled to those in power. He was a most entertaining talker, with a strong and sometimes biting sense of humour, to which he gave epigrammatic expression. For example, of a certain somewhat undistinguished physicist who had a double name—let us call him Wolf-Braun—he said, "Gauss–Weber were two men, Mittag-Leffler was one man, Wolf-Braun was nobody". He had a close acquaintance with German university folk-lore, including the legends of Bonifacius Kiesewetter, and a great knowledge of German literature in general, including many byways. He will long be remembered by all who had to do with him, and especially by the few still living who knew him at Heidelberg.

E. N. da C. Andrade

Sir John Stirling-Maxwell, Bart., K.T.

Sir John Stirling-Maxwell died on May 30 at the age of eighty-nine at his home, Pollok House, famous for its lovely gardens, near Glasgow. He succeeded his father at the age of eleven, and went to Eton and then on to Trinity College, Cambridge. He was Conservative member of Parliament for the College Division of Glasgow between 1895 and 1906, when he lost the seat. It was then that he gave his time to his real hobby. Sir John may be termed one of the early modern pioneers of forestry, then called arboriculture in Scotland and England, in the latter part of the past century and the early years of the present. He studied the subject intensively in many European countries and made use of the knowledge so acquired on his own estate, and was always ready with advice or suggestions to friends.

In his own practice, after failures to establish sitka spruce plantations on his estate at Corrour, and his greatly loved lodge there, by the usual methods of level surface planting on peat soils, he introduced the method he had seen in Belgium of mound planting, in which the plants are placed in holes in the turves cut out in making the drains. He had immediate success at Corrour; and when, a few years later, the Forestry Commission began its work in the country, it followed Sir John on peat soils, afterwards greatly elaborating other methods. Sir John, whose whole heart was in forestry, was one of the first Commissioners, and his appointment as chairman of the Forestry Commission in 1929 was warmly hailed by foresters and all who knew of his work and his enthusiasm, and his departure at the end of his term of office at the end of 1932 was equally regretted. His quiet geniality, understanding and common sense were greatly appreciated and loved.

Sir John's life was devoted to public service. He had a great affection for art and acted in many public positions in this respect: as trustee of the Royal Fine Art Commission for Scotland, chairman of the Ancient Monuments Board of Scotland and as a trustee of the Scots National Galleries. He was an original member of the Board of Trustees of the Wallace Collections appointed to administer the bequest in 1897, and he served continuously on the Board, being its chairman for the past twenty-five years.

Sir John did a great deal to encourage the beginnings of forestry in Great Britain, and his name will remain enshrined in the annals of forestry.

E. P. Stebbing

NEWS and VIEWS

Experimental Philosophy at Oxford: The Right Hon. Viscount Cherwell, P.C., C.H., F.R.S.

For a man who shuns publicity, Lord Cherwell has been much in the news lately. In the recent Birthday Honours List he was made a Viscount and very shortly afterwards he announced his impending resignation from the Dr. Lee's chair of experimental philosophy at Oxford. F. A. Lindemann (now Viscount Cherwell) was educated in England and Germany and took his Ph.D. degree under Nernst at the University of Berlin in 1913. During his period in Germany he published, in conjunction with Nernst, a series of papers on "Studies of Specific Heats at Low Temperatures", and also proposed modifications in the Planck–Einstein formula for specific heats of solids based on the quantum theory and extended it to gases. Later, he published a book entitled "The Physical Significance of the Quantum Theory". During the First World War, Lindemann served as an experimental pilot and research scientist at the Royal Aircraft Establishment, Farnborough. It was during this period that he played a very large part in the successful solution of the spinning aircraft problem. In 1919, Lindemann was appointed professor of experimental philosophy at Oxford, so that he has held this chair for thirty-seven years. During this period he has built up the Clarendon Laboratory and initiated many important researches to such effect that to-day the Clarendon Laboratory is among the best equipped and staffed laboratories in the world for both low temperature and nuclear research work.

In pre-war years Lindemann formed a very firm friendship with Winston Churchill, and when at the outbreak of the War the latter was appointed First Lord of the Admiralty, Lindemann joined him in the capacity of personal scientific adviser. Later, when Churchill became Prime Minister, he moved with him to Downing Street. He was raised to the Peerage as Lord Cherwell in 1941 and in 1942 became Paymaster General and a member of the Cabinet. His duties were primarily scientific and statistical, and he was charged with the responsibility of keeping the Prime Minister acquainted with all the scientific problems and developments which affected the war effort. This he did largely by the use of his characteristically simple but illuminating methods of presenting information. In addition to this, he also accompanied the Prime Minister to the historic Quebec and Potsdam Conferences. Cherwell again became Paymaster General in 1951 and served in a similar capacity. His particular interests at this period were in the atomic energy field, and he was one of the main protagonists of the plan afterwards adopted for the removal of the Atomic Energy programme from the Civil Service. After his return to Oxford in 1953 he continued to serve as a member of the new Atomic Energy Authority. Cherwell is a man of strong opinions which he has not hesitated to advance. Many people have disagreed with him, but few will deny that he has had an important influence on our time.

Sir Francis Simon, C.B.E., F.R.S.

Sir Francis Simon, professor of thermodynamics in the University, has been appointed to succeed Viscount Cherwell. The Clarendon Laboratory will thus have as its new head a man who has a world-wide reputation for his achievements in all branches of low-temperature physics. Sir Francis, like Lord Cherwell, began his scientific career under Nernst, and it is not surprising that much of his earlier work was connected with the Nernst heat theorem. Indeed, the fact that this theorem is now generally recognized as the third fundamental law of thermodynamics is largely due to his work. During this period in Germany he also devised the small-scale cryogenic techniques, in particular the expansion method for liquefying helium, which made it possible to conduct low-temperature work even in laboratories with only quite modest facilities. On leaving Germany in 1933, he went to the Clarendon Laboratory at the invitation of Prof. Lindemann and became reader and later professor of thermodynamics. Under him the low-temperature department of the Clarendon Laboratory has grown to be one of the leading cryogenic laboratories of the world. His many interests have included the properties of liquid helium, magnetic cooling, low-temperature specific heats (in particular, the study of internal transitions), nuclear orientation, thermal conductivities and the properties of solids and fluids at high pressures and low temperatures. During the War, Prof. Simon played an important part in the British Atomic Energy project. He was one of the first to see the feasibility of a diffusion plant for the separation of the uranium isotopes on an industrial scale and he had a large group working under him on this project. Since the War he has also turned his attention to many questions of scientific policy, and he is well known for his views on fuel policy, on scientific and technological education, and on the correct use of scientific man-power.

Chemistry at Birmingham : Prof. M. Stacey, F.R.S.

Prof. M. Stacey, who succeeds Prof. H. W. Melville (see *Nature* of February 11, p. 260) at the end of the present academic year as Mason professor of chemistry in the University of Birmingham, is the most outstanding Birmingham graduate of his time. He graduated under the late Sir Norman Haworth and continued, with short breaks in London and in the United States, at Birmingham as research student, lecturer, reader, until in 1946 a special chair was created for him to give him further scope for all his activities. Since that time he has expanded enormously the organic work at Birmingham. For many years under Haworth, Birmingham was the centre for carbohydrate chemistry in Great Britain, and the great advances made in this period laid the foundations of much of the subsequent developments into wider fields. Stacey's work was interrupted by the Second World War; but under the auspices of the Tube Alloys' project in Britain, he became interested in the chemistry of uranium and also of fluorine. This gave him the opportunity to enter the field of the organic chemistry of fluorine compounds and this part of his activities has flourished just as much as the carbohydrate field; at various academic institutions in Britain he has developed unique methods of dealing with the synthesis of a great variety of fluorine compounds and in seeking new uses for them in every possible way. Under Stacey's leadership, organic chemistry has increasingly widened its scope in Birmingham, with emphasis, too, on the biological implications of these developments of organic chemistry. In all these developments full use has been made of the more specialized techniques that have been available in the laboratory, especially on the physical side. These have made progress possible which was undreamt of in pre-war years. With greater responsibilities, the Chemistry Department under Stacey's guidance will, without doubt, develop actively and broadly in the years to come.

Italian Honours for Sir Cyril Hinshelwood and Prof. E. B. Chain

On June 5, the Italian Foreign Minister honoured two British men of science, Sir Cyril Hinshelwood, president of the Royal Society, and Prof. E. B. Chain, by bestowing on them the order of the Grande Ufficiale al Merito della Repubblica, one of the highest civil distinctions in Italy. Sir Cyril Hinshelwood has been a frequent visitor to Italy, and his work and personality are greatly appreciated in this country, the language of which he has mastered with perfection. He has done much to strengthen the ties between British and Italian scientists. Prof. Chain, formerly of the University of Oxford, has worked since 1949 in Rome, where he has built up a large and very active department for biochemical research at the Istituto Superiore di Sanità, the chief centre for medical research in Italy.

Expansion of Metallurgy at Oxford

At a meeting of Congregation on June 12, a statute was promulgated which added the science of metals to the list of subjects that may be offered at Oxford in the Honour School of Natural Science. This subject covers much of the ground that is covered by those who offer chemistry in that Honour School. The amount of organic chemistry, however, has been reduced in order to provide room for the science of metals. The new course is divided into Parts I and II on the same lines as the chemistry course, and in Part II a candidate will submit a thesis on a metallurgical subject after spending a year on research. Classified honours will be awarded on the combined results of both parts.

The new course marks a further stage in the development of metallurgy at Oxford which follows the establishment of the George Kelley readership by the Pressed Steel Co. and the appeal for funds for the subject which was strongly supported by the late chairman of the Company, Major Albert Pam. Post-graduate research work in metallurgy has been carried out at Oxford for more than thirty years under Dr. W. Hume-Rothery in the Inorganic Chemistry Laboratory, where its development owes much to the interest of Sir Cyril Hinshelwood. An independent Department of Metallurgy under Dr. Hume-Rothery is now being set up in temporary accommodation, and it is hoped that a new laboratory will be built in the next few years. The new development is particularly welcome in view of the close association of Oxford with metal-using industries.

National Parks Commission

There are now eight national parks in Britain—the Lake District, the Peak District, Snowdonia, Dartmoor, the Pembrokeshire Coast, the North York Moors, the Yorkshire Dales and Exmoor, with a total area of 4,333 square miles—while two further areas have been designated as national parks—Northumberland and the Brecon Beacons. One of the duties of the National Parks Commission is to bring to the notice of the public the setting up of these parks and to explain why they have been set up. There is still much misunderstanding among the general public, and the Commission takes every opportunity to show that the designation of an area as a national park effects no change in the ownership of land. The land is not 'nationalized' nor does designation as a national park confer on the public any right of access. Users of national parks are asked to respect privately owned country inside the parks in the same way that they would outside. They are also asked to observe the "Country Code", a code of behaviour for visitors which has been set out in an attractive booklet by the Commission and which can be obtained from H.M. Stationery Office, price 4*d*.

Museum of English Rural Life, Reading

The first annual report of the Museum of English Rural Life at Reading, although dated 1955, covers the first four years of the existence of this rapidly growing institution. This Museum had the great advantage of starting from scratch and thus was able to determine its policy and administration, both of which were based on orthodox museum practice in Great Britain. Contrary to traditional custom, however, the report, rather than being a record of month-by-month activities, includes the abbreviated text of a lecture delivered by Mr. Uldall, keeper of Frilandsmuseet, the open-air section of the National Museum of Denmark. This lecture details some of the principles which are now slowly emerging concerning folk museums and folk parks and stresses the fact that the material acquired should be regarded primarily as objects for the basis of scientific study rather than exhibition pieces.

Beauty and Order

A FINELY illustrated article by Dr. P. Weiss in a recent issue of the *Scientific Monthly* (81, No. 6; December 1955) elaborates the regularity and consistency of design in living forms. The regularity is expressed in such features as symmetry, repetition and alternation of elements; and consistency, as in the use of curves, proportions, size gradients, and so forth, in subdividing space. The rule of order over randomness, of pattern over chaos, of law over accident is well brought out, while patterns in Nature are shown to be of both space and time. In the last analysis, each organic form has had its history and has come to be what it is through long sequences of developmental processes. Since all form is thus merely a momentary cross-section through a stream of formative and transformative processes, what is admired as order and beauty in the final form is only a product and an index of the measured orderliness of the developmental actions and interactions by which it has come about. Static form is only a precipitate of underlying and antecedent formative dynamics.

Population Structure in Salt-Marsh Song Sparrows

THE song sparrows (*Melospiza melodia*) that live on the salt marshes of San Francisco Bay, California, have attracted the attention of students of birds for the past sixty years. The principal reason for this has been their morphological distinctness from all other song sparrows, including those which live in areas close to the salt marshes. Such a pattern of differentiation and distribution has always raised the problem of how the salt-marsh populations maintain themselves as distinct entities. A study by Richard F. Johnston continues previous work on salt-marsh song sparrows to determine what characteristics of salt-marsh populations influence or have some relationship to the maintenance of their morphological and/or genetical integrity, and how these characteristics express themselves (*Condor*, 58, No. 1; January–February 1956). Factors influencing the initiation of breeding in the song sparrow are closely associated with the biological growing season and include the photoperiod, temperature of the preceding three months, and the amount and distribution of the winter rainfall; these also influence the amount and quality of the song sparrow's food, which may well be the most proximate factor. The inception of breeding seems not to be closely related to any 'temperature threshold' or 'warmth-sum'.

Breeding spans the period March–June; the peak of first nestings is at the end of March. This is more than two weeks earlier than in upland song sparrows at the same latitude and seems to represent an adaptation to marsh life, for the birds thus nest mainly during lower tidal conditions. It is not the absolute height of the tides that governs egg and nestling mortality, but whether or not the birds can nest early enough to escape the high run of tides in April to June; when they breed late, there is high mortality caused by the high tides. Male song sparrows set up territories during late autumn and winter and are completely territorial by late February. Territorial defence is lacking during July–September when the adults moult; autumnal territoriality is seen in mid-September. Adult birds rarely shift their territory from one breeding season to the next. Dispersal of juveniles occurs in the late spring and summer and halts in late August and September when territorial activity rises. The median distance of dispersal, hatch-site to breeding-site, for 34 song sparrows was 185 metres. The limited adult movement and restricted distance of dispersal of these song sparrows mark them as one of the most sedentary population of birds yet investigated.

Predator Control

THE *Bulletin of the International Union for the Protection of Nature* (5, No. 1; April 1956) includes an account of the effects of attempted predator control in America. On the Kaibab Plateau in north-western Arizona, an area so noted for its mule deer that it was made into a game reserve more than fifty years ago, cougars and wolves were trapped to ensure that the deer would be protected. Within a few years the deer population had increased to such an extent that pasture-land was exhausted and even the forest was damaged. As a result, thousands of deer starved because of loss of their food supply. On Valcour Island, in Lake Champlain, an investigation was carried out to test the possibility of augmenting game by means of successful predator control. This operation allowed the game, mainly ruffed grouse and hares, to increase during the first four years from a small to a moderately high level, and then the population began to decline. In the absence of predation, disease apparently became a major limiting factor. As the sick were no longer eliminated, unchecked epidemics ravaged the game which was to be protected.

A Virus Latent in Turnips

J. P. MACKINNON has reported on this phenomenon as follows (*Canad. J. Bot.*, 34, 1, 131; 1956). Green peach aphids reared on turnip stecklings acquired a virus that was transmitted to plants of *Physalis floridana* Rydb. and *P. pubescens* L., hosts used in potato leaf-roll studies. Symptoms on these hosts consisted of a yellowing of the veins of the leaves. *Nicandra physalodes* L., when infected, showed severe stunting and chlorosis. The virus was carried without symptoms on turnips and showed only slight stunting on several species of *Brassica*. It was not transmitted by mechanical inoculation, and it does not appear to be similar to any of the viruses previously reported in turnips. The aphid *Myzus persicae* (Sulzer) acquired the virus during a seven-hour feeding period, and after a latent period of approximately 23 hr., transmitted the virus during a one-hour test-feeding period. Once infective, aphids remained so for several days.

American Prairies

IT has long been held that the vast extent of grassland, which is almost treeless, extending from western Indiana to the eastern slopes of the Rocky Mountains was made by man and due to the 'fire hunting' of Indian tribes. Among many tribes, fire drives were used in the pursuit of bison and other large-game animals. Whatever their purpose, such fires ran unchecked until they reached a stream or other baulk. Repeated burning destroyed existing trees and prevented their replacement by new growth. This belief has now been challenged by an American archæologist, Dr. W. R. Wedel (Smithsonian News Release, Dec. 23). Studies of habitation sites show that there were great dust movements over the plains before there was any agriculture. The dust, he suggests, must have been picked up from dry uplands from which the grass had been killed by drought. Geological surveys also show that there were typical grassland soils in the area throughout the ice ages. They were typical of each recession of the glacier and are now buried deep under the present land surface. At present, natural tree growth is practically restricted to river-bottom lands and ravines, and there is very little tendency for the woodlands to spread out over the plains.

The Weather Service in Great Britain

A NEAT little pamphlet entitled "Your Weather Service", prepared by the Meteorological Office and Central Office of Information (revised edition; pp. 52+8 plates. London: H.M.S.O., 1955; 1s. 6d. net), describes in popular form the organization of the Meteorological Office, the making of meteorological observations, and their collection and use both in weather forecasting and in the longer-term climatological work which the Meteorological Office performs in its capacity as the public memory of the weather. The terms used in broadcast weather forecasts are defined, and maps show the areas used in the forecasts broadcast for the British Isles and the adjacent sea areas. The pamphlet gives full details of how to obtain special weather forecasts and meteorological advice, and ends with a table of the normal temperatures of each month in each of the areas used in the broadcasts and a detailed table of mean and extreme temperatures, sunshine, relative humidity, fog, thunder, snow and wind at Kew Observatory. Plates show the making of surface and upper-air observations and their collection, the plotting of them on charts, and the testing of instruments. One plate shows in diagrammatic form the very wide sphere of applications from which inquiries are received in the British Climatology Branch of the Office, ranging from "where to live" to the design of cooling towers at power stations. On the much-discussed subject of "old-fashioned summers", there is no evidence that Britain is either warmer or colder than it was a century ago. The pamphlet describes the services of reference on the spot and of lending of the Meteorological Office Library, which contains the greatest collection of meteorological literature in Britain and is one of the largest in the world. The pamphlet also gives an outline of the publications, from the Daily Weather Report to the highly specialized research series of Geophysical Memoirs prepared in the Office.

Geophysics in Pakistan

THE director of the Meteorological Service of Pakistan, Mr. S. N. Naqvi, began last year the publication of a duplicated series entitled "Geophysical Review". Part 4, "Technical Progress Review, No. 7" (September 30, 1955), describes the current state of geophysical research in Pakistan, and in particular the work in progress on atmospheric physics, geomagnetism and seismology. In cloud physics, condensation on large hygroscopic particles has been studied under the guidance of Dr. E. M. Fournier d'Albe, and trials of cloud-seeding by spraying salt particles into the air have been made. Actinometers have been brought into use and their records analysed to obtain the usual statistics of solar radiation and the 'measure of turbidity' which is the exponent of the Rayleigh transmission factor of the solar beam. The Agrimeteorological Observatory has worked on soil temperature and water content at depths up to 1 m. in an orchard in relation to the minimum water requirements of the fruit trees. The Geomagnetic Section has studied the variation of the scale values and temperature coefficient of the horizontal force magnetometer, ionospheric structure and, with a Dobson spectrometer, the variation in ozone content of the air. The Seismological Observatory has installed accelographs at Quetta and Sylhet (East Pakistan), the records of which will be valuable in the construction of buildings to resist earthquakes, and has made detailed studies of the recent larger shocks in the Dominion. Geophysical research is developing rapidly in Pakistan, and the Meteorological Service of Pakistan, one of the most recently formed such services in the British Commonwealth, is doing valuable service in publishing this record of progress up to date.

Higher Education in the United States

IN the September issue of the *Annals of the American Academy of Political and Social Science*, under the title "Higher Education under Stress", is presented a comprehensive picture of the issues confronting higher education in the United States. Three general papers, by F. J. Brown on a long-range view of higher education, by G. K. Chalmers on the purpose of learning, and by M. H. Trythen on meeting man-power needs, are followed by eight others dealing with specific issues in the United States. These are of slight interest to the British reader, with the exception of Dr. H. D. Gideonse's "Academic Freedom: a Decade of Challenge and Clarification" and Dr. H. E. Wilson's review of the role of the university in international relations; but for these two papers alone the number will be welcomed by many in Britain. The greater part of the issue is devoted to the papers presented at the Conference on Methods of Financing Higher Education, held in Philadelphia during May 20–21, 1955. For the most part they are concerned with specifically American issues which have no close counterpart elsewhere, and, while the issue forms an admirable supplement which brings up to date J. D. Millett's report on "Financing Higher Education in the United States", published in 1952, except for the papers indicated it throws little light on the problems with which the university administrator or teacher in Britain is confronted.

Education through Physics

WHAT qualities does the world expect of a well-educated man? That he should have a tough and inquiring mind, able, and indeed anxious, to tackle new problems, new situations. That he should be creative, not hidebound, independent and not relying solely on the minds of others. That he should be well informed generally and really knowledgeable about certain subjects or parts of subjects. That he should appreciate spiritual and æsthetic values. That he should be intellectually honest, able to recognize a hard fact, and not afraid to give up preconceived ideas in the face of demonstrable proof. That he should be able to express himself clearly, convincingly and concisely in writing and in speech. That he should be able to live with and collaborate with others, showing the tolerance which arises from an understanding of studies and beliefs other than his own, but not tolerance of slovenliness of any kind. That he should exhibit the qualities of perseverance and humility, and above all, of judgment. These views were put forward by Prof. F. A. Vick at a meeting of the Education Group of the Institute of Physics. Prof. Vick does not pretend that all these qualities can be acquired solely from courses in physics, although he believes that most, if not all, f them can be developed by contact with some physicists. A great deal more could be done to ducate students' minds than is sometimes done. Courses in the physical sciences could make contributions to the education of the mind which few other subjects can.

Science Masters' Association

Besides details of a wide range of activities in 1955, the annual report of the Science Masters' Association contains one item which reflects the enthusiasm and enterprise of its members. Its radioactive isotopes sub-committee has continued to nvestigate the possibility of producing experiments suitable for schools. Much research has been carried on to devise suitable and inexpensive apparatus, especially that which can be put together in the school itself. The sub-committee is particularly anxious to recommend experiments which can be done by use of radioactive isotopes only, or can be done more effectively by their use than by the conventional methods used hitherto. The sub-committee does not look with favour upon the use of fundamental particles as 'wonders' but desires to make use of them as 'tools', an adjunct to technique rather than a new body of phenomena to be added to an already over-filled syllabus. Progress in this work has been delayed because the necessary Statutory Panel demanded by the Radio-active Substances Act has not yet been set up by the appropriate Government departments. Recently steps have been taken by the Ministry of Education to form such a Panel, and publication may shortly be expected of the schedule defining the limits within which experiments in schools will be permitted.

Announcements

Prof. John F. Fulton, of the Yale University School of Medicine, has recently received an honorary doctorate of medicine of the University of Upsala.

The following appointments have been made in the University of London: Dr. W. S. Peart, senior lecturer in St. Mary's Hospital Medical School, to the University chair of medicine tenable at that School; Dr. Harry Wilman, lecturer in applied physical chemistry in the Imperial College of Science and Technology, to the University readership in applied chemical physics tenable at that College.

The sixth Parliamentary Conference on World Government will be held in the County Hall, London, during July 28–31. Further information can be obtained from the secretary-general, G. McAllister, 21 Hampstead Lane, Highgate Village, London, N.6.

The next Cytological Congress will be held at the University of St. Andrews, Scotland, during August 28–September 3, 1957. Admission will normally be restricted to members of the Society for Cell Biology and their guests. Others wishing to attend should communicate with the secretary of the Congress, Prof. H. G. Callan, Department of Natural History, The University, St. Andrews, Scotland.

The U.S. Combustion Institute will hold its sixth international symposium in Yale University during August 19–24. A large number of aspects of combustion will be discussed; but in general the purpose of the symposium is to consider new experimental results and advances in theory, as well as their application in engineering practice. Further information on the technical programme can be obtained from the Combustion Institute, 200 Alcoa Building, Pittsburgh 19, Pa. Those wishing to attend the symposium should write to the Combustion Symposium Office, Mason Laboratory, Yale University, 400 Temple Street, New Haven 11, Conn.

The British Society for Research on Ageing has planned a joint meeting with Dutch gerontologists, to be held in Amsterdam on the afternoon of July 27 and following morning. The meeting is open to all, and those attending the International Physiological Congress in Brussels, commencing on July 30, may find it convenient to attend the Amsterdam meeting *en route*. Further information can be obtained from the honorary secretary of the Society, Dr. G. H. Bourne, London Hospital Medical College, Turner Street, London, E.1.

The eighth British Mathematical Colloquium will be held in the University of St. Andrews during September 4–6. The subjects for discussion on the respective days will be algebra and the theory of numbers; analysis; and geometry and topology. As in previous years, the Colloquium is open to university academic staff, Civil servants in scientific departments and, subject to limitations of accommodation, to research students. The membership fee is 10*s*. Application for membership should be made to D. Borwein, Department of Mathematics, St. Salvator's College, St. Andrews, from whom further information can be obtained.

A joint meeting of Commissions I and II of the International Institute of Refrigeration will be held in Louvain during September 4–7. Four general topics will be discussed: methods for the detection at very low temperatures of traces of impurities in metals, semiconductors and other solids (magnetic susceptibility, electrical resistance, electronic resonance, heat conductivity, etc.); heat conductivity and viscosity coefficients of gas and liquid mixtures at low temperatures; relationship between insulating materials and the gas or vapour included; and hygrometry. Those interested in attending should write to Prof. I. van Itterbeek, Naamsestraat 73, Louvain, Belgium, from whom further information can be obtained.

A European mycological congress will be held in Brussels during September 15–22, and all persons interested in the study of higher fungi are invited to attend. This is the first such meeting, and it is proposed to repeat it at three-year intervals. The working languages will be French, English and German. Further information can be obtained from Dr. P. Heinemann, 26 Rue J. W. Wilson, Brussels. Immediately after the congress a symposium will be held in the University of Liège on the ecology of higher fungi. Those interested should write directly to Dr. F. Darimont, Institut Botanique de l'Université, 3 Rue Fusch, Liège, indicating the subjects they would like to be covered.

A fourth list of amendments to the third edition of the "World List of Scientific Publications", including amendments to library holdings after the date of publication, has been published by the Documentation Committee of the Society of Chemical Industry in *Chemistry and Industry* (1955, 1764–67). Details of any errors discovered in the "World List" should be sent to: Miss M. I. Wyatt, The Laboratories, J. Lyons and Co., Ltd., 149 Hammersmith Road, London, W.14.

BRITISH RAYON RESEARCH ASSOCIATION

OPEN DAYS

THE British Rayon Research Association held open days during May 10–11 at its laboratories at Heald Green, Wythenshawe, on the south side of Manchester. These open days are intended to be an annual event in future. Representatives of member firms, universities, technical colleges, trade associations, the Department of Scientific and Industrial Research, other research associations, scientific and technical societies, and trade unions took advantage of the invitation to inspect the Association's work. This can be divided into three main sections: fundamental research, which absorbs approximately 40 per cent of the effort; applied research, including machinery development and instrumentation, which absorbs a further 40 per cent; and member service.

The fundamental research can be briefly described as an investigation into the chemical and physical structure of cellulose and into its physical properties interpreted in terms of structure. It is, of course, impossible to indicate in detail all that is taking place; but very considerable progress has been made in elucidating the precise molecular arrangements in the various crystalline forms of cellulose. In this connexion the use of infra-red spectroscopy has proved particularly valuable. By means of a new technique—that is, the replacement of hydrogen in the amorphous region by deuterium—it has been found possible to separate the absorption of the crystalline regions of cellulose from that of the amorphous regions, and thus to study each region separately. The method has established the fact that two of the oxygen atoms in each pyranose unit are proton donators only, and that two of them are both proton donators and acceptors. The use of polarized infra-red gives the direction of each hydrogen bond. All this information is being carefully collated with the information obtained from X-ray analysis of crystal structure, and from organic and from physico-chemical studies.

Work is proceeding on strain birefringence. The basic theory has been worked out, and the technique has been applied to a study of the stress-relaxation of polymers at constant length. Three typical modes of photo-elastic behaviour are possible: in polymers of amorphous network the birefringence decreases with the stress; in crystalline polymers the birefringence remains constant during the relaxation; and in polymers in which stretching induces crystallization the birefringence increases as the stress decreases. In other words, the method can be, and is being, used for obtaining information regarding the physical structure and the deformation mechanism of polymers.

Two organic groups are concentrating their attention on the breakdown of cellulose during the alkali refining of tyre cord pulp, since very heavy losses take place at this stage. It is possible that the losses could be avoided if we understood better the precise mechanism of the process.

Two groups of physical chemists are studying the kinetics of the photochemical breakdown of cellulose. They have already elucidated the essential mechanism of the process; that is, that the dyestuff, under the action of light, assumes the activated triplet state and in this state it removes a hydrogen atom from the cellulose molecule. A free radical is thereby produced, which promptly combines with molecular oxygen to yield a peroxide radical which initiates the breakdown.

This work involves a study of the transient states of dye molecules, for which Prof. G. Porter's flash-photolysis technique is peculiarly suitable. A qualitative survey of the field is now complete, the spectra of all the transient states of duroquinone have been identified, and quantitative work has been commenced. It is being extended to reactions in the solid state.

The Association's technological work includes a large programme of work on blended yarns. Viscose is being mixed with acetate, cotton, nylon, 'Terylene' and 'Orlon' in turn, spun into yarn and woven into cloths of shirting and gaberdine construction. The cloths are being dyed and finished in several ways and then tested. So far as the work has gone, it is clear that in the spinning, warping and weaving there are no outstanding difficulties in producing cloths from blends. Some problems have been encountered in dyeing and finishing; but it is not expected that they will be insuperable.

Visitors showed considerable interest in the Stains direct spinner, which produces spun yarns from continuous-filament tow. The work so far has been concerned mainly with the production of viscose yarns, for which tows are fairly readily available in Britain.

An intense effort is being devoted to the short processing of rayon. The basis for the method lies in a new 3-over-4 draw frame developed by the Association. This produces a much more regular sliver than normal, with the result that at least one set of speed frames can be eliminated and single packages can be used on the ring frame, with a saving of more than 2*d*. per lb. in yarn spinning costs. Improved instrumentation is playing a vital part in this work, since it enables the mill manager to detect at once whether any of his frames are likely to give trouble.

Other machinery developments are in hand, including an important chemical engineering project recently launched. The Association is attempting to apply fluid bed techniques to yarn and fabric drying, dyeing and finishing. At first pilot plant and then full-scale plant are being erected for each application, with the view of collecting the information on which the design of commercial plant can be based. An association of British machinery manufacturers has been formed to put the invention on the market. The method offers great potential savings. For example, it is possible to dye hydrophobic fibres such as 'Terylene' and nylon by a continuous process in ten seconds instead of taking several hours in pressure vessels in batch processes. Resin baking can be carried out in twenty seconds instead of three to four minutes. Spun nylon can be singed in a tenth of a second.

Various instruments designed originally by the Association for research purposes are now being manufactured and sold by instrument firms. The two instruments which have proved most popular are the yarn speed indicator and the loom setting indicator.

The Association runs a very active member service section, which provides literature and patent surveys, examines and reports on defective fabrics, and gives immediate assistance on factory production difficulties.

The staff numbers 260, made up as follows: research staff, 86; laboratory and technological assistants, 82; engineering, drawing office, and maintenance staff, 55; and library and administrative staff, 37. The Association has just agreed to the new terms of grant for the next five-year period, under which the industry is to subscribe £270,000 a year, against a grant from the Department of Scientific and Industrial Research of £90,000 a year, although the expenditure, which for the current year is to be £322,000, will not build up to £360,000 until the end of the five-year period.

POLYMERS, BIOCOLLOIDS AND POLYELECTROLYTES

SYMPOSIUM IN ISRAEL

UNDER the title of "Polymers, Biocolloids and Polyelectrolytes in Solution" an International Symposium on Macromolecular Chemistry was held in Israel during April 3–9 under the auspices of the Commission on Macromolecules of the International Union of Pure and Applied Chemistry and the Weizmann Institute of Science, Rehovot. This was the first time that such a symposium had been held outside America or Western Europe, and the efficiency of the arrangements and success of the meeting completely justified the choice. More than a hundred foreign scientists attended, including delegates from the U.S.S.R. and Eastern European countries, in addition to an Israeli group of the same size. Sessions were held in the Weizmann Institute, the new campus of the Hebrew University of Jerusalem, and the Institute of Technology at Haifa. It is typical of the rate of development in Israel that meetings in all three centres were held in auditoria that had been completed only recently.

In addition to eighty papers, lectures summarizing recent developments in polymerization were given. The topics discussed were the Ziegler-type polymerization of olefines (Mark, of New York), organic reactions of vinyl polymers (Smets, of Louvain) and the effect of high-energy radiation on vinyl monomers and polymers (Magat, of Paris). More specialized lectures were also given at the start of every session. Space permits no more than a mention of most of the papers that were presented, and for the same reason it is impossible in some cases to give all the authors' names.

The first section of the symposium dealt with the general behaviour of polymers in solution, and included lectures on the statistical thermodynamics of polymers (Prigogine, of Brussels), hydrodynamic properties of polymer solutions (Hermans, of Leyden) and a hydrodynamic study of sedimentation and diffusion (de Groot, of Leyden). Calculations have been made of the molecular extensions of polysaccharides and polybutadienes (Eliezer and Hayman, of Jerusalem), and the matrix method employed in the theory of ferromagnetism has been shown to be useful in statistical problems involving polymers (Hill, of Bethesda). Departures from random mixing in polymer-liquid systems were considered by Gee (Manchester), and Rinfret (Montreal) summarized his recent accurate measurements of heats of mixing and partial specific volumes of polymer solutions, both of which show discontinuities that are dependent on molecular weight. Studies of the viscosity (Rempp, of Strasbourg) and vapour pressure and heat of dilution (Banderet, of Mulhouse) of solutions of paraffins and simple derivatives have been made. Interaction between solvents and cellulose derivatives (Moore, of Bradford) or nylon 66 (Valentine, of Leeds) has been measured by various techniques. Staverman (Delft) described an osmometer the 'membrane' of which is a vapour slit between two disks of sintered glass, and experiments in which diffusion through a conventional membrane was measured. The velocity of dissolution of polystyrene has been shown to depend on the molecular weight and can, after standardization, be used for measuring molecular weights (Ueberreiter, of Berlin). Studies on viscosity included the effect of shear (Eisenberg, of Rehovot) or capillary size (Lifson, of Rehovot) and the anti-thixotropy shown by solutions of poly*iso*butylene in tetralin (Crane and Schiffer, of Haifa).

Optical and electro-optical investigations were described in several papers by Cerf, Leray and Wippler (Strasbourg), Janeschitz-Kriegl (Delft), Peterlin (Ljubljana), Tsvetkov (Leningrad) and in a lecture by Sadron (Strasbourg). The present increased interest in the dielectric properties of solutions of polymers was reflected by papers by van Beek and Hermans (Leyden), de Brouckère (Brussels), Marchal and Benoit (Strasbourg) and Mandel (Brussels). For high degrees of polymerization, the root-mean-square dipole moment is found to be proportional to the square root of the degree of polymerization.

Several papers dealt with the solution behaviour of highly polar polymers. Morawetz (New York) stressed the importance of local concentrations in the molecular coil in determining the formation of association complexes. Viscosimetric and turbidimetric studies suggest that polymethacrylic acid is strongly intra-molecularly bonded, and that this may be responsible for its negative thixotropy (Eliassaf, Silberberg and A. Katchalsky, of Rehovot). The solution behaviour of chemically synthesized, branched polyglucoses (Mora, of Oxford) and the coacervation of polyamides (Turska, of Lodz) were also discussed.

As might be expected from the strong interest of Israeli scientists in this field, the behaviour of biocolloids and polyelectrolytes in aqueous solution was thoroughly discussed. Fuoss (New Haven) initiated the session with a lecture, and papers on theoretical aspects were presented by Oosawa (Nagoya), Lifson (Rehovot) and Michaeli and Overbeek (Utrecht). Topics discussed included the effect of the size of gegen-ions (Gregor, of New York) and the distance between ionizing groups (Dobry-Duclaux, of Paris). The experimental determination of the charge on the polymethacrylate ion was discussed by Jordan (Adelaide), and a new simple theory of polyelectrolytes which leads to good agreement between experiments on velocity of migration, conductivity and activity was presented by Dobry-Duclaux. Other polyelectrolytes that were discussed were polyvinylamine hydrobromide and polyvinylpiperidine (A. Katchalsky), vinyl amphoteric polyelectrolytes (Alfrey and Pinner, of New York), lithium polyphosphate (Saini, of Turin), polymethacrylic acid (Kryszewski, of Torun, Poland), sodium alginate (Allgen, of Stockholm) and the sulphate of aminoacetalized polyvinyl alcohol (Matsumoto, of Okayama). The electroviscous effect shown by rigid polyelectrolytes (Donnet, of Mulhouse), the interaction of ionized polyelectrolytes with polarized mercury-water interfaces (Miller, of Rehovot) and the potentiometry of polyelectrolyte gels (Michaeli and A. Katchalsky, of Rehovot) were also discussed. The unequal permeability to different ions of hydrophilic membranes impregnated with polyelectrolytes, particularly the copper ferrocyanide and sulphuric acid/'Cellophane'/barium hydroxide membranes, was studied by Hirsch-Ayalon (Utrecht).

In the field of protein and polypeptide chemistry, two papers on the surface chemistry of synthetic polypeptides (Isemura, of Osaka) and gliadin and zein (Jaffe, of Brussels) were presented. The deuterium exchange of poly-DL-alanine with water suggests that it exists in aqueous solution in a folded, possibly helical form (Berger and Linderstrøm-Lang, of Copenhagen), while a reversible transformation between helix and random coil has been found for solutions of poly-L-glutamic acid (Doty, of Harvard; Blout, of Boston). A general review of the solution behaviour of poly-α-amino-acids was given by E. Katchalsky (Rehovot); and the reversible heat coagulation of some of these was described by Noguchi (Kanazawa). Polybases (for example, polylysine) agglutinate red blood cells, altering their surface potentials (Nevo, de Vries and A. Katchalsky, of Israel), Meyer (New York) reviewed recent developments in our knowledge of the structure of connective tissue, and other proteins investigated were bovine serum albumin (Champagne, of Strasbourg) and actomyosin (Wassermann, of London).

Nucleic acids were also discussed in several papers and in two lectures by Jordan (Adelaide) and Watson (Cambridge, Mass.). These polymers have been investigated by a variety of physico-chemical techniques: for example, the ultra-centrifuge (Shooter and Butler, of London; Desreux, of Liège), light-scattering (Pouyet and Weill, of Strasbourg), streaming birefringence (Wahl, of Paris; Mathieson, of Nottingham), electrophoresis (Mathieson) and titration (Peacocke, of Birmingham; Mathieson).

Carbohydrates also received some attention. In a most interesting paper, Usmanov (Tashkent) discussed the physico-chemical behaviour of native cellulose and showed that the molecular weight increases steadily as the cotton fibre becomes older, so that the biosynthesis of cotton is apparently a polycondensation process. Spectroscopic studies of the ageing of starch were described by Samec (Ljubljana), while other carbohydrates investigated were levan, a polymer of D-fructose (Feingold and Gehatia, of Israel) and the cycloglucans (Freudenberg, of Heidelberg). Although cupriethylene diamine and cuprammonium hydroxide can be used as solvents in the molecular fractionation of cellulose, they are not recommended because of the degradation that may occur (Sihtola, of Helsinki). Theoretical aspects of polydispersity were considered by Hultin (Stockholm) and Daune (Strasbourg). The swelling of regenerated cellulose (Nowakowski, of Lodz), the sorption and diffusion of organic vapours by ethyl cellulose (Barrer and Barrie, of London) and adsorption on glass-like polymers (Kargin, of Moscow) were also investigated. The flexibility in solution of molecules of hyaluronic acid was reported by Rowen (Los Angeles).

Miscellaneous studies on vinyl polymers included the effect of branching on the solution properties of polyethylene (Trementozzi, of Springfield, Mass.; Mussa, of Turin), the irradiation of polymers in solution (Charlesby and Alexander, of England), the swelling of graft copolymers of acrylonitrile on polyethylene (Chapiro, of Paris) and the preparation of various graft copolymers (Mesrobian, of Brooklyn). Finally, the preparation and properties of several nitrogen-containing polymers were described: for example, polyaminocarboxylic acids and polyvinylamides (Smets, of Louvain) and poly-N-vinylpyrrolidone (Breitenbach, of Vienna).

It is to be hoped that this highly compressed survey gives some idea of the tremendous variety of topics discussed. This catholicity was deliberate, as one of the objects of the organizers was to bring together workers on biocolloids and synthetic polymers so that cross-fertilization of ideas could take place. Judging by the animated discussions that took place inside and, to an even greater extent, outside the lecture halls, this aim was fulfilled. All the papers, together with the discussions, will be printed in full in a special issue of the *Journal of Polymer Science*.

L. VALENTINE

PROGRESS IN THE STUDY OF THE BRITISH FLORA

KNOWLEDGE of the British flora has advanced during the past decade at a rate which has never been equalled before. New techniques and a fresh approach to old problems have resulted in rapidly increasing progress, and the present is therefore an appropriate time for review of old and new methods with the object of suggesting the most fruitful lines for future development. This was the purpose of the conference arranged by the Botanical Society of the British Isles under the title of "Progress in the Study of the British Flora", which was held in Bedford College, London, during April 13–14.

The conference was opened by Prof. T. G. Tutin (University College, Leicester), who directed attention to the importance of learning to regard the flora of the British Isles as a small part of that of Europe. The insularity of British workers has not yet been entirely broken down, and a wider view can have important consequences for the future progress in the study of the British flora. To know their flora properly, British workers must enlarge their scope, and a start in this direction has already been made by experimental taxonomists and specialists in certain genera. Prof. Tutin suggested that the Society could play a valuable part in helping workers to take this wider view, and this proposal was enthusiastically supported by later speakers.

Most of the first day was devoted to consideration of old methods. Canon C. E. Raven discussed "The Early Development of a Knowledge of the British Flora". He pointed out that William Turner, the 'Father' of English botany, had little success in his efforts to identify English plants in the classical botany books until he travelled abroad. As soon as he came across the dried herbaria of Luca Ghini and the admirable pictures in Brunfels, his task became manageable. The discipline which this primary business of nomenclature involved was an exacting, and therefore very valuable, preparation for botanical studies: it gave to these early students a power of detailed observation and minute discrimination which has seldom been surpassed. Ray very seldom confused species that we distinguish, or, except when he relied on hearsay evidence, described plants which we cannot easily and accurately name. This primary business of naming, and its sequel in arrangement and classification, gave rise to study of the habitat and of problems of plant structure and physiology, and the seventeenth-century botanists got as far as was possible until the basic sciences emancipated themselves from magic and tradition. During the discussion which followed Canon Raven's paper, attention was directed to the value of these old records as a starting-point for new investigations. It is significant that some species, such as *Veronica spicata* in Cambridgeshire, have remained for a period of three centuries in the same localities without extending their range, while others have shown rapid spread in much shorter periods.

The next paper, by Mr. J. E. Lousley, considered "The Contribution of Exchange Clubs to Knowledge of the British Flora". When large-scale organized exchange of herbarium specimens was started in Edinburgh and London in 1836, facilities for studying dried and localized dried material were very limited indeed. For the first twenty years, their efforts were directed towards supplying herbarium specimens in large numbers to meet the need of the time. From 1857 to 1878 there was a transitional period when emphasis passed from mere exchange to the study of critical plants, which was their proper function for the remainder of their history. They provided much of the standard material now available for consultation, and the notes printed in the reports provide a record of the views of contemporary botanists on these specimens. By focusing attention on variation, they brought to notice almost all the segregates which cytology or other modern methods have shown to be of importance, and many hints for useful new work may still be found by examination of old reports and the specimens to which they refer.

Dr. J. G. Dony then followed with a paper on "The Place of the Local Flora in the Study of the British Flora". He suggested that local floras have been largely responsible for making Britain, from the botanical point of view, the best-studied part of the world and have served to collect together information on the behaviour of our plants in addition to detailed data on their distribution. There is hope that a fresh pattern for local floras will emerge from the new methods of study now available. The system of working on the basis of the squares of the National Grid which is being used for the new Cambridgeshire, Derbyshire and Warwickshire Floras shows considerable promise.

Prof. P. W. Richards described the progress of the "Biological Flora" which is appearing in parts as supplements to the *Journal of Ecology*. Since active work on this project commenced in 1940, accounts of seventy-four species have been published, and about a hundred and sixty more are in preparation; although contributors work to a schedule, the plan allows for considerable elasticity in the treatment of individual species. Several suggestions for increasing the scope of this very useful work emerged from the discussion which followed. These included a plea for more detailed cytological information, a request for really full descriptions of each species to cover characters omitted for lack of space in most descriptive floras, and a suggestion that there is a need for a central office on the lines of the Maps Scheme of the Botanical Society of the British Isles to collect autecological information and give assistance[1] and encouragement to volunteers.

On the second day of the conference all the speakers were concerned with recent developments. Mr. Keith Jones (Welsh Plant Breeding Station, Aberystwyth) directed attention to the importance of current work in cytology in his paper on "Some Aspects of Plant Variation: the Grasses". It is common knowledge that a species is not necessarily characterized by one chromosome number alone, but may embrace forms having two or more different numbers; perhaps it is not so well-realized that there can also be pronounced intraspecific variation in chromosome pairing at meiosis. This can give important information about the nature and evolutionary origin of a species. Mr. Jones showed from examples that cytological work on artificially reared seedlings can give very different results from similar work on natural populations of the same species. The experimental taxonomist is concerned with the species as it exists after natural selection has operated, and for this purpose it is necessary to collect plants in the field. Studies based on a few individuals are of limited value, and in all cases it is important that the source of material used for chromosome determinations should always be clearly stated in publications.

"The Importance of Experimental Ecology in the Study of the British Flora" was the subject of a contribution from Dr. F. H. Whitehead (Department of Botany, University of Oxford). He pointed out that descriptive ecology discloses problems and suggests hypotheses which should then be tested by experimental work at various levels of refinement. One of his examples covered recent work at Oxford on two calcifuges, *Galium saxatile* and *Holcus mollis*, and two calcicoles, *Scabiosa columbaria* and *Asperula cynanchica*. When *Scabiosa columbaria* was grown in standard water cultures, one with a high pH and the other with a low pH, there was no significant difference in the growth of the plants, and yet when grown from seed in contrasting soils the plants behaved quite differently. These differences were maintained in water cultures prepared from soil adjusted to high and low values of pH. It was concluded that the soil substance affecting growth was water-soluble, and likely to be aluminium. In water cultures with aluminium salts added, *Scabiosa columbaria* behaved in the same way as in cultures prepared from acid soils and produced a small and malformed root system. Thus, on acid soils containing aluminium this plant would be eliminated at the seedling stage during a period of drought. Although it grows especially on soils with a high pH due to a high proportion of calcium carbonate, it will grow equally well on soils rich in other bases—the effect of calcium carbonate is only secondary in making the aluminium not available to the plant. Very similar results were obtained for *Asperula cynanchica*. Examples of this kind show that problems are much more complex than has been hitherto believed, and Dr. Whitehead concluded with a plea for more experimental work of an autecological nature.

Dr. F. Rose (Bedford College, London) opened his paper with a similar plea. In considering "The Importance of Relict and Disjunct Distributions in the Interpretation of the History of the Present British Flora", he put forward hypotheses explaining modern distributions in terms of post-glacial historical changes with the view of stimulating detailed autecological work on the groups of species he mentioned. Dr. S. M. Walters (Botany School, University of Cambridge) gave a survey of the history of mapping plant distributions. In Britain, H. C. Watson in 1836 published a clear statement of the different possible methods to be adopted—area outline, vice-county, and dot maps as they later developed—but, apart from Miller Christy's map of the oxlip in 1884, his ideas were not followed up. The first published vice-county maps for the whole of the British Isles appear to be those in Sir Edward Salisbury's "East Anglian Flora" (1932), although county maps had been included in the "Cambridge British Flora" (1914–20). In visual presentation of distribution data, we have made a much later start than other European countries. Dr. Walters suggested that we could repay our debt to European phytogeography by proposing a practical, standardized method to map the European flora, and he exhibited the outline of such a method.

In the last paper delivered to the conference, Prof. D. H. Valentine (University of Durham) considered "The Study of our Flora as Part of a Whole". Using the family Primulaceae as his main example, he demonstrated the importance of looking at the British flora as a constituent part of the boreal flora as a whole, and emphasized the importance of combining cytogenetical and taxonomic investigations. He urged co-operation with botanists in Europe and the production of a European Flora as outstanding needs.

In addition to the main papers, six exhibitors read short accounts of their exhibits. Mr. A. D. Bradshaw (Department of Agricultural Botany, University College of North Wales, Bangor) described an investigation of the *Agrostis* population of a very old pasture, Port Meadow, Oxford. The composition of a sample of sixty plants on a morphological basis, confirmed by pollen fertilities, was shown to be *A. tenuis* 1½ per cent, *A. stolonifera* 3½ per cent, plants of F_1 type 70 per cent, and plants not easily ascribable to these categories, presumably F_2's or back-crosses, 25 per cent. The population is therefore composed almost entirely of sterile hybrid plants able to compete successfully with their parents under heavily grazed conditions. Miss M. E. Bradshaw (University of Durham) reviewed the distribution of the segregates of *Alchemilla vulgaris* aggr. in Britain, Mr. P. A. Gay (University College of Wales, Aberystwyth) discussed the taxonomic status of *Erica mackaiana*, and Mr. K. M. Goodway (University College of North Staffordshire) the morphological and cytological types of *Galium pumilum*. Mr. D. M. Moore (University of Durham) considered the status of *Viola lactea*, and Dr. W. S. Lacey (University College of North Wales, Bangor) described the spread of *Galinsoga parviflora* and *G. ciliata* in Britain.

Looking back over the two days of the conference, it is clear that there was general agreement that the most promising lines for furthering our knowledge of the British flora are yet closer collaboration between field and laboratory studies, and greatly increased collaboration with European botanists. It was remarkable how these general proposals kept cropping up in almost every paper and throughout the discussions, and there was enthusiastic support for some of the measures suggested for putting them into practice. The proceedings of the conference will be published by the Botanical Society of the British Isles later this year in a book under the same title.

J. E. Lousley

THE POSITIVE CONTRIBUTION BY IMMIGRANTS

A SYMPOSIUM, "The Positive Contribution by Immigrants", prepared for the United Nations Educational, Scientific and Cultural Organization by the International Sociological Association and the International Economic Association (pp. 203. Paris: Unesco; London: H.M.S.O., 1955; 600 francs, 12*s*. 6*d*. or 2.25 dollars), includes five national studies covering the United States, Great Britain, Australia, Brazil and the Argentine Republic. There is also a short survey of the economic aspect, by Brinley Thomas, which details some of the outstanding inventions or industries in the United States attributed to immigrants and suggests that the qualitative contribution of immigrants as a source of outstanding talent and of general man-power is likely to remain a vital factor in economic development. Australian economic life has been much enriched by men of diverse nationalities endowed with varied skills and aptitudes, and in reviewing recent British experience he remarks of science that in no department of human activity is it truer to say that protective barriers are a cause of impoverishment and that their removal will always redound to the benefit of the community as a whole.

Dealing specifically with Great Britain, Mr. J. Isaac quotes some examples of the wide range of scientific activities which have been influenced by alien immigrants since 1933. Of 533 Fellows of the Royal Society, twenty-one went to Britain as refugees from the Continent of Europe, and many chairs at British universities are held by such immigrants; they have participated in such achievements as the British contribution to the development of nuclear energy, and a particularly noteworthy example is that of Prof. H. A. Krebs and Prof. E. B. Chain, who have shared the Nobel Prize for Medicine. As entrepreneurs and managers, pre-war immigrants have made notable contributions, introducing new ideas or specializing in branches of trade neglected in Britain, and their contribution in the Welsh Development Area in particular has received high praise in Parliament. The contribution of immigrants to the relief of Britain's post-war man-power problems has been limited by the qualified support given by British trade unions, the low standards of medical fitness, education or intelligence used for the selection of the workers, and by difficulties in finding accommodation in Britain for other members of the worker's family. Discussing the demographic aspect, Mr. Isaac points out that it would be a fallacy to assume that Britain could absorb a constant inflow of large numbers of immigrants in the future with similar favourable results, even if suitable persons were available, unless the immigrants could show that they have a special contribution to make.

In a concluding chapter, Mr. Oscar Handlin reviews generally the contributions of immigrants, particularly with reference to the depth of their influence on the host cultures and the extent to which those contributions were determined by the social conditions the immigrants encountered or by the character of the immigrants themselves. Finally, he concludes that, in a larger perspective, immigration establishes a complex of human ties and linkages that play a significant part in extending international understanding.

UNIVERSITY COURSES IN THE U.S.S.R.

On September 1, 1955, new syllabuses came into force for first-, second- and third-year students of all university faculties in the U.S.S.R. These have been described by M. G. Uroyev, of the Central Board of Universities and Institutes of Law and of Economics.

Fourth- and fifth-year students continue to follow the old courses; but there is an important addition for students in the faculties of philology, history, physics and mathematics, biology, chemistry and geography. In their seventh term they will take a course on teaching methods and, in their eighth term, will do teaching practice in schools for six weeks; during this time they will have no lectures or other work.

For a number of subjects one of the main weaknesses of the old syllabuses was that they produced specialists of too narrow a type. One of the chief demands of the new syllabuses is that they should provide conditions suitable for the training of 'broad' specialists—people with a command of the fundamentals of the sciences but with a proper preparation for work in various branches of industry and culture.

Subjects of general scientific and technical importance are given more weight in the syllabuses; for closely related degree subjects within the faculties of biology, geology, philology and geography there will be unification of the general theoretical grounding given to all students. For the first two or three years students taking kindred subjects will follow exactly the same courses, covering the same ground and devoting the same amount of time to various courses. For example, for the six different degree courses which can be taken in geology, there are twenty-seven courses which are the same for all students. These take up to 66–68 per cent of the total time of the syllabus, leaving 32–34 per cent of their time for special subject courses.

The new syllabuses provide for broader subject divisions than the old and do not, as a rule, allow for specialization within the chosen subject. Such excessively specialized degree subjects as, for example, 'the editing of literary and political writings', 'the economics of the countries of the non-Soviet East', 'world economics', 'the history of international relations', 'Darwinism and genetics' have been discarded. Inorganic chemistry, organic chemistry and analytical chemistry, which used to be independent degree subjects, have now become subjects in which one specializes inside the framework of a general chemistry degree.

The number of hours available for faculty courses and seminars has been reduced. Universities now have the right to decide for themselves the subjects and extent of faculty courses and seminars, and to discuss and approve for themselves the advance plans produced for such courses. In this way such courses and seminars will reflect the scientific work being done in the given university.

In the case of students in the faculty of biology, the reduction in the amount of time allowed for their faculty courses and seminars has made it possible to increase the time devoted to learning a foreign language, to studying teaching methods of their subject, and to physics, chemistry and botany and higher mathematics.

The importance of the independent work done by students is recognized and reflected in the new syllabuses in the following way: the number of lectures and classes at which attendance each week is obligatory has been cut down; certain classes, in which the material dealt with can well be mastered by the student independently, have been done away with altogether; and the number of pieces of independent work required from the student in different courses has been increased.

The increase in the time given to teachers' training is of major significance; the main task now is to train teachers for the senior classes of the secondary schools. As from 1956, not less than 80 per cent of each year's graduates in the faculties of philology, history, geography and biology, and not less than 60 per cent from the faculties of chemistry and physics and mathematics, will be going to work as secondary school teachers.

The actual titles of the qualification received by graduate teachers has also been changed: the diploma given to a graduate used to read "qualified in history (or mathematics)" but will now read "qualified in history and as a teacher of history in secondary schools"*.

* *Translators' note.* The translators, who have carried out their task on behalf of the Society for Cultural Relations, write that the way in which Soviet and British university 'technical terms' have been equated in the translation is not consistent. Soviet graduates, for example, do not receive degrees, but diplomas The word 'term' has been used for translating the Russian 'semestr', though this is really a half-year; but 'faculty' has been used in the Soviet way, although their faculties correspond to our schools or departments.

OVERSEAS FOOD CORPORATION

REPORT FOR 1954–55

The annual report of the Overseas Food Corporation for the year ended March 31, 1955*, is the last report which the Corporation will publish, since the balance of funds made available for investigating the economics of mechanized and partly mechanized agriculture under tropical conditions has been transferred to the Colonial Development and Welfare Fund for the use of the newly established Tanganyika Agricultural Corporation, which will continue the investigations until September 1957 and report on them in due course. The legislation establishing the new Corporation provides also for the dissolution of the Overseas Food Corporation, and accordingly this final report is accompanied not only by the usual statement of accounts for the year but also by an interim review of the work of the whole undertaking from its inception. Some of the findings and conclusions merely confirm those of other workers in the Colonial Empire; but others are original, and the report should be of value to many concerned with the development of tropical agriculture both in East Africa and elsewhere. Moreover, it indicates the excellent work carried out not merely by the Scientific Department but also in land clearing and development. The African Tenant Farmers Scheme is developing satisfactorily in all three areas, and results have justified a continued extension of the Scheme. There is now every probability of consolidating one of the Corporation's original areas, Urambo, into an economic communal enterprise based on a flue-cured tobacco economy, and experience gained in cattle-ranching in Kongwa indicates that the potentialities of that area for beef production are good.

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* Overseas Food Corporation. Annual Report and Statement of Accounts for the Year ended 31st March, 1955. Pp. viii+183+8 plates. (London. H.M.S.O., 1955.) 6*s*. 6*d* net.

The report thus indicates the real dividend that has accrued from the vast investment in the original Groundnut Scheme, and the chapter reviewing the scientific and experimental work over the whole period, which includes a list of published papers as well as an outline of present and future lines of research, should be of some general scientific interest. The areas in which the work has been done represent vast tracts of Africa which, if they could be opened up and economically developed, would play a major part in the development of those territories. Since the revised agricultural plan was introduced in 1951, the Corporation has had to dispense with the services of more than 1,100 Europeans and 14,700 Africans, most of whom have found satisfactory employment elsewhere, almost three out of every four Europeans remaining in Africa.

Steady progress was made in the investigations during the year, and although it is yet too early to say which size of farm and method of farming will eventually prove to be the most economical, the farm with 1,000 acres under crop appears to have a distinct advantage over those having 1,500 and 2,000 acres under cultivation in allowing a higher degree of supervision, while a combination of annual and perennial crops should prove the safest and most remunerative in the long run. As a result of experience during the past four years and with the advice of the Empire Cotton Growing Corporation and the Department of Agriculture, Tanganyika, it has been decided to discontinue cotton in Nachingwea, chiefly owing to the incidence of red bollworm.

The scientific and experimental work carried out during the past five years or more has covered soils and soil fertility, agronomy, pests and diseases, the residual effect of fertilizers, nitrate accumulation, rainfall and weed control, chiefly with reference to groundnuts, soya, maize, sorghum, sunflower and cotton. It has been shown, for example, that, for the successful production of groundnuts and the harvesting of a good final population, early planting and harvesting at the correct time are of particular importance and much more important than cultural methods. Early experiments have shown the great value of seed dressings of the organic mercurial type for improving stands, two dressings based on an organic mercurial and on tetramethylthiuram proving consistently better than the others. Seed-bed losses were due chiefly to a wide range of fungi, mainly of the Phycomycetes group, while fungi of the *Aspergillus niger* van Tiegh. and variants were responsible for post-emergent losses. A serious threat to the production of groundnuts is rosette disease; a virus disease transmitted by the aphis, *Aphis craccivora* Koch, and it has been established that in the Nachingwea district a local variety, Asirya Mwitunde, showed field resistance to this disease; it is hoped that selection will further raise the general level of resistance of the variety. Rosette infection has also been reduced considerably by treating groundnut seed with the systemic insecticide 'Schradan'.

The success of crop production at Nachingwea depends fundamentally on the maintenance of soil fertility and especially of soil structure so that the rainfall percolates into the soil where it falls, thus preventing soil wash at times of heavy rainfall and holding the water where the plant can use it, particularly in seasons of low rainfall. Permanent experiments have been laid down to test the value of continued application of artificial fertilizers and of two- and three-year Rhodes grass leys; but a solution must be sought along the lines of a resting phase that will reconstitute drainage channels in the soil and in soil-management methods such as ridging. Methods of stubble disposal may also be important in this context.

When the present work on producing uniform varieties of Katambli that are resistant to *Polysora* rust disease is complete, the prospect of producing good yields of maize and groundnuts appears to be reasonably high. To complete a basic rotation, a white sorghum with good resistance to central shoot fly, *Atherigona indica subfuscata*, is needed. The variety Dobbs shows appreciable resistance. Soya bean yields also require a great improvement or else other crops must be introduced to provide breaks between successive cereal crops since, if these form too high a proportion of a rotation, the danger of serious losses from *Striga* is high. Work to produce a suitable sorghum and on breeding and selecting higher-yielding varieties of soya has commenced, as well as on sunflower and castor bean.

A study on the economic usage of fertilizers is projected. Even on one soil yields vary from field to field, and the continued application of phosphate on some of the older fields may have improved their phosphate status. Groundnuts generally respond well and economically to 100 lb. of single superphosphate. Maize often responds well to 100 lb. of single phosphate and 100 lb. of ammonium sulphate under experimental conditions; but the economic value of the fertilizer under production conditions is doubtful, while the response of soya and sorghum to fertilizers is low and unlikely to be economic. Future work should accordingly be directed to assess the value of the fertilizer for rotations rather than for individual crops.

Soil types on the catena vary greatly, and full utilization of these would assist the maximum utilization of land; but to use the easily erodible types is a work of great magnitude. So far, erodible types that have been cleared have been laid down as cashew plantations, but their use as pasture in a system of cattle management designed to bring fertility uphill is worth considering. Research at Kongwa is now devoted to pasture studies, particularly of the effects on natural pasture of grazing at different seasons of the year and intensity of grazing. Other investigations include the improvement of pasture by planting various mixtures and numbers of plants, seed-rates with and without superphosphate, seed production, protection of sown seed against ants, and the selection of improved strains of a wide variety of grasses. A study of 'dry farming' demonstrated that benefits of dry farming can be achieved with a protective covering of a short-season shallow-rooted grass, and that weeds and self-established grasses extract as much water as do heavy crops of maize and sorghum.

Urambo is a typical area of miombo bush, and the clearing is surrounded with forest heavily infected with *Glossina morsitans*. Recommendations made by the East Africa Tsetse and Trypanosomiasis Research Organization for controlling sleeping sickness and the fly population have been adopted by the Corporation and modified as experience indicated; but an experiment in the elimination of fly population by air spraying indicated that the cost—£1,000 per square mile—is not warranted unless immigration f further flies is impossible. Discriminative clearing as proved very successful around Tabora, and a lan has been adopted to eliminate breeding areas nside the barrier clearing, to strengthen the barrier learing so that the bush inside is isolated, and to educe the pressure on the outside of the barrier by iscriminative clearing for two miles into the bush ll around the area. The results should be apparent uring the next two years. It is not anticipated that immigration will ever be completely prevented; but the danger can be substantially eliminated by the destruction of all habitat inside the barrier. If cattle are to be kept economically, cover in which 'immigrants' can live should be eliminated so far as possible from the bush around the grazing area. The present acreage of tobacco and consequent use of firewood for curing should ensure automatic clearing of most of the inside bush in future.

STERIC EFFECTS IN ANIONOTROPIC REARRANGEMENTS*

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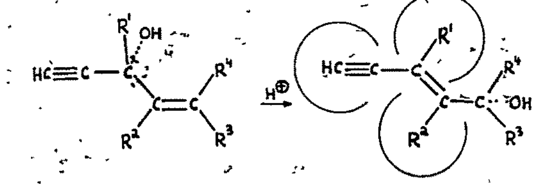
THE concept of steric hindrance, as applied to the reactions of organic compounds, has undergone a great deal of elaboration in recent years. Two main types of phenomena may be distinguished, though they are necessarily interconnected: those which arise primarily from spatial resistance by the molecule undergoing change to the approach of the reagent ('kinetic' effects); and those which are due mainly to either an increase or a decrease in steric strain in going from the reactant to the product ('thermodynamic' effects). Steric effects of thermodynamic origin have been rather less fully studied than those of kinetic origin; yet the former should be more readily amenable to quantitative interpretation since the reactivity differences will, in general, bear a more direct relationship to the physical properties of the reactants or products. We have established such a correlation between the rates of formation and the electronic spectra of certain conjugated systems, and since the principles involved should be of general applicability, a summary is presented here.

The reactions concerned are acid-catalysed anionotropic rearrangements of the type $X\text{—C(OH)—C=C} \rightarrow X\text{—C=C—C(OH)}$, where X is an acetylenic, ethylenic or phenyl group. Previous studies have shown[1] that, under the usual conditions, these rearrangements proceed via the corresponding oxonium ions as indicated below, and are normally facilitated by electron-donating substituents, such as methyl, as would be expected for a reaction involving preliminary addition of a proton. The present data cover a range of reaction-rates of more than 10^{10}, and show that the differences of rate are largely due to changes in the energies of activation.

Table 1. REARRANGEMENTS OF ALKENYLETHYNYLCARBINOLS (I) → (II)

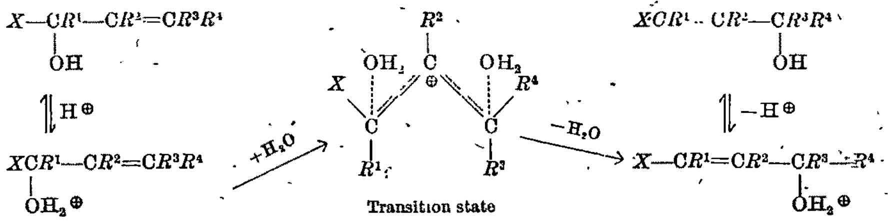
R^1	R^2	R^3	R^4	k'	ΔE_A	$\Delta\Delta E_A$	$\lambda_{max.}$	ε
H	H	H	H	0·00001	—	—	2230	13,500
Me	H	H	H	0·0002	−1·8	0·0	2235	13,500
H	Me	H	H	0·00005	−1·0	0·0	2230	13,500
H	H	Me	H	0·0006	−2·5	0·0	2235	13,500
H	H	Me	Me	0·13	−5·7	0·0	2240	13,000
Me	H	Me	H	0·09	−5·5	−1·2	2235	13,000
Me	H	Me	Me	4·0	−7·7	−0·2	2240	12,500

In this and the following tables, k' are the specific first-order rate-constants (min.$^{-1}$) in 60 per cent aqueous dioxan-hydrogen chloride at 30°, and λ_{max} and ε are the wave-lengths (in A.) and molecular extinction coefficients of maximal near ultra-violet absorption of the rearrangement products. For the meaning of other symbols, see text; ΔE and $\Delta\Delta E$ values are in k.cal./mol.



(I) (II)

When X is C≡CH, the accelerating influence of methyl substituents is apparent at each of the positions R^1, R^2, R^3 and R^4, and the effects of several substituents when expressed as the decrease in energy of activation ($-\Delta E_A$) are approximately additive (Table 1). No steric hindrance in the resulting conjugated vinylacetylene system is indicated by scale projections, even in the highly substituted derivatives, and this is borne out by the fact that the characteristic electronic spectra of the products show only minor differences in this series.



Quite a different situation is encountered when X is Ph (Table 2). Methyl substituents again cause an acceleration at R^3 or R^4; but at R^1 or R^2 they produce a decrease in rate and an increase in the energy of activation, which can be expressed as the difference ($+\Delta\Delta E_A$) between the observed and the additive or calculated values. These retarding effects are evidently not electronic and may therefore be presumed to be steric; but they can scarcely be of kinetic origin

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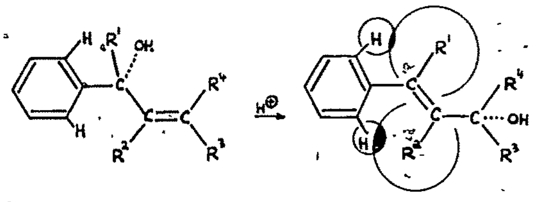
* Paper read at the XIVth International Congress of Pure and Applied Chemistry in Zurich on July 22, 1955.

Table 2. Rearrangements of Alkenylphenylcarbinols (III) → (IV)

R^1	R^2	R^3	R^4	k'	ΔE_A	$\Delta\Delta E_A$	$\lambda_{max.}$	ε	θ°	$\Delta\Delta E_R$	$\frac{\Delta\Delta E_A}{\Delta\Delta E_R}$
H	H	H	H	0·0038	—	—	2510	19,500	0	0·0	—
Me	H	H	H	0·0027	+0·2	+2·0	2490	16,000	25	−1·3	1·5
H	Me	H	H	0·00024	+1·7	+2·7	2440	13,000	35	−2·4	1·1
H	H	Me	H	1·74	−3·7	0·0	2510	19,500	0	0·0	—
H	H	Me	Me	80	−6·0	0·0	2510	18,500	10	−0·3	—
Me	H	Me	Me	7·8	−4·6	+3·2	2480	10,000	44	−3·4	0·9
H	Me	Me	Me	3·0	−4·0	+3·0	2460	7,000	53	−4·5	0·7
Me	Me	Me	Me	9·8	−4·7	+4·1	2440	8,000	50	−4·1	1·0



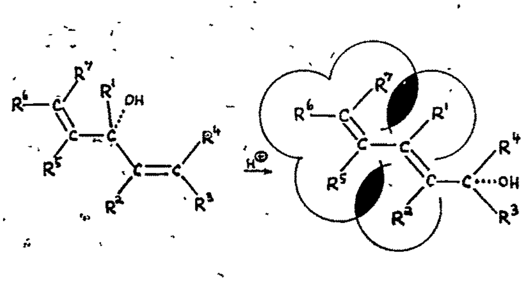
(III) (IV)

since substituents at R^1 or R^2 will cause no appreciable hindrance either to the attachment of a proton to the hydroxyl group, or to the approach of a solvent molecule to the carbon atom bearing R^3 and R^4. The scale projections indicate, however, that methyl substituents at R^1 and R^2 will prevent the styrene system formed in the reaction from taking up a uniplanar conformation owing to interference with the *o*-hydrogen atoms of the phenyl group; they also show that interference will be less severe for a substituent at R^1 than at R^2. Now, non-planarity is well known to decrease the resonance energy associated with a conjugated system and will therefore raise the energy-level of the products with respect to the reactants, that is, reduce the resonance energy gain ($+\Delta E_R$) accompanying the rearrangement. Further, since conjugation already becomes partially effective in the intermediate stages of the act of isomerization, non-planarity will also raise the energy-level of the transition state, that is, increase the energy of activation. Thus, the retarding influence of methyl substituents at R^1 and R^2 clearly represents an example of 'thermodynamic' steric effects.

The non-planarity of the hindere styrene derivatives is reflected i their electronic spectra. In eac case where the formation of th conjugated system is stericall retarded, the rearrangement pro duct exhibits a maximum at th usual wave-length, but of reduce intensity (Table 2); and th greater the retardation, the large the drop in the absorption coeffi cient (ε). It has recently bee shown[3] that such spectral effect permit the calculation of the mea interplanar angle θ in the ground state by the simple relation $\varepsilon/\varepsilon^0 = \cos^2\theta$, where ε^0 is the absorptio coefficient for the unhindered paren system. If we make the assump tion that the dependence of resonance energy on interplanar angle obeys a simila relation $E_R/E_R{}^0 = \cos^2\theta$ ($\cos^1$ to $\cos^6$ function have been advocated; but the $\cos^2$ function i the simplest which passes through the fixed point when θ is 0, 90° and 180°), we can deduce from th spectral data the *loss* in resonance energy gai ($-\Delta\Delta E_R$) due to steric hindrance. A comparison o these values with the increase in activation energ ($+\Delta\Delta E_A$) derived from the rate-measurements wil provide a direct measure of the relative importanc of resonance in the transition state and in the fina product. The ratios ($+\Delta\Delta E_A/-\Delta\Delta E_R$) found ar approximately constant and not far from unity indicating that resonance stabilization is about equa in the transition states and in the products. Thi conclusion is in accord with the mechanism show above, the transition state of which is essentially strongly solvated carbonium ion. The extra resonanc energy of such an entity would be expected to b intermediate between that of the corresponding semi conjugated neutral system (about $\frac{1}{2}\Delta E_R$) and tha of the corresponding free charge-resonance system[3], (about $2\Delta E_R$), that is, close to that of the neutra conjugated system (ΔE_R). The actual values o $\Delta\Delta E_A/\Delta\Delta E_R$ depend, of course, on ΔE_R, estimate of which vary considerably. We have chosen 7 k.cal for the styrene system and 5 k.cal. for the butadien system as reasonable figures.

Table 3. Rearrangements of Di-alkenylcarbinols (V) → (VI)

R^1	R^2	R^3	R^4	R^5	R^6	R^7	k'	ΔE_A	$\Delta\Delta E_A$	$\lambda_{max.}$	ε	θ	$\Delta\Delta E_R$	$\frac{\Delta\Delta E_A}{\Delta\Delta E_R}$
H	H	H	H	H	H	H	0·0018	—	—	2230	25,000	0	—	—
H	Me	H	H	H	H	H	0·0033	−0·4	+0·6	2250	22,000	23	−0·7	0·9
H	H	Me	H	H	H	H	1·75	−4·2	0·0	2230	26,000	0	—	—
H	H	Me	Me	H	H	H	145	−6·8	0·0	2230	26,000	0	—	—
Me	H	Me	H	H	H	H	22	−5·7	+0·3	2280	20,000	28	−1·2	0·3
H	Me	Me	Me	H	H	H	132	−6·7	+1·1	2340	17,000	36	−1·8	0·6
H	H	H	Me	H	Me	H	184	−6·9	0·0	2270	26,000	0	—	—
H	H	Me	Me	H	Me	H	12,100	−9·4	+0·1	2270	26,000	0	—	—
Me	H	Me	Me	H	Me	H	3,700	−8·3	+2·5	2280	13,000	45	−2·5	1·0
H	Me	Me	Me	H	Me	H	6,400	−9·1	+1·4	2380	15,000	40	−2·1	0·7
H	H	Me	Me	H	Me	Me	300,000	−11·4	0·0	2370	26,000	0	—	—
Me	H	Me	Me	H	Me	Me	5,900	−9·0	+4·2	2230	8,000	56	−3·5	1·2
H	Me	Me	Me	Me	Me	Me	35	−5·9	+7·5	2280	5,000	64	−4·2	1·8



(V) (VI)

Similar results have been obtained in the formatio of the butadiene system by rearrangement of di ethylenic alcohols[5] (Table 3). Once again, methy substituents in the 'outer' positions R^3, R^4, R^6 an R^7 accelerate the isomerization, while those in th 'inner' positions R^1, R^2 and R^5 retard it. As before retardation goes together with non-planarity of th conjugated system formed, as indicated by scal projections and by the decrease in intensity of the characteristic bands in the electronic spectra. With methyl substituents at either R^1 or R^2, but not simultaneously at R^7 or R^5, the steric retardations are relatively small ($+\Delta\Delta E_A < 2$ k.cal./mol.), since only methyl-hydrogen interference will occur. On the other hand, with methyl substituents at R^1 or R^2 and simultaneously at R^7 or R^5, as in the last two examples in Table 3, the steric retardations are large ($+\Delta\Delta E_A > 4$ k.cal./mol.), since in these cases interference between two methyl groups is involved. The $(+\Delta\Delta E_A/-\Delta\Delta E_R)$ ratios, though of the same order, are more variable in this series and the differences can be interpreted; but their limited accuracy does not in our opinion justify carrying the analysis further at present. The estimated or observed values of $(+\Delta\Delta E_A/-\Delta\Delta E_R)$ could obviously be used, however, to calculate the relative rates of formation of other hindered conjugated systems from their electronic spectra, or *vice versa*.

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SPIRACULAR CONTROL OF DISCONTINUOUS RESPIRATION IN INSECTS

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THE respiration of many groups of insects is remarkable in that metabolic carbon dioxide is retained within the insect and released during brief periods in 'bursts'[1]. In diapause pupæ of the Cecropia silkworm, *Platysamia cecropia*, more than nine-tenths of the metabolic carbon dioxide is stored and then released in brief bursts which occur from once every week to many times per hour, depending on the temperature and metabolic rate. The remaining carbon dioxide escapes during the interburst period. The uptake of oxygen, unlike the release of carbon dioxide, is continuous and steady. If the spiracles are sealed with paraffin, virtually all the respiratory exchange ceases; the spiracles are, therefore, the site of both the discontinuous release of carbon dioxide and the simultaneous continuous uptake of oxygen[2].

Since oxygen uptake is continuous, the spiracles must remain partially open between bursts, permitting oxygen to diffuse in. Thus we are confronted with two perplexing facts; namely, that oxygen enters the insect during the interburst period at many times the rate at which carbon dioxide leaves, and that the insect releases its carbon dioxide periodically. The latter is the simpler to explain and is considered here.

The fact that the spiracles are partly open between bursts has led some to conclude that the opening and closing of the spiracles cannot be responsible for the discontinuous release of carbon dioxide[3]. During the past two years, however, we have obtained considerable evidence that the cycle of retention and release of carbon dioxide does indeed result from the cyclical activity of the spiracles. The aperture of each spiracle is regulated by a spiracular valve served by a closer-muscle. When this muscle relaxes, the valve opens because of its own elasticity and because of the tension of an elastic ligament which opposes the closer-muscle. The muscle receives nerve fibres from the corresponding segmental ganglion and from the median nerve of the previous segment[4].

The central importance of the spiracular valves in the discontinuous release of carbon dioxide was suggested by the observation of Buck *et al.* that intubating the spiracles of *Agapema* pupæ eliminated the bursts of carbon dioxide[5]. Similarly, we observed that excision of the valve from one of the fourteen functional spiracles of a *Platysamia* pupa caused carbon dioxide output to become continuous. Lowering the metabolic rate of these surgically treated pupæ by keeping them at 10° C. did not cause the bursts to reappear. Indeed, the only manœuvre that restored the discontinuous release of carbon dioxide was the sealing of the open spiracle. It appears from this experiment that all the spiracles remain nearly closed during the interburst, preventing carbon dioxide from diffusing out in substantial quantities, and that one or more of the spiracles opens during a burst. The spiracular valves are thus the key to the discontinuous release of carbon dioxide.

The activity of the valves in the living pupal silkworm was recorded by following the leading edge of a valve with the hairline of an ocular micrometer, the movements of which were translated into a kymograph trace by a system of pulleys and levers. Fig. 1 is a portion of a typical record of the activity of an abdominal spiracle of a *Platysamia* pupa. The ordinate of the trace shows the width of valve-opening in arbitrary units, while the abscissa denotes the duration of the opening. A consistent pattern of valve movement occurred in cycles lasting 45 min. to 2 hr. After a period during which it remained closed and motionless, the valve fluttered for about 15 min., and then, within a minute, the valve movements progressively increased in amplitude until the valve opened fully. Swaying slightly, it remained open for several minutes. Then it alternately opened and closed for several minutes, and the valve movements gradually decreased in amplitude and duration until the valve closed altogether. Following this, the valve remained motionless until the fluttering preceding the next period of wide openings. This cycle was repeated over and over and apparently represented the normal behaviour of the spiracle. Manometric observations of the carbon dioxide output of this pupa revealed bursts of carbon dioxide at intervals of 30 min. to 2 hr. A similar correlation between the frequency of carbon dioxide bursts and periods when the valve was widely opened has been consistently observed in all other silkworm pupæ studied. It is evident that the periodic release of carbon dioxide by the insect results from a periodical prolonged opening of the spiracles which I term a 'burst'. Moreover, it appears that the continuous interburst inflow of oxygen and outflow of carbon dioxide is not the result of occasional small openings of valves between bursts. Rather, oxygen enters and a trace of carbon dioxide leaves through the very small opening which must persist after the valve closes.

Variations in the ambient tensions of oxygen and carbon dioxide exert a profound effect on this cycle of valve activity (Fig. 2). Increasing the oxygen tension above the 21 per cent in air progressively eliminated the interburst fluttering but left the burst-frequency unaltered. Decreasing the oxygen tension below 21 per cent progressively increased the interburst fluttering until, at tensions below 15 per cent, the bursts disappeared and the valve fluttered continuously. Finally, when the oxygen tension fell to about 5 per cent, the valve remained wide open, closing only intermittently. As carbon dioxide tension increased above 5–8 per cent, the frequency of bursts increased and the duration of the bursts lengthened. In 15 per cent carbon dioxide the valves fluttered continuously, and at still higher tensions of carbon dioxide they behaved as they did in 5 per cent oxygen.

These findings explain the previous manometric findings that increasing ambient oxygen tension decreased the interburst output of carbon dioxide, that increasing the carbon dioxide tension above 5–8 per cent increased the frequency of carbon dioxide bursts, and that low tensions of oxygen and high tensions of carbon dioxide eliminated the discontinuous respiration[2]. Moreover, the observations suggest that within the insect the normal stimulus for cyclical valve activity is a combination of decreasing internal tension of oxygen and increasing internal tension of carbon dioxide during the interburst period. The following hypothesis is consistent with all the observations.

Immediately after a burst the valves are closed; but they leak sufficiently to permit some inflow of oxygen and outflow of carbon dioxide. The valve opening, however, is so small and the gradient driving oxygen in so slight that oxygen inflow does not match oxygen utilization, and the oxygen tension within the tracheal system of the insect falls. When the intratracheal oxygen tension falls to about 10 per cent, the spiracular muscle partially relaxes and the spiracle opens, permitting oxygen to enter. This increases the oxygen tension, and the valve promptly closes. This pattern of opening and closing is repeated and represents the period of fluttering prior to a burst. During the interburst period some carbon dioxide escapes, but at a rate less than that of its production. The internal carbon dioxide tension ultimately reaches a critical threshold and the closer-muscle relaxes, the valve opens widely in a burst, carbon dioxide pours out and oxygen flows in. As the internal carbon dioxide tension now decreases and the internal oxygen tension increases, the valve begins to close and open periodically with diminishing width and duration of opening until finally it remains closed and the cycle is completed.

Further support for this hypothesis comes from the following observations on animals with intubated spiracles. A series of pupæ had tiny glass tubes inserted in several of their spiracles beyond the spiracular valves, placing their tracheal system in free communion with the air. The carbon dioxide tension within the insect fell and the oxygen tension rose as the gas tensions within the insect approached that of the outside. In such pupæ, the unintubated spiracular valves remained tightly closed for many days, presumably because the normal stimuli triggering spiracular activity were absent. The spiracles opened, however, when the ambient oxygen tension was reduced below about 10 per cent or the carbon dioxide tension raised above about 10 per cent. Further, we noted that the threshold concentration of carbon dioxide needed to trigger the opening of the spiracles diminished as the oxygen tension was decreased below 21 per cent[6].

Having established a possible sequence of events to account for the cyclical activity of the spiracles, we come to the question of the co-ordination of this activity and the location of the chemoreceptors sensitive to changes in gas tension. Although a localized stream of carbon dioxide could cause individual spiracles to open, in the normal insect the spiracular valves were co-ordinated. When the valves opened in a burst or closed at the end of one, they did so within a minute of each other, though when they fluttered the pulsations were not in exact synchrony. Moreover, in an intubated pupa the carbon dioxide and oxygen thresholds for spiracle opening were very similar in the several spiracles of an individual. There is, however, no indispensable central respiratory centre for all the spiracles;

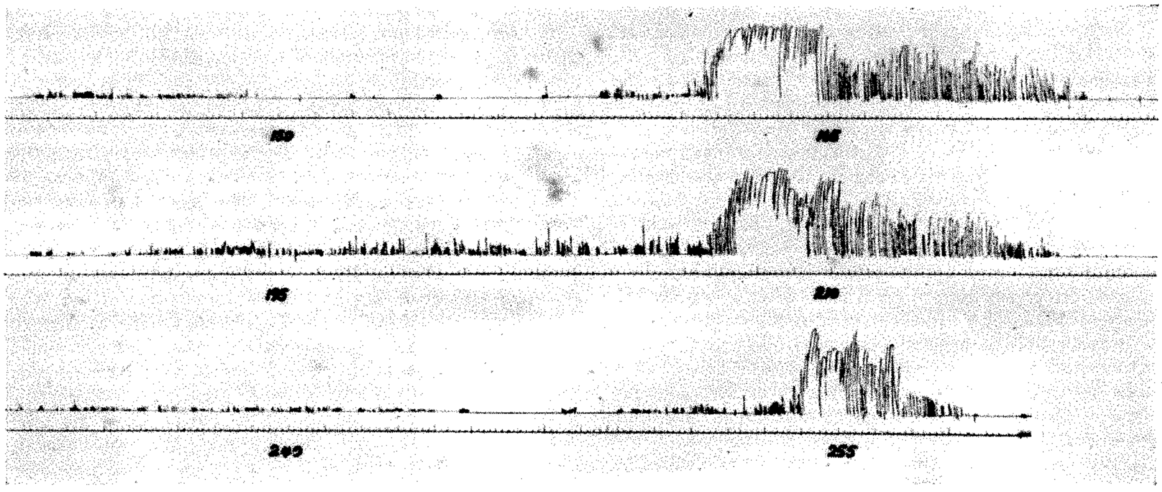

Fig. 1. Portion of a typical record of the valve movements of the third abdominal spiracle of a *Platysamia* pupa in diapause at 25° C.

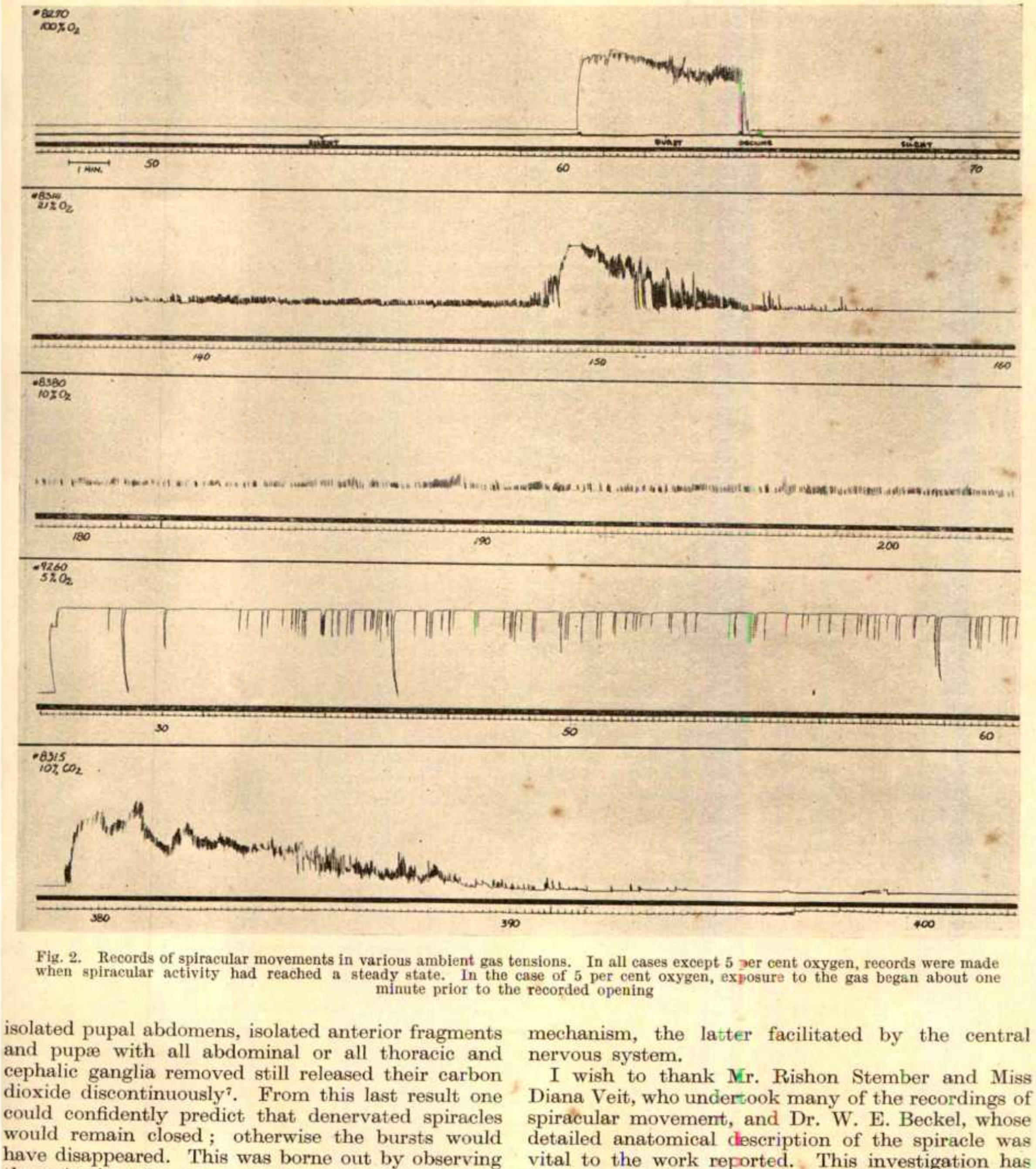

Fig. 2. Records of spiracular movements in various ambient gas tensions. In all cases except 5 per cent oxygen, records were made when spiracular activity had reached a steady state. In the case of 5 per cent oxygen, exposure to the gas began about one minute prior to the recorded opening

isolated pupal abdomens, isolated anterior fragments and pupæ with all abdominal or all thoracic and cephalic ganglia removed still released their carbon dioxide discontinuously[7]. From this last result one could confidently predict that denervated spiracles would remain closed; otherwise the bursts would have disappeared. This was borne out by observing the spiracles of pupæ with one or more segmental ganglia removed: the spiracles serving the denervated segments remained closed in air. They opened in low oxygen tension or high carbon dioxide tension but were somewhat less sensitive than innervated spiracles of the same individual[8]. The response persisted for at least forty-two days after denervation. The stimulus for contraction of the closer-muscle of the spiracle after it was deprived of all central nervous connexions remains for the present a mystery. Efforts to demonstrate a peripheral ganglion near the muscle have thus far met with failure. Further histological as well as pharmacological studies of the spiracular mechanism are under way in an effort to clarify this issue. Present evidence points to a peripheral sensory mechanism and a peripheral motor mechanism, the latter facilitated by the central nervous system.

I wish to thank Mr. Rishon Stember and Miss Diana Veit, who undertook many of the recordings of spiracular movement, and Dr. W. E. Beckel, whose detailed anatomical description of the spiracle was vital to the work reported. This investigation has been supported by Grant *H*-1887 from the National Heart Institute of the U.S. Public Health Service and the Sage and Sackett Funds of the Zoology Department of Cornell University.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Flying-Spot Monochromatic Ultra-Violet Television Microscope

ATTENTION has been directed by Young and Roberts[1] to the advantages of utilizing the flying-spot technique for the production of absorption images of living cells at 2600 A. These advantages are the immediate visual presentation of the image and a great reduction in the amount of ultra-violet radiation necessary for the production of the image, the latter advantage being due to the much greater quantum efficiency of photocathodes over photographic emulsions.

Practical realization of these advantages has now been made possible because of the utilization of new deep ultra-violet scanning cathode-ray tubes and ultra-violet photomultipliers of high quantum efficiency, in conjunction with certain recent developments in technique we have devised. These developments consist of the employment of 4-sec. frame-sweep speeds, 60-cycle line presentation on a radar (cathode-ray) tube, and photographic integration of the image on the monitor tube. The purpose of the 4-sec. frame, 60-cycle line is to reduce the amount of radiation received by the specimen while at the same time obtaining the maximum signal-to-noise ratio on the presentation tube ; photographic integration then allows for a further increase in the signal-to-noise ratio and is obtained by exposing the photographic plate to several successive frames. The image then builds up in proportion to the number of frames, while the statistically random distribution of the noise allows it to build up as the square root of the number of frames. The limits of this integration process are : (*a*) the signal-to-noise ratio of the specimen image on the monitor tube should be sufficient to allow for ease in focusing the microscope ; (*b*) the total integration time should be short when compared to particle movement within the living cell ; in the case of mitosis this would perhaps be of the order of one minute or less. In the observation of non-living material (*b*) does not apply, and integration may be virtually infinite. Improved ultra-violet scanner tubes are in the process of construction which will provide a greatly improved signal-to-noise ratio ; the necessity of photographic integration will be minimized and may be obviated, dependent on the image-forming characteristics of the specimen.

Flying-spot ultra-violet television microscopy should show considerable advantage over television-camera ultra-violet microscopy since the television camera tube has a considerable background of noise, not due to statistical arrival of photons ; and the lack of really high gain between its photocathode and the associated amplifier means that the first valve contributes noise. Neither of these disadvantages applies to photomultiplier tubes.

The accompanying illustrations demonstrate the principle of photographic integration. The specimen is a tissue-culture preparation of the Hela strain of human cancer cells, mounted between 'Vycor' cover slips. The specimen was scanned by a monochromatic ultra-violet spot at 2600 A. with a band-width of 100 A. The photographs show identical absorption images of the same living cells, and differ only in the number of frames integrated. Fig. 1 is the result of exposure of the plate to one frame, Fig. 2 to sixteen frames, and Fig. 3 to sixty-four frames.

Thanks are due to Mrs. O. Walker for the photographs and to Mrs. D. Robbins for the tissue culture preparations ; to the E.M.I. Research Laboratories, Ltd., and the Allen B. Du Mont Corporation for the development of the flying-spot scanner tubes. Grants-in-aid were made by private citizens of Dallas, Texas, the Damon Runyon Memorial Fund, the Rockefeller Foundation, and the Texas Instruments–Geophysical Service, Inc., Foundation.

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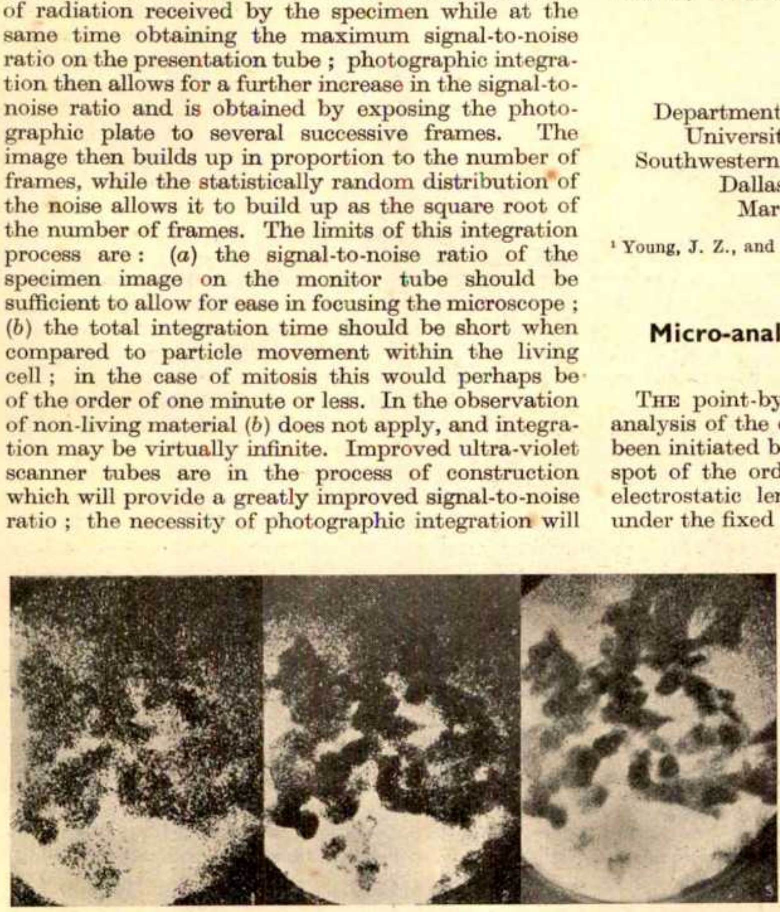
Micro-analysis by a Flying-Spot X-Ray Method

THE point-by-point investigation of a surface by analysis of the characteristic X-ray line emission has been initiated by Castaing[1]. He obtained an electron spot of the order of 1 micron in diameter with an electrostatic lens system and moved the specimen under the fixed spot ; the point examined was identified by means of an optical viewing system. Analysis is greatly facilitated if the electron spot is scanned across the specimen and if a counter is used for collecting part of the emitted X-rays. The signal from it can be transferred to a cathode-ray tube scanned in synchronism, so that a picture is displayed of the part of the surface under investigation. Such a system is similar to the electron scanning microscope[2]. It differs appreciably from that proposed by Pattee[3], in which an electron spot scans a thin target of a pure metal next to which is placed the specimen to be examined, so that image con-



(1) One 4-sec. frame. (2) Four 4-sec. frames. (3) Sixteen 4-sec. frames. Monochromatic ultra-violet absorption images of living Hela cells at 2600 A., bandwidth 100 A.

trast is due not to emission but to differential absorption, as in the normal form of X-ray projection microscope[4].

We have built and operated successfully a flying-spot X-ray microscope of the emission type. Magnetic lenses have been used, so as to obtain a smaller electron spot or alternatively a greater beam current in a spot of the same size, as compared with electrostatic lenses. By employing a proportional counter, a particular X-ray line can be selected as the imaging signal, so that in the picture only those parts of the surface appear bright which contain a given element. Fig. 1,*A*, *B*, *C*, *D* shows the degree of differentiation obtained from an impure sample of beryllium. Fig. 1,*A* is obtained when all quanta are recorded, and Fig. 1,*B*, *C*, *D* when those of certain energies only are passed by the pulse analyser. The magnification and contrast of the image can be controlled electronically and the area of specimen scanned may be varied at will. By stopping the electron probe over a selected point on the surface, the spectrum of X-rays emitted by it may be mapped by varying the band accepted by the pulse analyser. In this way the bright areas in Fig. 1,*B*, *C*, *D* were identified as manganese, nickel and calcium respectively.

In quantitative analysis the ability to discriminate one element from another is limited to approximately $\Delta Z \gg 4$; the natural width of a characteristic line is considerably broadened by the proportional counter. The accuracy can be greatly improved by using a simple crystal spectrometer for initial analysis of the X-rays. A new magnetic lens has been designed and constructed which allows this to be done through one exit port, while through a second port another portion of the X-rays emitted from the surface is accepted by a scintillation counter for the purpose of image formation. Direct quantitative results for the concentration of an element can thus be obtained; it will be possible to separate neighbouring elements in the periodic table. The concentration sensitivity and accuracy of location are now the subject of detailed investigation.

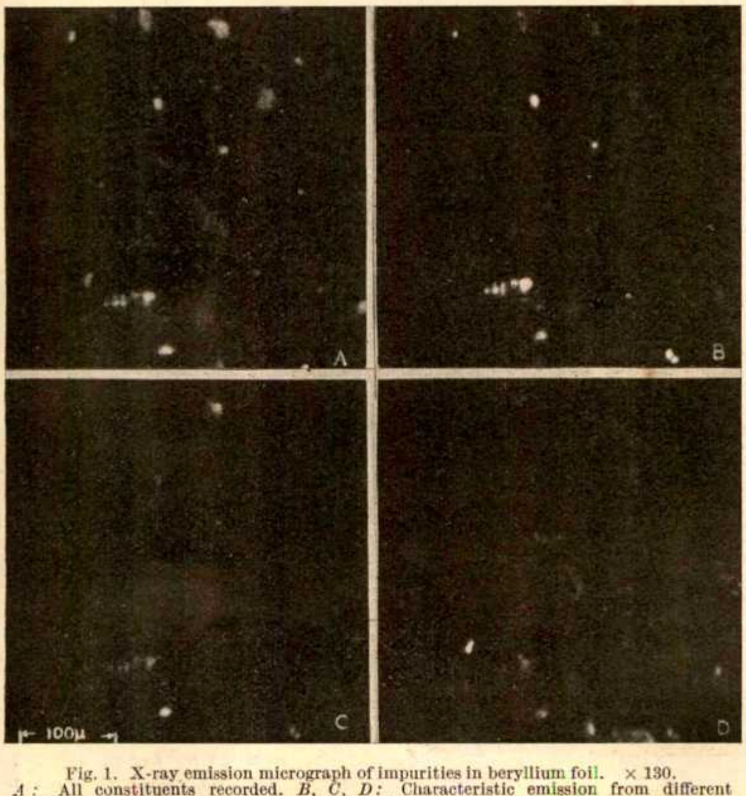


Fig. 1. X-ray emission micrograph of impurities in beryllium foil. × 130. *A*: All constituents recorded. *B*, *C*, *D*: Characteristic emission from different impurities, separately selected—magnesium, nickel and calcium respectively

We wish to thank Dr. W. C. Nixon and Mr. J. V. P. Long for many useful discussions and to the Department of Scientific and Industrial Research for a maintenance grant to one of us (P. D.).

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Cosmic-Ray Increase observed at High Southern Latitudes on February 23, 1956

THE large, sudden increase in cosmic-ray intensity between the hours 0300 and 0400 G.M.T. on February 23 was observed at Hobart, Tasmania, Australia, and also at the Australian National Antarctic Research Expedition's bases at Macquarie Island and Mawson, Antarctica. At the same time radio fade-outs, ionospheric and magnetic disturbances were recorded. The cosmic-ray increase resembles those observed in other places on four previous occasions in association with solar flare activity, namely, on February 28 and March 7, 1942, July 25, 1946, and November 19, 1949[1].

The increase was observed at the three stations with counter telescopes, and also with a 23-litre shielded ionization chamber at Hobart. The telescopes at Hobart and Mawson have 1-metre square counter trays, the extreme tray separation being 1·5 m. At each of these stations there are two telescopes, one of which is operated vertically, the other inclined at 45° to the zenith. Each telescope contains 10 cm. of lead absorber. At Macquarie Island there is a small vertical array of four 20 cm. × 20 cm. counter trays equally spaced by 15 cm. with 10 cm. of lead between trays 2 and 3, and also between trays 3 and 4, numbering from the top tray. The trays were connected to two three-fold coincidence circuits in such a way that the intensity of particles able to pass through 10 cm. or alternatively 20 cm. of lead is recorded separately.

The time of commencement of the cosmic-ray increase observed with the ionization chamber was 0341 G.M.T., the maximum possible error of timing being estimated at ± 2 min. The rate of increase of ionization was very high, and the commencement time given above

Table 1

Station	Lower limits of percentage increase above the mean for 6 hr.			
	Ion chamber 10 cm. lead	Vertical tel. 10 cm. lead	Inclined tel. 10 cm. lead	Differential tel. 10 cm. but not 20 cm. lead
Hobart (Geomag. co-ord. 52° S., 224° E.)	135	169	67 (East)	
Macquarie Island (61° S., 243° E.)		139		360
Mawson (73° S., 103° E.)		175	185 (West)	

Cosmic ray increase commenced at Hobart at 0341 G.M.T. ± 2 min. Duration about 4 hr.

Radio fade-out observed at Sydney, 0332–0444 G.M.T.
Solar radio noise on 85 Mc./sec. observed at Sydney, 0335 G.M.T. End not observed.
Solar radio noise on 19 Mc./sec. observed at Sydney, 0335 G.M.T. Ended at 0406 G.M.T.
} Information supplied by the Radiophysics Division, Commonwealth Scientific and Industrial Research Organization, Sydney.

Radio fade-out began at Mawson, 0342 G.M.T.

Magnetic disturbance at Macquarie Island began 0333 G.M.T. Duration about 2 hr.

is the instant at which the intensity departed from the normal level by an amount equal to the 95 per cent confidence limit. The peak intensity was not observed, as the recorder went off-scale.

Recording intervals of 1 hr. were in use with the telescopes at the time of the increase, so that the peak intensities were not observed. However, by assuming that the time of commencement of the increase was the same at each recorder, it is possible to calculate the lower limits for the peak intensities. These and other relevant details are set out in Table 1.

The following comments may be made concerning the observations:

(1) The cosmic-ray increase began within a very few minutes of the accompanying radio fade-outs and the arrival of ultra high-frequency solar radio bursts at the Earth. Also, the duration of the increase was of the same order as that of the fade-outs and bursts. This suggests that on this occasion the acceleration of the particles took place on the Sun at practically the same time as the enhanced ultra-violet and radio emission. If this is so, consideration of the time of flight of the particles leads to the conclusion that the path-length cannot have been more than 1½ times the Sun–Earth distance. This is consistent with a very weak general solar magnetic field.

(2) The effect was more pronounced at low particle-energy, as shown by the large percentage increase in the low-momentum band (235–340 MeV./c for μ-mesons) detected at Macquarie Island. This is also supported by the results from the inclined telescopes, bearing in mind that the most favoured direction of approach for positive particles of low energy is from the west.

(3) No cosmic-ray decrease was observed in association with the magnetic storm which occurred on February 25. In this respect the flare effect was similar to those of March 1942 and November 1949, but differed from those of February 1942 and July 1946.

(4) The increases observed at Macquarie Island and Mawson, and possibly those at Hobart, are not consistent with the impact zones predicted using a simple dipole field[2]. Assuming that a particle must have a rigidity greater than 3 BV. to produce a meson component at sea-level, and that the solar source is 25° in diameter, the background zone cannot extend beyond lat. 51° S. Particles of rigidity greater than 3 BV. may reach higher latitudes than this in localized impact zones; but none of the stations is in such a zone. The departure from simple theory is not unexpected, as increases were observed at high northern latitudes on the four previous occasions.

(5) After correction for atmospheric pressure, the intensity at each station for a few days prior to the increase was about 2 per cent less than normal, and after the increase returned to the depressed level for a period of a few days. If this decrease is to be interpreted as a screening effect produced by magnetized gas clouds[3], it might explain qualitatively the discrepancy between the observed increases and the predicted impact zones. The magnetic disturbance observed at Macquarie Island is a further indication that complicating agencies were present at the time.

This work was assisted by the Australian National Antarctic Research Expedition, the Australian Atomic Energy Commission and the Commonwealth Scientific and Industrial Research Organization.

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Effect of Shape on the Static and Dynamic Stress–Strain Relationship of Bonded Rubber in Compression

The stress–strain relationship of rubber under unidirectional compression with free expansions in the other two directions has been derived from the kinetic theory of rubber-like elasticity by Treloar[1] and others. These conditions can be simulated by compressing the rubber between parallel plates at which friction is eliminated by lubrication. The static compressive stress σ_s (lb./in.^{2}) is given by

$$\sigma_s = G_s(\lambda - \lambda^{-2}) \qquad (1)$$

where G_s is the static shear modulus and λ the ratio of compressed to initial height. This relationship holds true provided the lubrication is adequate. Where free lateral expansion is prevented by friction or bonding at the confining surfaces, the shape of the rubber influences the stress–strain relationships in a way that has hitherto defied systematic analysis. Kimmich[2] showed that most of the difficulty in correlating published results may be explained by the nature of the surface of the compressing plates and of the rubber, the manner of applying the stress, the thixotropic behaviour of some rubbers, and because the stress–strain relationship is not linear. As the industrial uses of rubber in compression (usually with the faces bonded to metal) are very numerous, a mathematical relation between stress

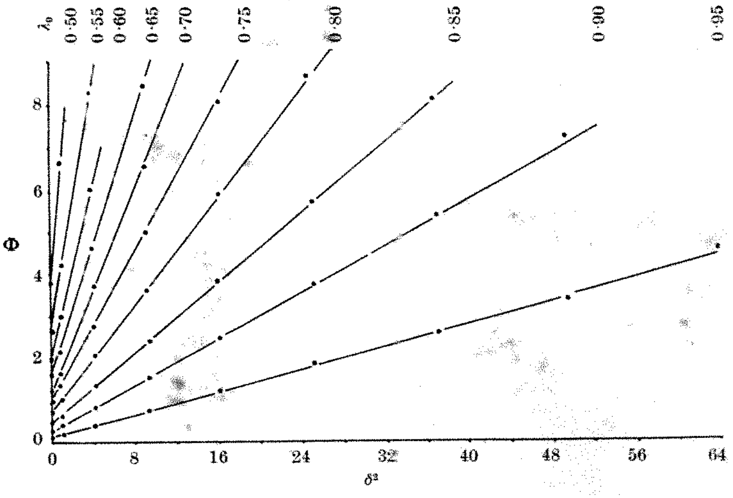

Fig. 1

and strain is essential for design purposes. It is the purpose of this communication to point out a general relationship obtained from experimental results for rubber specimens of various sizes bonded to metal plates.

From a critical discussion of the literature on shape effects, it was concluded that the static stress–strain curve of a bonded rubber can be described by

$$\sigma_s = G_s \Phi \qquad (2)$$

where $\Phi = f(\lambda, \delta)$, δ being a shape factor related to the geometry of the rubber; for example, for cylinders δ is the radius/height ratio. The above expression separates the rubber property G_s from the purely geometrical term Φ. Any change in the properties of the rubber due to its nature, to speed of test, temperature and thixotropy are therefore reflected only in the G_s term.

The stress–strain curves for bonded rubber cylinders of various values were obtained using a pure gum natural rubber vulcanizate. The values for particular λ and δ were obtained from the stress–strain curves by dividing the stress by G_s, derived from the linear relationship (equation 1) between stress and $(\lambda - \lambda^{-2})$ for the rubber compressed between lubricated plates.

Fig. 1 shows that the plots of Φ against δ^2 are linear over the ranges of shape factor and precompression studied and conform to the equation:

$$\Phi = (\lambda - \lambda^{-2})(1 + K\delta^2) \qquad (3)$$

where $K = 0{\cdot}413$. Shape factor zero ($\delta = 0$) thus corresponds to a perfectly lubricated rubber, and a bonded rubber with $\delta > 0$ differs from this ideal case by the factor $(1 + K\delta^2)$. The constant K is similar to that proposed by Hattori and Takei[3] from classical theory for small finite strains. Similar expressions to the above but differing mainly in the coefficient K and definitions of δ have been obtained for other shapes, for example, squares and rectangles.

If now a sinusoidal dynamic strain of amplitude H is superimposed upon a static compression to a height λ_0, the total stress $\sigma_T(t)$ at any time t is

$$\sigma_T(t) = \sigma_s + \sigma_D(t) \qquad (4)$$

where σ_D is the instantaneous dynamic stress, given by

$$\sigma_D(t) = G_D \int_{\lambda_0}^{\lambda_0 + H\sin\omega t} (\mathrm{d}\Phi/\mathrm{d}\lambda)\mathrm{d}\lambda \qquad (5)$$

G_D being the fundamental dynamic shear modulus at the frequency of test.

The overall dynamic stress variation σ_0 over one cycle is

$$\sigma_0 = G_D \int_{\lambda_0 - H}^{\lambda_0 + H} (\mathrm{d}\Phi/\mathrm{d}\lambda)\mathrm{d}\lambda \qquad (6)$$

As Φ increases monotonically with λ, then (from equation 3):

$$\sigma_0 = G_D(1 + K\delta^2)\,(\lambda - \lambda^{-2})_{\lambda_0 - H}^{\lambda_0 + H} \qquad (7)$$

A typical experimental graph plotting values of σ_0, for precompressions from $\lambda = 1{\cdot}0$ to $0{\cdot}55$ and superimposed dynamic oscillations $H = \pm\,0{\cdot}004$ to $\pm\,0{\cdot}086$ against $(\lambda - \lambda^{-2})_{\lambda_0 - H}^{\lambda_0 + H}$, indicates that a linear relationship the slope of which is $G_D\,(1 + 0{\cdot}413\,\delta^2)$ fits the experimental points, G_D having been obtained from a similar set of dynamic tests using lubricated faces.

The above relationships hold for the in-phase or elastic component of the complex dynamic modulus, and also for the out-of-phase or viscous components. These relationships have been applied to the published results on the static stress – strain curves of Kimmich[2], Hattori and Takei[3], and Schay and Ször[4], and for the dynamic results of De Meij and van Amerongen[5]. Without exception, the above relationships give an adequate description of the experimental results.

It is hoped to publish a fuller account of this work elsewhere, together with a further discussion using these relationships for various shapes and for various types of rubbers, including those which show marked thixotropic behaviour.

This work forms part of a research programme on the static and dynamic properties of rubber, and I thank the Council of the Research Association of British Rubber Manufacturers for permission to publish this communication.

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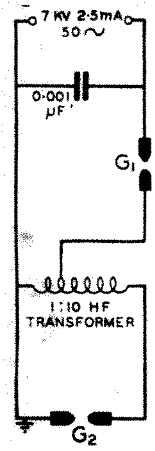
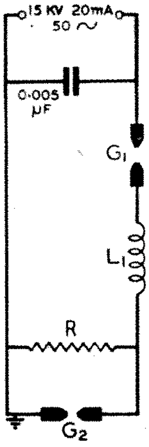
Absence of Shock Hazard with Certain Multigap Spark Circuits

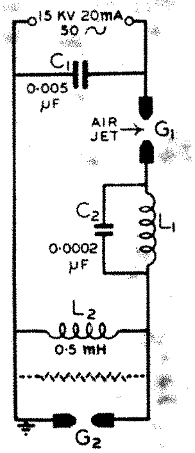
I HAVE found that the shock hazard associated with some electric spark generators is not so great as is generally believed and can be reduced to negligible proportions by appropriate design. Kaiser and Wallraff[1] and others have shown that spark-gap voltages are quite low (order of 50 V.) during discharge and that, in a twin-gap circuit similar to circuit 2, a high voltage appears across the gap G_2



Circuit 1



Circuit 2



Circuit 3

for only a fraction of a microsecond at the beginning of each discharge. Since it is known that the human body can tolerate high-voltage pulses of very short duration, a reasonable inference is that little or no shock should be felt on touching the electrodes of G_2, provided the gap continues to break down in normal fashion. Most people would be reluctant to put this to the test, and I have not seen any report of it having been done.

The experiments to be described were carried out with spark circuits of a type and power-level widely used in spectrographic analysis. In each of the circuits shown, G_1 represents the control gap determining the striking voltage, while G_2 represents the analysis gap which, for convenience in manipulation, is often unprotected by a cage.

Preliminary experiment with the safe low-energy discharge produced by circuit 1 showed that touching the electrodes of G_2 did not prevent a spark jumping the gap, at least up to 3 mm. length, and that no shock was felt. It was then practically certain that the same would hold with circuit 2, since the body currents incurred would be of the same order of magnitude and duration, though the spark currents would be much greater than with circuit 1. This was confirmed with a gap of 4 mm. at G_1, 2 mm. at G_2 and no added inductance at L_1, all electrodes being graphite. The resistance R was merely that provided by touching the electrode holders with two fingers of one hand, probably equivalent to 1,000–2,000 ohms[2]. Since the sparks produced by this circuit are highly energetic and noisy, the demonstration makes quite a spectacular display.

In later trials, however, it was found that when an inductance of 0·03 mH. was added at L_1, frequent shocks were received, even when G_2 was made very short. No improvement followed when an inductive bridge of 0·5 mH. was placed across G_2 for the purpose of by-passing any anomalous low-frequency current. After some exploration, the shocks were eventually attributed to the occurrence of misfires with some 'tailing' sparks, that is, weak sparks which follow soon after a previous spark during the period of incomplete de-ionization, when the breakdown voltage is much less than normal. Photographs showed that increasing the inductance of the discharge loop results in more frequent occurrence of tailing sparks, and de-ionization-rates appear to be so erratic that occasionally the breakdown potential of G_1 may be temporarily lower than that of G_2. Should a spark occur on such an occasion, G_2 will not fire. Blowing a 50 metre/sec. jet of air across G_1 after the manner of Enns and Wolfe[3] eliminated tailing sparks and shocks.

To ensure breakdown of G_2, a liberal excess of voltage should be provided; that is, in circuit 2, G_1 should be considerably longer than G_2. As L_1 is increased, the voltage available at G_2 is reduced (for example, when R is 1,000 ohms and L_1 is 1 mH., the calculated maximum voltage at G_2 is about 75 per cent of the initial voltage at G_1). If R be replaced by an inductance L_2, the maximum voltage at G_2 in an idealized circuit would be $L_2/(L_1+L_2)$ times the initial voltage at G_1. With both L_2 and R in parallel with G_2 the voltage would be still lower. Another consequence of increasing L_1 is that the time of rise of voltage at G_2 is lengthened, so that eventually a stage would be reached at which shocks would be possible because of the long delay in attaining the breakdown voltage at G_2. The limit in this respect was not determined. Both these dangers accompanying the increase of inductance L_1 can be overcome by placing in parallel with L_1 a small condenser C_2 as in circuit 3. For a brief period immediately after the breakdown of G_1, C_2 virtually short-circuits L_1, and thus, irrespective of the value of L_1, practically the whole of the initial voltage becomes available at G_2 with a very short time of rise. The characteristics of the succeeding discharge, for spectrochemical purposes at least, are only slightly affected by the presence of C_2, provided that C_2 is small compared with C_1.

A fuller account is to be given elsewhere of this work, and of the application of the series-gap device to removing the shock hazard from a spark-ignited arc source. In the arc circuit the isolating gap can be shorter than the exposed gap.

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Fatigue of Metals under Random Loads

The stresses produced in an aircraft structure during flight are of an irregular random nature, reflecting the characteristics of the source of the stresses, namely, atmospheric turbulence. It is often necessary to try to estimate the fatigue life of a structural member under these flight loads. Usually the only fatigue data available are from laboratory tests in which the applied stress is a constant-amplitude sine wave. Miner[1] has suggested a procedure by which, knowing the fatigue life at various sine-wave amplitudes, the fatigue life under a given irregular loading may be calculated.

Many tests of Miner's rule have been made with an applied stress which is sinusoidal and the amplitude of which is varied at intervals during the test. These have shown that Miner's predicted fatigue life may differ from that measured by factors up to 30. However, to our knowledge, there had not been any fatigue tests carried out with a random stress waveform. A random-noise fatigue machine has therefore been constructed, and a typical time trace of the stress produced in the specimen is shown in Fig. 1. The fatigue machine consists of a thermionic noise

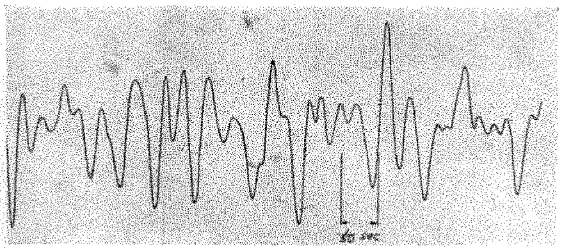

Fig. 1. Typical stress wave-form in specimen

source, the random output voltage from which is amplified by a 20-W. amplifier. This drives a moving-coil vibrator which is connected to the test specimen, stressing it in alternating bending. By substituting a sine-wave source for the random-noise generator, conventional constant-amplitude fatigue tests may be carried out in the same machine. Using 24 *ST* aluminium alloy specimens, the fatigue life at eight sine-wave stress levels and two random-noise levels was determined using five to seven specimens at each level. Mean and minimum *S*—*N* curves were drawn through the sine wave results, and with these, Miner's rule and the probability distribution of stress peak amplitudes in the noise wave form (as given by Rice[2]), the mean and minimum predicted fatigue life at the two noise levels could be calculated. These are compared with the measured fatigue lives in Table 1. It will be seen that the predicted life is longer than that found experimentally by a factor of 2–3·5. In the calculation of predicted lives, Miner's rule has been used in its most severe form, namely, that a given stress peak is counted as equivalent to a half-cycle of a sine wave of the same peak amplitude with zero mean load. It is known that other interpretations of Miner's rule lead to even longer predicted lives.

Table 1. COMPARISON OF PREDICTED AND EXPERIMENTAL FATIGUE LIVES UNDER RANDOM LOADING

	Average fatigue life in 'cycles'			Minimum life in 'cycles'		
	Experimental	Predicted	Ratio	Experimental	Predicted	Ratio
Noise 1	$2 \cdot 0 \times 10^6$	$6 \cdot 9 \times 10^6$	3·45	$8 \cdot 8 \times 10^5$	$3 \cdot 0 \times 10^6$	3·40
Level 2	$1 \cdot 15 \times 10^6$	$3 \cdot 4 \times 10^6$	2·96	$7 \cdot 3 \times 10^5$	$1 \cdot 5 \times 10^6$	2·06

Note: A maximum and a minimum of the random wave form is counted as one 'cycle'.

In effect, the motion of the specimen (and the corresponding stress produced) is an amplified version of the Brownian motion of the resonant system formed by the mass of the moving coil of the vibrator and the spring of the specimen. To produce the amplitudes used in these tests by thermal activation would require a temperature of 10^{17}° K. The contribution of the room-temperature Brownian vibrations of the system to the stress level is quite negligible, a rough calculation of the fatigue life under these stresses giving a life of $10^{10^{21}}$ sec.

Full details of this work will be published elsewhere. For permission to publish this communication we thank the Chief Scientist, Department of Supply.

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Metal Ion Catalysis and Polarity of Environment in the Aerobic Oxidation of Unsaturated Fatty Acids

IT is frequently stated that the intense activity of certain metallic compounds as oxidation catalysts is a matter of great technological interest and that knowledge of how these compounds react is still obscure in many details[1]. The foundations of a better understanding of the mechanism of metal ion catalysis were laid by Haber and Weiss[2]. The most notable recent advances in this field were made by C. E. H. Bawn[3] and his school. It is now generally accepted that the aerobic oxidation of linoleic acid and its esters proceeds through a chain reaction with the free radicals $R\cdot$ and $RO_2^{\cdot}$ as chain carriers, namely:

$$R\cdot + O_2 \rightarrow RO_2^{\cdot} \quad (1)$$

$$RO_2^{\cdot} + RH \rightarrow ROOH + R\cdot \quad (2)$$

The most difficult aspect is the initial production of free radicals. It is this aspect which is most directly related to metal catalysis. The following heavy-metal stearates were prepared and their catalytic effect examined: cupric, ferric, (partially oxidized) ferrous, cobaltous, manganous, cerous, vanadyl, thallous and stannous stearates. The latter two were investigated with the object of determining whether two-electron transfer would be more efficient than one-electron transfer in the initiation process. In the polar solvents ethyl alcohol, ethyl acetate and ethyl caprylate, none of the heavy metal stearates had any appreciable catalytic activity at 25° C., approximately $0 \cdot 1\ M$ methyl linoleate (or linoleic acid) and a catalyst concentration equal to or less than $M/5{,}000$. In dilute benzene solutions, cobaltous, manganous and cerous stearates were the only active catalysts leading to hydroperoxide formation. At a catalyst concentration of $M/5{,}000$, 25° C. and $0 \cdot 1\ M$ methyl linoleate, the rates of formation of hydroperoxide were approximately seven, five and four milliequivalents methyl linoleate hydroperoxide per mole methyl linoleate per hour with cobaltous, manganous and cerous stearate, respectively. Cupric stearate did not catalyse the formation of hydroperoxide but appeared to be an active catalyst in its decomposition into unsaturated aldehydes and ketones. The activation energy of hydroperoxide formation catalysed by cobaltous stearate was determined as 20 k.cal.

An even more pronounced catalytic effect was obtained with some heavy-metal phthalocyanines and octamethyltetrazaporphins (conjugated macrocycles), which were readily measurable at 25° C. in dilute benzene solutions down to a catalyst concentration of $5 \times 10^{-8}\ M$ ([methyl linoleate] $= 0 \cdot 1\ M$). The observed rates of hydroperoxide formation with ferrous phthalocyanine, cobaltous phthalocyanine and cobaltous octamethyltetrazaporphin (these substances were kindly supplied by Dr. J. A. Elvidge, of the Imperial College of Science and Technology) were about two milliequivalents per mole methyl linoleate per hour, at 25° C., a catalyst concentration of $5 \times 10^{-7}\ M$ and a substrate concentration of $0 \cdot 1\ M$. This is ten times the rate of the (apparently) uncatalysed reaction under similar conditions.

The general rate law for the aerobic oxidation with the heavy-metal catalysts in organic solvents was established as:

$$\frac{d[ROOH]}{dt} = k[RH]\,[\text{catalyst}]$$

A kinetic analysis indicated that this rate equation would be compatible with the general scheme:

$$Co^{2+} + O_2 \rightleftharpoons Co^{2+}.O_2$$
$$Co^{2+}.O_2 + Co^{2+}(XH) \rightarrow Co^{2+} + Co^{3+}X^- + HO_2^{\cdot}$$

$HO_2^{\cdot}$ radicals thus formed would initiate the chain reaction (1) and (2). The direct formation of $HO_2^{\cdot}$ by the reaction $RH + O_2 \rightarrow R\cdot + HO_2^{\cdot}$ is very much slower, as the endothermicity of this reaction would exceed 40 k.cal.[4] (the reaction $H + O_2 \rightarrow HO_2^{\cdot}$ being exothermic to an extent of approximately 35 k.cal.). The existence of similar complexes with molecular oxygen was recently postulated by J. Weiss[5] and P. George[6] in the aerobic oxidation of ferrous ion in aqueous solution.

The solvent effect was studied quantitatively in a mixture of the polar nitrobenzene (dielectric constant 37) and the non-polar benzene (dielectric constant 2·29). The effect was of such magnitude that I consider it must be attributed to the formation of different co-ordination spheres, which would alter the oxidation-reduction potential and the affinity to oxygen of the heavy-metal catalyst. The magnitude of this effect is illustrated in Table 1.

Table 1. EXPERIMENTS (AT 25° C.) WITH VARYING NITROBENZENE CONCENTRATIONS IN BENZENE–NITROBENZENE MIXTURES AND BLUE (ANHYDROUS) COBALTOUS STEARATE AS CATALYST
Total volume, 7·5 ml., including 0·5 ml. methyl linoleate (0·202 *M*)
[Cobalt stearate] = 1·87 × 10^{-4} *M*

Nitrobenzene (Vol. per cent)	Molar ratio $(C_6H_6)/(C_6H_5NO_2)$	Rate of formation of the hydroperoxide (m.equiv./mole methyl linoleate/hr.)
0	—	14·4
25	3·47	13·4
30	2·70	12·3
35	2·14	7·6
40	1·74	3·88
45	1·42	1·86
50	1·16	0·68
75	0·385	Nil
100	—	indistinguishable from blank tests

When the logarithm of the rate of hydroperoxide formation was plotted against the logarithm of the molar ratio benzene : nitrobenzene, the curve obtained was nearly parallel to the abscissa axis at low nitrobenzene concentrations ($\leqslant$ 25 per cent) with a gradually increasing slope which reaches the limit of six at about 50 per cent nitrobenzene. This would be in accordance with expectation if, as we assume, the cobaltous stearate solvated by benzene is catalytically active whereas the nitrobenzene-solvated compound is inactive. The limit slope of six would imply an inner co-ordination sphere with six solvent molecules.

There is also a distinct solvent effect due to co-ordination with the metal phthalocyanine catalysts; however, this effect has not yet been studied quantitatively. It was observed that the heavy-metal complexes of conjugated macrocycles were not affected by the addition of malic acid. On the other hand, the catalytic effects of cobaltous and manganous stearate in benzene at a concentration of $M/5{,}000$ were quantitatively suppressed when malic acid was added at a molar ratio greater than 1 : 1. The catalytic activity of the heavy-metal porphin derivatives can be inhibited by the addition of free radical acceptors such as butylated hydroxy anisole, and in my experience even more effectively by quercetin and rhamnetin. The latter two substances merit more attention as efficient antioxidants.

The observations relating to the solvent effect (in the co-ordination sphere) have their practical counterpart in the storage of dehydrated food products, where oxidative rancidity abruptly sets in and becomes the decisive factor when the moisture concentration drops below a critical limit. This critical limit is connected, in my view, with the stage in dehydration in which the co-ordination spheres of trace metals would be affected.

Radioactivation analysis for trace metals (after pile irradiation at the Atomic Energy Research Establishment, Harwell) was carried out with crude lipids and purified methyl linoleate, and preliminary results indicate that even the trace-metal content of purified methyl linoleate is of an order of magnitude comparable with the concentrations in which catalytic effects with the heavy metal porphin derivatives were observed.

I wish to thank Miss M. R. Menzies for her assistance in the experimental work. A detailed account of this investigation will be published elsewhere.

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Absorption Spectra arising from the Photolysis of Lead Tetramethyl

THE flash photolysis technique[1] has been used to examine the photochemical decomposition of lead tetramethyl. At an energy of 2,500 joules (50 μF.; 10 kV.) the decomposition of lead tetramethyl at pressures up to 12 mm. mercury was shown to be largely complete in 1·2 m.sec. after the initial light flash; this was the time for the reaction vessel to become opaque to light due to the deposition of a lead film. The contents of the quartz reaction vessel (volume 500 cm.^{3}, surface/volume = 1·6) were examined in this interval by passing a second light flash through the length (1 metre) of the vessel into a large Littrow (Hilger *E*1) spectrograph using a slit width of 0·02 mm.

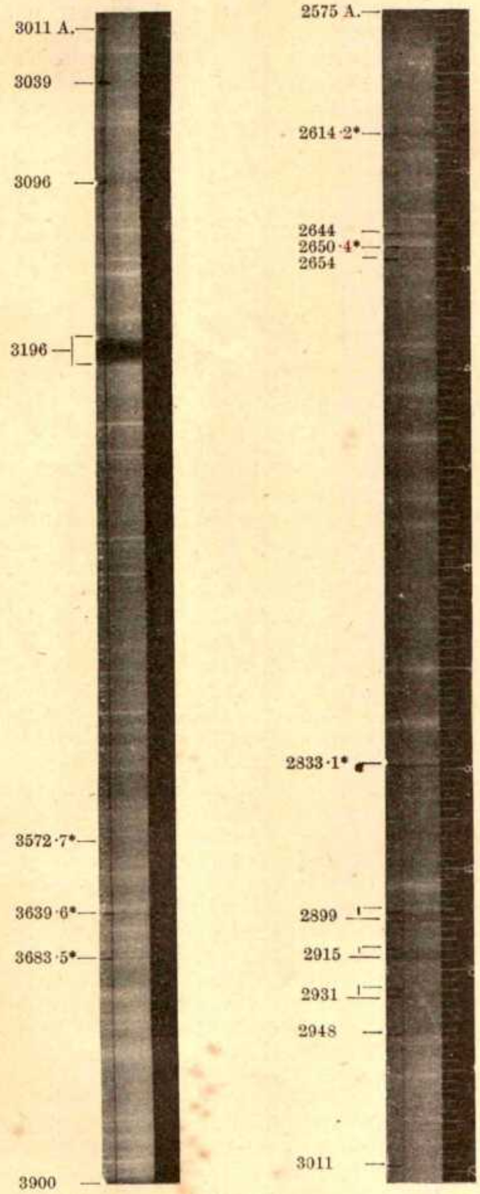
The absorption system shown (Fig. 1) was observed within 200 μsec. of the initial light flash. It consisted of a number of sharp lines due to atomic lead, together with a number of absorption regions not previously described (Table 1). The most prominent feature occurs with a maximum intensity at 3196 A. On exposures where this band is most intense, further bands are observed at shorter wave-lengths along with continuous absorption over the region below 4000 A. and increasing in intensity towards the ultra-violet region. In addition, a further series of bands, sharply degraded towards the violet and with heads at 2948, 2932, 2915 and 2899 A., have been seen on several occasions.

Analysis of the lead film on the walls of the vessel showed the photolysis to be very nearly quantitative. The efficiency of the photolysis lamp was determined by actinometry with uranyl oxalate[2]. At a vapour pressure of 12 mm. mercury the amount of lead deposited gave a quantum yield of about forty. The product gases on analysis were found to contain largely ethane (more than 90 per cent) and only a trace of methane. It would appear that a chain reaction, based on methyl radical attack on lead tetramethyl, is involved, in competition with the reaction of two methyl radicals, to give ethane. The abstraction of hydrogen by methyl to yield methane occurs to a very minor degree.

A sample of fully deuterated lead tetramethyl was prepared from methyl-d_3 bromide[3] via the Grignard compound and lead chloride. On photolysis it behaved in an identical manner, with no significant change in the absorption system. If the observed spectra are associated with the methyl radical, then deuteration may be expected to have a marked effect. Assuming the primary photolytic act is rupture of the lead–carbon bond:

$$Pb(CH_3)_4 \rightarrow CH_3^{\cdot} + {}^{\cdot}Pb(CH_3)_3$$

the lead trimethyl fragment may equally well give rise to the absorption system observed. Deuteration would in this case be expected to have little effect. Photolysis of lead tetra-ethyl also resulted in a deposit of lead on the reaction vessel; but only continuous absorption was observed from 4000 A. towards shorter wave-lengths.



* Atomic lead lines

Fig. 1

Table 1. ABSORPTION SPECTRA ARISING FROM THE PHOTOLYSIS OF LEAD TETRAMETHYL

λ (A.)	ν (cm.$^{-1}$)	$\Delta\nu$ (cm.$^{-1}$)	Intensity
3196	31,290	—	very strong
3096	32,300	1,010	weak
3039	32,910	610	very weak
3011	33,210	300	very weak
2948	33,920	710	weak
2931	34,120	200	weak
2915	34,305	185	weak
2899	34,490	185	weak

Photolysis of lead tetramethyl has also been attempted using a solution in *E.P.A.* glass[4] at 77° K. The apparatus closely resembled that described by Norman and Porter[5]. No absorption comparable to the system observed in the vapour phase has so far been detected. It is conceivable, in the light of recent work[6], that the absorption system observed arises from the lowest triplet level of ethane, which becomes populated through the excited ethane molecules formed by methyl radical combination. This work is still in progress and will be published in detail elsewhere.

We are indebted to the Chief Scientist, Department of Supply, Australia, for permission to publish this communication.

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Mathematical Chemical Periodicity

LENGTHS of the periods and atomic numbers, L and Z, of a bidimensional continuous system based on the electronic structure of the elements, are numerical characteristics precisely definable, as functions of the principal and orbital quantum numbers n and l ($0 \leqslant l \leqslant n-1$), by the following general equations:

$$L = \tfrac{1}{2}[n + l + f(n + l)]^2 - E$$

$$Z = \binom{n + l + 2}{3} + \tfrac{1}{2}(n + l + 1)f(n + l) - 2l^2 - E$$

In these equations, the term of the periodical discontinuity, $f(n + l)$, as a quantum number function, is

$$\tfrac{1}{2}[1 - (-1)^{n+l}] \text{ or } \cos^2 \tfrac{1}{2}\pi(n + l + 1)$$

or an equivalent, and E is the number of missing electrons required for the completion of the subshell in which the given element occurs. For $E = 0$, one expresses the distances from the last inert gas (partial lengths of the periods) and atomic numbers, respectively, of the subshell closing elements, so that, in the particular case of $n = 1$, the length of the complete periods and the atomic numbers of the inert gases are found.

The two equations correspond to previously obtained combinational expressions[1] which here have been given a most convenient simplification. By placing the periodicity term $f(n + l)$ in algebraic form, L can reduce to the Tomkeieff's rule[2] ($E = 0$; $l = 1$), and Z becomes analogous to Hakala's law[3]. Thus they are shown to achieve wider generalization than the hitherto known formulæ.

Moreover, the close relationship established between L and Z constitutes synthetic mathematical evidence of a bidimensional double periodicity in the chemical table.

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Thermodynamic Interpretation of the Eötvös Constant

EÖTVÖS[1], in 1886, proposed the following equation for liquids

$$\gamma(M\upsilon_{\mathrm{sp.}})^{2/3} = K_E\,(T_c - T) \qquad (1)$$

where γ is surface tension, M is molecular weight, $\upsilon_{\mathrm{sp.}}$ is specific volume and T_c is critical temperature, which is found to be strikingly valid over a wide range of temperature for most non-polar compounds. Even for polar compounds the equation is valid though to a more limited extent; but the value of the constant, K_E, is often very different from the usual value, 2·12. This empirical equation has been given some theoretical support (cf. Partington[2]). The purpose of the present communication is to point out a simple thermodynamic interpretation of the above equation.

Since the left-hand side of the equation is a free-energy term and the right-hand side is linear in T, its formal similarity with the standard thermodynamic equation, $\Delta F = \Delta H - T\Delta S$, is apparent. Based on this we can identify the Eötvös constant as the entropy of formation in proper units of $(M\upsilon_{\mathrm{sp.}})^{2/3}$ surface area starting from liquids in the interior. Since a mole of a liquid considered as a cube presents an area of any face equal to $(M\upsilon_{\mathrm{sp.}})^{2/3}$, and since this cube can be divided into $N^{1/3}$ such faces, the molar entropy is easily obtained by multiplying both sides of equation (1) by $N^{1/3}$. Converted into calories, we obtain the molar entropy of surface formation for non-polar compounds,

$$2{\cdot}018 \times K_E \text{ cal./deg.} = 4{\cdot}28 \text{ entropy units}$$

Thus we arrive at the interesting conclusion that the Eötvös constant is a measure of the entropy of formation of surface and the entropy change in bringing liquid molecules from the interior to the surface is the same for all non-polar liquids and nearly the same for all liquids, and is equal to 4·28 calories per degree per mole. In other words, the Eötvös equation is the liquid-surface analogue of Trouton's law relating to vaporization.

It seems plausible that this excess entropy on the surface is almost wholly configurational, arising out of increased symmetry in the interior of a liquid and the non-spherical shape of liquid molecules. This idea is supported by the fact that the corresponding entropy changes for alcohols are much lower, being 1·88 for methyl alcohol and 2·18 for ethyl alcohol. This loss of entropy for polar liquids is thus to be ascribed to the well-known orientation of such molecules on the interface. This also agrees with the observation that mercury ($K_E \simeq 1$), which presumably has more or less spherical molecules, has a lower Eötvös constant, and geometrically complicated molecules, for example, tripalmitin (K_E = 5·4), have higher Eötvös constants.

Conversely, a thermodynamic deduction of Eötvös equation from the above assumption, the temperature independence of ΔH, and the boundary condition of zero free-surface energy at the critical temperature, is simple and need not be elaborated here. The next step would be to investigate the possibility of deduction of the numerical value of K_E from statistical thermodynamics.

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Oxidation-Reduction Potential of Modified Cytochrome *c*

THE presence of modified cytochrome *c* in the widely used Keilin and Hartree preparation was first reported by Margoliash[1]. Separation was effected by chromatography at *p*H 7·0 on a column of the resin 'Amberlite *IRC*-50'. Modified material was present to the extent of 10–25 per cent and was characterized by having a lowered enzymatic activity in the cytochrome oxidase (heart muscle) and succinic oxidase (kidney) systems but an increased rate of ascorbic acid oxidation. Visual spectroscopy, however, did not show any difference between this and other cytochrome *c* fractions. Evidence was presented that the modification was caused by the action of trichloracetic acid on cytochrome *c* during the extraction procedure.

We have recently compared[2] the E'_0 values at *p*H 6·4 and 25° C. of the usual Keilin and Hartree type preparation with cytochrome *c*, purified on a resin column, from both ox- and horse-heart muscle. It was suggested that the slightly higher value of the less pure samples (0·270 V.) compared with the resin-purified samples (0·255 V.) was due to the presence of modified cytochrome *c*. We have now determined the E'_0 value of this material as separated by the above procedure from ox-heart cytochrome *c* and find it to be 0·310 V. under the same conditions of *p*H and temperature.

In order to attempt its complete modification, a sample of ox-heart cytochrome *c* purified on a resin column was subjected to prolonged treatment with trichloracetic acid (2·5 per cent, 18 hr. at 25° C.), followed by dialysis against 0·5 per cent sodium chloride. The potential of the resulting pigment solution was found to be very close to the above value, namely, $E'_0 = 0{\cdot}308$ V. at pH 6·4 and 25° C. This material did not show any increased ascorbic acid oxidase effect over the values usually obtained for Keilin and Hartree preparations of cytochrome *c*. There was present, however, after the above dialysis, a small residue of cytochrome *c*-like material, soluble in dilute ammonium hydroxide. This had a sevenfold increase in catalytic effect on the oxidation of ascorbic acid. The potential of this residue has not as yet been determined. Absorption curves for these fractions, reduced with sodium dithionite, revealed band positions identical with those of resin-purified cytochrome *c*. However, differences in the degree of light absorption were observed, particularly on the longer wave-length slopes of the α-bands.

The increase in E'_0 value of cytochrome *c* on modification brings about what is almost certainly a critical shift of its position in the classical picture of stepwise tissue oxidation as proposed by Ball[3]. Although it is not yet possible to define the nature of such modification which results in an increase of just over 50 mV. in the potential-level, it is clear that the effect must be taken into account in assessing the results of studies involving the catalytic functions of cytochrome *c*.

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Tocopherol Content of Heart-muscle Preparations

THE possible role of vitamin E in respiratory enzyme systems has often been suggested; but supporting evidence of the actual presence of vitamin E in active enzyme preparations has not been published. We have now found appreciable amounts in heart sarcosomal (mitochondrial) fragments (Keilin and Hartree heart-muscle preparation).

Sarcosomal fragments prepared by one of us (E. C. S.) in Cambridge were analysed by Dr. K. L. Blaxter and Miss R. F. McGill at the Hannah Dairy Research Institute, Scotland. The first preparation showed no tocopherol activity measured as the free alcohol or its esters. When, with later preparations, the non-saponifiable material from alcoholic extracts of dried sarcosomal fragments was treated with stannous chloride in dioxane in order to reduce any oxidized tocopherol which might be present, an appreciable amount of material reducing ferric chloride was obtained. This behaved like α-tocopherol on reversed-phase chromatography[1]. In view of these results, a more detailed investigation was made in the Amsterdam laboratory.

The freeze-dried preparation of sarcosomal fragments (4 gm., containing 2·40 gm. protein) was extracted with dry alcohol containing pyrogallol, and the extract saponified. The ethanolic solution of the non-saponifiable fraction was refluxed with ascorbic acid in strong hydrochloric acid to convert any tocopherylquinone to tocopherol. After removal of sterols by treatment with methanol, and of carotenoids by passage through a column of 'Floridin *XS* Earth', the ethanolic solution containing the tocopherol was subjected to the paper-chromatography procedure of Green *et al.*[2]. A spot was obtained of an R_F a little more than that of a pure solution of α-tocopherol run simultaneously (Fig. 1). When, however, α-tocopherol was added to the alcoholic solution derived from the heart-muscle preparation, one spot only was obtained. No β- or γ-tocopherol, which is readily separated from α-tocopherol by this procedure, was detected.

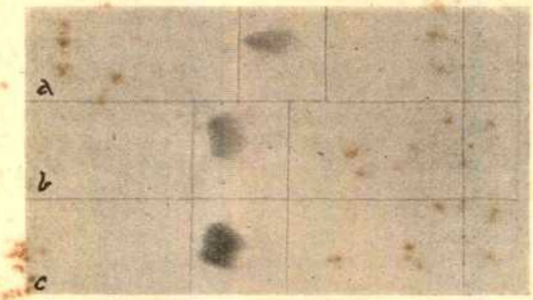

Fig. 1. Paper chromatogram, made according to the procedure of Green *et al.* (ref. 2): *a*, pure α-tocopherol (20γ); *b*, purified extract from heart sarcosomal fragments (0·02 ml.); *c*, α-tocopherol (20γ)+the purified extract (0·02 ml.). The papers were sprayed with ammoniacal silver nitrate, and the excess reagent removed with sodium thiosulphate

The identity of the material giving the spot on the chromatogram with α-tocopherol was confirmed by extraction with ethanol and oxidation with ferric chloride. The oxidation products were extracted with petroleum ether, and after evaporation dissolved in ethanol. This solution showed the typical two-banded spectrum obtained with tocopherol oxidized under these conditions. The positions of the bands (262 mμ and 269 mμ) coincided exactly with those ascribed to toco-red[3].

The amount of α-tocopherol was determined by extraction of the area of the spots with warm ethanol, followed by estimation of the tocopherol content by the method of Emmerie, using the spot with added α-tocopherol as an 'internal standard'. The amount found was 1·1 μmole per gm. protein. This value refers to α-tocopherol plus its oxidation products (for example, α-tocopheroxide or α-tocopherylquinone) which might be present in the heart-muscle preparation. It does not, however, include any tocopherylhydroquinone, which would probably not be extracted into the non-saponifiable fraction. It is hoped that further investigations will reveal the form of tocopherol which is present in the heart-muscle preparation.

Vitamin E is the only fat-soluble vitamin present in the heart-muscle preparation in appreciable amounts. The preparation contains less than 0·01 μmole vitamin K/gm. protein (analysis kindly carried out by Miss I. Kruse, of the Department of Biochemistry and Nutrition, Danish Polytechnic Institute, Copenhagen), less than 0·03 μmole vitamin D/gm. protein (analysis kindly carried out by Dr. E. Kodicek, of the Dunn Nutritional Laboratory, Cambridge) and less than 0·01 μmole vitamin A/gm. protein (our own analysis). These values are so low that it is unlikely that any of these vitamins are involved in the non-phosphorylating respiratory chain of the sarcosomal fragments.

On the other hand, the amount of α-tocopherol (1·1 μmole/gm. protein) is of the same order of magnitude as of known components of the chain (for example, cytochrome *c*, 0·8 μmole/gm. protein). Although the presence of tocopherol in the preparation does not prove that it is involved in the respiratory chain, the actual amount found makes this not unlikely, especially when taken in conjunction with the important experiments of Nason and Lehmann[4]. These authors have shown that added vitamin E activates the reduced diphosphopyridine nucleotide oxidase activity of a particulate preparation from rat skeletal muscle, especially after extraction of the preparation with *iso*-octane. Although Nason and Lehmann were able to activate the enzyme preparation by the lipid present in the *iso*-octane extract, they were unable to detect vitamin E in the extract. We have been able to show the presence of α-tocopherol (or its oxidation products) in *iso*-octane extracts of suspensions of the heart-muscle preparation.

We are grateful to Dr. G. Baxter, Distillation Products, for supplying samples of pure tocopherols.

Note added in proof (June 1). Nason *et al.*[5] have recently shown that the reduced diphosphopyridine nucleotide oxidase system in the rat muscle preparation could be reactivated by high concentrations of crystalline serum albumin, as well as by α-tocopherol. Albumin, previously extracted with *iso*-octane, was ineffective. We have now found that crystalline bovine serum albumin (Armour) contains 0·056 μmole α-tocopherol/gm. protein.

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Pharmacological Action of Rauwolscine

Rauwolscine (kindly supplied by Mrs. A. Chatterjee, University College of Science and Technology, Calcutta), an alkaloid of *Rauwolfia canescens* Linn.[1], has been found to be a potent adrenolytic compound[2,3]. It has further been shown to be α-yohimbine[4]. Yohimbine is an adrenergic blocking alkaloid; but it produces certain other effects, such as stimulation of the central nervous system, local anæsthesia and vague aphrodisiac activity[5], which have precluded its use in clinical practice. No detailed report has appeared so far of any investigation of these properties; we have therefore examined these pharmacological actions of rauwolscine with the following results.

(1) A 2 per cent solution of rauwolscine giving a visible film on the guinea pig cornea produces complete surface anæsthesia starting 5–7 min. after instillation and lasting up to 15–20 min.

(2) 0·25 c.c. of a 0·2–2·0 per cent solution of rauwolscine in normal saline (*p*H 5·2–5·5) produced local anæsthesia in guinea pigs as tested by the method of Bülbring and Wajda[6], and lasts more than 2 hr. This, however, appears to cause local damage to the tissues.

(3) 10–20 mgm./kgm. injected intraperitoneally into guinea pigs produces signs of psychic excitement and erection in the male animals. The animals become highly excitable and restless.

(4) 25 mgm./kgm. injected intraperitoneally in rats lowers the convulsant threshold level of metrazol.

(5) 12–15 mgm./kgm. injected intravenously in rabbits produces sudden clonic convulsions lasting 2–3 min., accompanied by increased respiratory-rate and followed by sexual excitement. When injected intraperitoneally, 20 mgm./kgm. produces no convulsions but other effects; for example, increased motor activity, psychic excitement and increased respiration appear in 5–10 min.

A comparison of the adrenergic blocking activity of rauwolscine with 2-benzyl-imidazoline hydrochloride ('Priscol', Ciba), an agent recommended in the treatment of peripheral vascular diseases on the basis of its adrenolytic activity, was also undertaken. This study was carried out on the isolated guinea pig seminal vesicle following the method described by Stone *et al.*[7]. In concentrations of 1 in 250,000 to 1 in 80,000, the two compounds show nearly equivalent adrenolytic activity; but in higher concentrations, for example, 1 in 60,000 to 1 in 50,000, tolazoline produces only 40–50 per cent adrenolysis whereas rauwolscine produces 81–93 per cent.

These studies thus indicate that in low concentrations rauwolscine possesses marked adrenolytic activity; but in relatively higher dosages it has some of the side-effects of yohimbine. Detailed comparison between rauwolscine and yohimbine and other adrenolytic compounds is now being carried out to determine the clinical potentialities of rauwolscine.

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Assimilation of Berberine by Bacteria

Berberine hydrochloride has been reported to be toxic in weak concentrations against some species of bacteria[1] and some fungi[2]. Recent studies in this laboratory have shown that several species of bacteria assimilate the alkaloid from media provided with suitable nutrients, as well as from extracts of plants containing berberine and chelidoxanthine.

Some of the bacteria tested are sensitive to berberine and do not grow at a concentration of the hydrochloride as low as 0·0025 per cent; others resist and are able to absorb it from media containing as much as 2 per cent. The bacteria, during growth, absorb (assimilate) the pure alkaloid into their protoplasm but do not use it either as a source of carbon or of nitrogen. The evidence for absorption is found by the bright yellow fluorescence of the cells in ultra-violet light, of the same fluorescence as that of the alkaloid, whereas there is only minimal absorption of washed resting cells in saline or nutrient-free media.

The cells, moreover, which have absorbed the alkaloid, when washed and used as a source of organic nitrogen in an otherwise berberine-free nutrient medium, serve to supply other bacteria with nitrogen. The bacteria that utilize the nitrogen of 'berberinized' cells may be the same species that provided the nitrogen, or other species. Evidence of this 'secondary assimilation' is found both in the yellow fluorescence of the second-culture cells, and in the clear zones of proteolysis surrounding their colonies on agar plates.

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Flight-muscle Changes during Adult Life in a Scolytid Beetle

IT has long been known that in ant and termite queens the wings are lost and the flight muscles degenerate after the mating flight. Recently, flight-muscle degeneration has been reported in aphids[1] and mosquitoes[2], although in the latter group further studies appear to be desirable[3]. In the Coleoptera, protection of the posterior membranous wings, when at rest, by the tough anterior wings or elytra makes possible utilization of confined habitats, such as burrows of various types, which are unavailable to many other winged insects. Whether or not such protection is related to loss or reduction of wings, the fact remains that in several families of this group flightless species have evolved[4]. Most of these species have membranous wings greatly reduced in size; but small wing muscles and other morphological indications of loss of the ability to fly have been noted in some instances where wings are normal. Certain species are variable with respect to capacity for flight, some individuals being able to fly although others are not. A seasonal change in flight muscles has been noted in a weevil, and evidence suggests that such a change occurs in certain water beetles.

I have recently investigated the capacity and inclination to fly in a member of the Scolytidae, the ambrosia beetle, *Trypodendron lineatum* (Oliv.). Individuals have been flown on fixed mounts or flight mills and have been tossed into the air at various times during their adult life. Beetles taken in the spring often show considerable capacity for flight. Some will fly for several (up to eight) hours continuously on flight mills or on fixed mounts. Individuals taken in flight will fly immediately when tossed; but those removed from well-established galleries will not.

In this species the young adults, after a feeding period within the galleries, generally fly from the brood logs to their over-wintering site and again the following spring when they carry out their first attack. The parent adults also fly from the brood logs in the first season and may attack other material then or in the following season, producing another brood in either case. Young or parent adults taken from galleries before natural emergence usually will not fly when tossed. They take to flight, however, after a period of time at room temperature.

Dissection of parent adults of either sex removed from galleries containing eggs or larvæ reveals that the large indirect flight muscles are greatly reduced in size, to such an extent that they have almost disappeared. In the females, the much enlarged ovaries project forward into space normally occupied by these muscles. In both sexes the ventriculus is enlarged at this time and also fills part of this space. Parent adults taken just before they emerge naturally from galleries, however, have large flight muscles which appear normal. We thus have an example of temporary but marked reduction in size of flight muscles during brood establishment, followed by return to normal size and, apparently, function.

The reduction of flight muscles occurs at a time of adult activity without feeding and, consequently, of depletion of metabolic reserves. Later, the beetles feed intensively within the galleries, and this permits a building up of these reserves and presumably affects the redevelopment of the flight muscles. The details of the changes in these muscles, however, remain to be worked out.

The flightless period during adult life has ecological significance in that beetles cannot abandon their galleries by flight during this time. It seems likely that the phenomenon occurs in other members of the Scolytidae also, as the pattern of life within the entire family is essentially similar and involves long periods within plant tissue preceded by, or alternating with, relatively brief periods of flight. In any event *Trypodendron* shows an interesting compromise, within the Coleoptera, between the need for sustained flight at certain times and the occurrence of long periods of adult activity in burrowing and establishing a brood in a protected and confined habitat, where flight is not necessary.

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Jan. 20.

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Heat Increments of Feeding in Ruminants

IN ruminants the heat losses associated with carbohydrate dissimilation amount to 30–70 k.cal./100 k.cal. carbohydrate digested[1], whereas in man such losses are only 5–7 k.cal./100 k.cal.[2]. In calorimetric experiments with fasted sheep, we have found that the steam-volatile fatty acids which are the major end-products of rumen fermentation of carbohydrate produce a greater heat increment than does glucose given under similar conditions, precautions having been taken to minimize bacterial fermentation of the sugar. Furthermore, in starved animals, and also in those receiving food, the energy-loss as heat is considerably greater for acetic acid than for propionic or butyric acids.

A typical starvation experiment was as follows. A fasted sheep, with a permanent rumen fistula, was confined in a respiration chamber[3], and physiological saline (6,570 ml./24 hr.) was dripped into its rumen at a constant rate. Oxygen consumption, carbon dioxide and methane production, urinary nitrogen and ketone body-excretion were measured

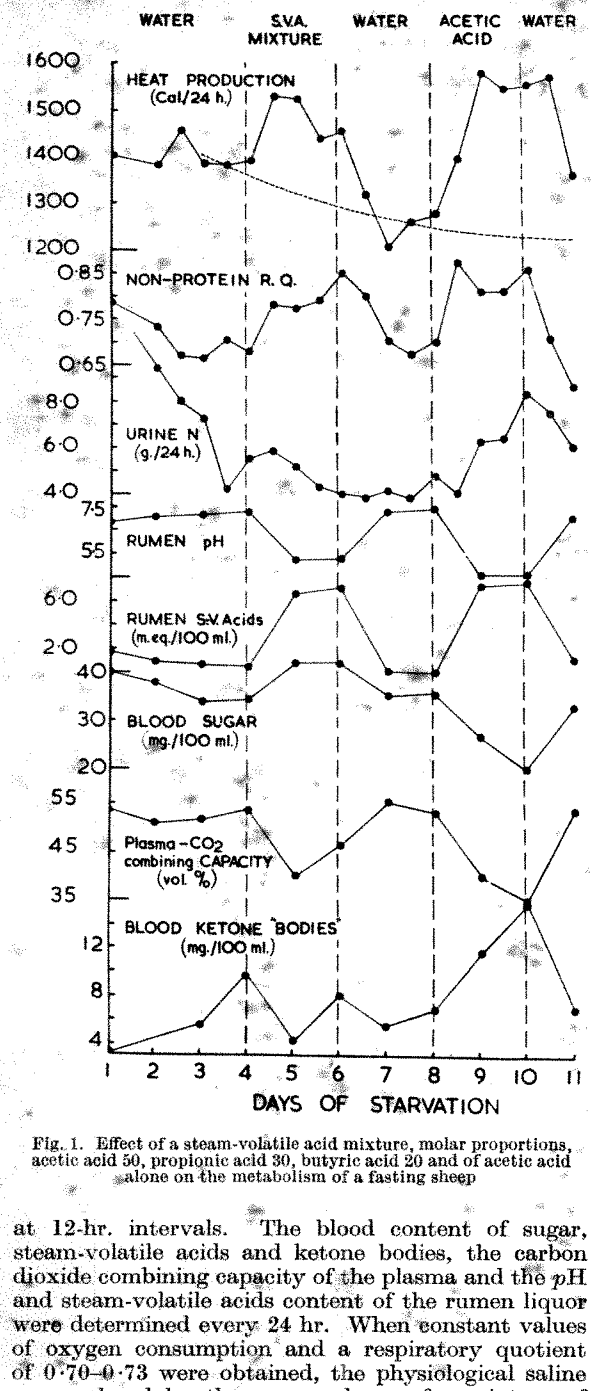

Fig. 1. Effect of a steam-volatile acid mixture, molar proportions, acetic acid 50, propionic acid 30, butyric acid 20 and of acetic acid alone on the metabolism of a fasting sheep

at 12-hr. intervals. The blood content of sugar, steam-volatile acids and ketone bodies, the carbon dioxide combining capacity of the plasma and the *p*H and steam-volatile acids content of the rumen liquor were determined every 24 hr. When constant values of oxygen consumption and a respiratory quotient of 0·70–0·73 were obtained, the physiological saline was replaced by the same volume of a mixture of acetic, propionic and butyric acids in the molar proportions 50 : 30 : 20, to supply 1,100 k.cal. in 24 hr. The acid mixture contained the same amount of modified saline as before and was given for 48 hr. The animal then received water and saline for a further 48 hr., followed by a similar period during which it received an acetic acid solution supplying 700 k.cal./24 hr. The sheep was then returned to the saline regimen for a final 24-hr. period. The results are summarized in Fig. 1.

The mixed steam-volatile acids did not depress the rumen *p*H beyond the limit of the normal physiological range, although initially a slight systemic acidosis developed. There was an appreciable rise in blood glucose. From the increase in oxygen consumption and carbon dioxide production, and from the elimination of urinary nitrogen, the heat increment, that is, the extra heat lost on giving the mixture of acids expressed as a percentage of the total calorie content of the acids, was calculated to be 16 per cent.

During the administration of acetic acid the very marked rise in heat production that occurred amounted to between 46 and 50 per cent of the energy input. A systemic acidosis developed with the accumulation of volatile acids in the peripheral blood. A decline in blood sugar, an increased excretion of nitrogen in the urine and a ketonæmia also occurred.

Further experiments have confirmed the high (44–50 per cent) heat losses associated with dissimilation of acetic acid in the fasting sheep ; in the fed animal even higher heat losses (56–61 per cent) occur. These results suggest that the efficiency of free-energy capture in acetic acid dissimilation is very appreciably lower than that from hexose or from butyric and propionic acids. It should be pointed out that in these experiments the acids have been given at constant slow rates in amounts which may be regarded as physiological.

The results may do much to explain the fact that heat increments in ruminants vary with the fibre content of the food[1], since the proportion of acetic acid in the fermentation products increases with increasing fibre content[4]. Whether measurements *in vitro* of the molar proportions of the steam-volatile acids formed when different foodstuffs are fermented by mixed rumen organisms will permit prediction of the heat increments of rations remains to be seen.

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Invagination as an Organic Process

It may be worth while pointing out that invagination is an organic process which is now known to occur at three levels of organic structure : (1) invagination of cells in the process of gastrulation, (2) invagination or ingrowth of furrows in the process of wall formation in the pollen mother cells of certain angiosperms, (3) ingrowth of dissepiments in the development of mitochondria in animal cells. The process thus applies to cell masses in gastrulation, to cell-wall formation in certain pollen mother cells, and to an organelle in the cytoplasm of animal cells.

There appears to be nothing in the inorganic world which corresponds to this organic process. On the contrary, the growth in length of plant cell walls through intussusception under the influence of auxin is followed by the apposition of thickening layers of fibrils in a manner resembling crystal growth ; but the regularity of the microfibrillæ as seen under the electron microscope never quite equals that of the molecules in a crystal.

Gastrulation of the blastula by invagination to form the archenteron is too well known to need comment. It occurs in invertebrate embryos, amphibians and reptiles, and is recognized in modified form in birds and mammals. The forces and processes inducing it have been much studied by experimental embryologists.

Gastrulation may be said to result from unequal mitotic-rates in cells of the blastula having different sizes, contents and potentialities, especially those of the organizer at the dorsal lip of the blastopore, where a meristem gives rise to both ectoderm and endoderm cells. The fundamental nature of this process arises not only from its widespread occurrence in animal embryology but also from the fact that in totipotent eggs single blastomeres of the 16- or 32-cell stage of the blastula are capable of forming embryos which undergo gastrulation.

No corresponding process occurs in plants at this level of structure, except in the reproductive stages of certain algae, such as *Volvox*[1]. Here the blastula-like hollow sphere of cells has an opening which corresponds to the blastopore. The latter opens out and the whole structure evaginates, turning itself inside out—a process in some respects the reverse of gastrulation.

The formation of cell walls by invagination or furrowing, thus cutting the pollen mother cell into four parts, was clearly described in *Lathraea*[2], in a paper which has been generally overlooked. Narrow, finger-like, hollow processes grow in from four points on the periphery of the mother cell and finally meet in the centre. As these furrows advance a delicate cell wall is secreted or laid down in their hollow interior. The same or a closely similar process has been described in the pollen mother cells of certain other plants, although in many Angiosperms the tetrad walls are laid down in a very different way, on the mitotic spindles. This furrowing process is very similar to the cell division by constriction which occurs in the cleavage stages of animal embryos. The only difference is in the narrower form of the cleavage furrows as described above in pollen mother cells.

The third form of invagination, in animal mitochondria, is most unexpected and has only come to light through the use of the electron microscope. Here again, thin, hollow, finger-like processes grow inward from the margin of the elongated mitochondrion. By reaching the opposite wall they divide the organelle into a series of compartments. This structure is now known in the mitochondria of mammals[3], invertebrates[4] (including insects), and Protozoa[5]. The universality of the septation of true mitochondria in animal cells seems to indicate that this organelle developed in animal cytoplasm at the unicell stage of evolution. Cytoplasmic granules which do not show septation should obviously be classed among the microsomes, though some of the latter may be preseptation stages of mitochondria. Thus the 'mitochondria' of bacterial cells are perhaps better considered as microsomes.

Pelade[3,6], in describing the mitochondria of rat liver, kidney tubules and striated muscle under the electron microscope, finds them surrounded by a membrane which appears double. Into the interior protrude ridges (cristae mitochondriales) which appear as parallel folds (c. 20 mμ in thickness) arising from the inner membrane. Pelade compares them with the villi of the intestinal mucosa. He suggests that the cristae serve to localize the oxidative enzymes known to be present in mitochondria. Sjöstrand[7] also describes the mitochondria as surrounded by a double membrane, the many cross-partitions also having a double membrane. In mouse kidney, Sjöstrand and Rhodin[8] find these cross-partitions to be double, the border membranes separated by a narrow space. Sjöstrand and Hanzon[9] find a similar structure in mouse pancreas cells, the double-edged membranes or plates being *c.* 170 A. thick.

From further evidence, Frey-Wyssling[10] concludes that the cristae arise as invaginations of the inner membrane, each invagination becoming a flat disk which takes the shape of a flattened bladder with a narrow neck. They are therefore true submicroscopic invaginations, as their double walls indicate. There is still, however, difference of opinion as to whether an osmotic membrane surrounds the mitochondrion[11,12]. Harman and Kitiyakara[13] find in the mitochondria of pigeon skeletal muscle no semi-permeable membrane but a gel-like internal matrix between the cristae.

It has been held that mitochondria undergo not only transverse but also longitudinal division. It is difficult to see how the latter could take place in a structure already septate.

The close relation of plant mitochondria to chloroplasts necessitates a different structure in them. Instead of septation the proplastid, according to the recent account of Mühlethaler[14], contains a single granum from which lamellæ grow out through the stroma of the plastid. This outgrowth again is an organic, in contradistinction to an inorganic, process, showing that even at submicroscopic levels purely physical (crystallizing) forces are not the only ones concerned in molecular alignments.

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A Rapid Method for Permanent Aceto-Carmine Squash Preparations

Most methods of preserving chromosome configurations prepared by aceto-carmine squash techniques involve either a somewhat lengthy procedure by which the tissues come to be mounted in balsam or 'Euparal', or else an effective sealing-off of the aqueous medium by ringing with 'Vaseline' or other impervious material. The former methods are time-consuming, and there is a risk that cells may become distorted in the process. The latter procedures are often unsatisfactory over long periods and frequently necessitate storage in the refrigerator to prevent darkening and deterioration.

The following technique is remarkably simple and effective. Freshly prepared squashes are thoroughly irrigated with 45 per cent acetic acid to remove all excess stain. (This may be facilitated by wiping the edges of the coverglass, holding the latter securely at one corner.) A small drop of 10 per cent glycerine in 45 per cent acetic acid is then placed at the margin of the coverglass and allowed to flow under as the aqueous portion evaporates. Should bubbles appear after a day or two, another drop of the glycerine solution may be added.

Advantages of the method are: (1) It is very rapid. (2) It is truly permanent. Even though large areas under the coverglass become filled with air, the glycerine remains in the individual cells and prevents their distortion. (3) Should darkening occur, 45 per cent acetic acid may be added at the edge of the coverglass and the slide gently heated until correct differentiation is achieved. (4) If care is exercised to avoid adding too much glycerine, the coverglass is held so firmly in place (by the evaporation of the acetic acid) that it may be rubbed quite vigorously without danger of displacement when removing oil or dirt. (5) The glycerine is so inert and non-volatile that there is no problem of artefact formation or of the medium becoming discoloured or brittle. (6) The refractive index of glycerine is sufficiently close to that of balsam to give a good microscopic image. It has the further advantage of complete transparency to ultra-violet and near-ultra-violet light.

The method may be extended to other types of microscopic preparation where the final mounting medium is soluble in water, and where pressure of the coverglass is not deleterious or the tissue too thick. It has been used for many years in this Department, for example, for preparations of macerated cells.

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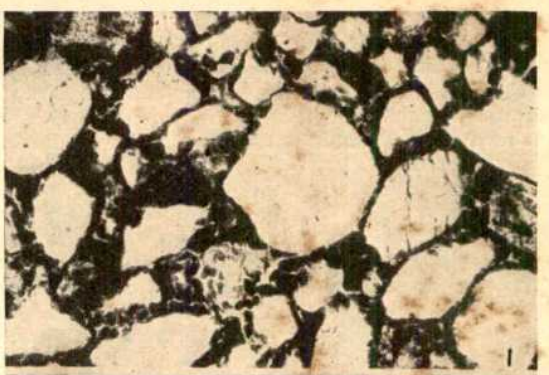
Sectioning of Soil

MANY workers interested in soil microbiology or soil structure have attempted to impregnate soil with materials such as balsam in the hope that the soil could be hardened sufficiently to enable sections to be prepared by normal geological techniques. Few of these attempts met with much success. Kubiena[1] made considerable progress by introducing the use of a thermolabile plastic material, and was able to prepare sections showing the soil structure in many different soil types. However, Kubiena's technique does not seem to have given satisfactory results in the hands of other workers. Haarløv and Weis-Fogh[2] have developed a method for sectioning litter, using a hardened agar, but their method is unsatisfactory for mineral soil. More recently, Alexander and Jackson[3] have described the use of a marco-resin for impregnating the soil and preparing thin sections.

We have found that the procedure can be greatly simplified by using a 'Bakelite' polymeric resin *S.R.* 17497 and its associated catalyst and accelerator. The resin has a low viscosity, good wetting powers and sets at room temperature in 12–24 hr. to a hard water-white solid which can be ground with carborundum. The setting time can be controlled by varying the amounts of catalyst and accelerator.



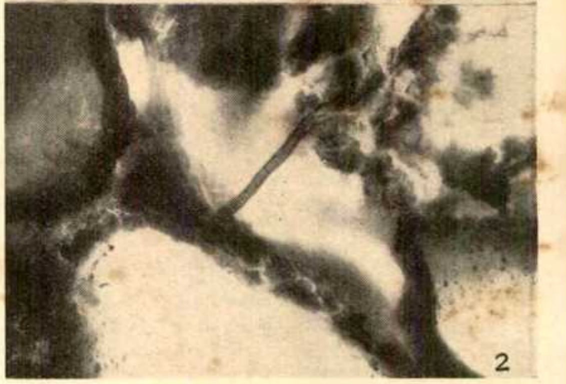


Fig. 1. B_1 horizon of a podzol, sand grains cemented with sesquioxide and humus. × 60 approx.

Fig. 2. Fungal hypha in pore space of the B_1 horizon. × 300 approx.

A piece of air-dry soil about 2 cm. × 1·5 cm. × 0·5 cm. is placed in a pool of resin on a slide. The resin readily fills the soil spaces, and after it has set the soil can be treated like a rock chip. The upper surface is ground to give the maximum surface area and then polished. The soil is taken off the slide and remounted in resin, polished side downwards. After the resin has set, the soil is ground down to a thin film and polished. Finally, it is mounted in resin under a cover glass. 'Carborundum' 280-grade has been used for the grinding and a No. 200 hone for polishing. Sections 50–60μ thick have been found suitable for the examination of the fungi in soil.

This method has been developed primarily for the study of fungal hyphæ in the soil; but mites, nematodes and thecate amœbæ have also been examined.

Fig. 1 shows the general distribution of quartz grains and the cementing sesquioxide and humus in the B_1 horizon of a podzol. In Fig. 2 a fungal hypha can be seen passing from the humus coating on one sand grain across the soil pore to another grain.

We would like to thank Messrs. Bakelite, Ltd., Redfern Road Works, Tyseley, Birmingham 11, for their kindness in supplying samples of resin.

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Jan. 26.

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FORTHCOMING EVENTS

Monday, June 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture heatre of the Science Museum, Exhibition Road, London, S.W.7), 5.30 p.m.—Prof. I. Bernard Cohen: "Some Aspects of the Aims, ethods and Influence of Newton's Scientific Work".

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at the Geogical Society, Burlington House, Piccadilly, London, W.1), at 30 p.m.—Dr. R. L. Metcalf (University of California): "Physicohemical Approach to Insecticide Action".

Thursday, June 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), t 4.30 p.m.—Sir K. S. Krishnan, F.R.S.: "The National Physical aboratory of India"

Thursday, June 28—Saturday, June 30

BIOCHEMICAL SOCIETY (joint meeting with the SCANDINAVIAN IOCHEMICAL SOCIETIES, in the Department of Biochemistry, Tennis ourt Road, Cambridge), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or efore the dates mentioned:

ASSISTANT, Grade B (graduate in mathematics, engineering or ience, with teaching or industrial experience) IN THE DEPARTMENT F MATHEMATICS—The Registrar, College of Technology and Comerce, The Newarke, Leicester (June 26).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours egree in mathematics and physics, or equivalent qualifications, postraduate research experience, and preferably with a knowledge of the heory of the outer layers of a star and experience in stellar spectroscopy r photoelectric photometry), at the Royal Greenwich Observatory, Herstmonceux, Sussex, to take charge of the department conducting strophysical work (as distinct from astrometric and solar work)—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlngton Street, London, W.1, quoting S.4599/56/7 (June 29).

LECTURER IN THEORETICAL CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (June 30).

LECTURER IN PHYSICS; ASSISTANT LECTURER IN CHEMISTRY; ASSISTANT LECTURER IN PHYSICS; and SENIOR LECTURERS (3) IN PHYSICS, at the Royal Technical College of East Africa—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSICS, to work on atmospheric electricity—The Secretary, The University, 38 North Bailey, Durham (June 30).

BENGER RESEARCH FELLOW (graduate in medicine or science (including pharmacy)) IN PHARMACOLOGY—The Registrar, The University, Manchester 13 (July 1).

PRINCIPAL LECTURER IN APPLIED MECHANICS at the Royal Naval College, Greenwich—The Secretary, Civil Service Commission, Burington Gardens, London, W.1, quoting 4600/56/8 (July 2).

SOIL ANALYST (with a degree or equivalent qualification in chemistry and at least two years subsequent experience), at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 3).

CHEMIST (with an honours degree in chemistry or chemical engineerng, or A.R.I.C., or equivalent qualifications) with the Ministry of Supply at Harefield, Middlesex, to assist in the technical direction of inspection of non-metallic aero materials, for example, metal–metal adhesives, windscreen glass, general chemicals and packaging materials, and to supervise all analyses, including spectrographic—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.388/6A (July 7)

RESEARCH ASSISTANT IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (July 7).

SCIENTIFIC OFFICER (honours graduate) IN THE ENTOMOLOGY SECTION, for ecological and population studies of soil pests as affected by insecticides—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 7).

LECTURER IN ELECTRICAL ENGINEERING; LECTURER IN CIVIL ENGINEERING; and a LECTURER IN MECHANICAL ENGINEERING—The Assistant Secretary, The University, Edinburgh (July 9).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Manchester 13 (July 9)

LECTURER (preferably with a knowledge of some aspect of nuclear engineering) IN ENGINEERING (Mechanical)—The Registrar, The University, Manchester 13 (July 9).

LECTURER IN GEOLOGY—Head of the Department of Geology, Imperial College, London, S.W.7 (July 10).

SCIENTIFIC TECHNICAL OFFICERS (with physics qualifications, preferably graduate), for research teams working on problems in classical physics, heat transfer and mechanical properties of materials and compacts for the preparation of special fuels from coal—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting SS/304 (July 10)

ASSISTANT IN AERODYNAMICS—The Secretary of University Court, The University, Glasgow (July 14).

ASSISTANT IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (July 14).

ASSISTANT LECTURER (TAXONOMIST) IN THE DEPARTMENT OF BOTANY—The Registrar, University College of Wales, Aberystwyth (July 14).

DEMONSTRATORS (2) IN PHYSICS—The Registrar, College of Technology, Manchester 1 (July 14).

LECTURER IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (July 14).

CHAIR OF PHYSICS—The Registrar, The University, Birmingham 15 (July 15).

CHAIR OF PHYSIOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 15).

LECTURER (with a good honour degree, including heavy current subjects, together with reasonable industrial and teaching experience, and preferably with experience with any of the following: high tension testing; modern servo-mechanisms; heavy current analogue computers) IN ELECTRICAL ENGINEERING—The Secretary and Registrar, The University, Southampton (July 15).

TUTORIAL RESEARCH STUDENT IN MATHEMATICS (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (July 21).

LECTURER (with qualifications in pure mathematics or applied mathematics) IN MATHEMATICS—The Registrar (Room 9 O.R.B.), The University, Reading (July 23)

LECTURER (with training or experience in one of the following fields: (a) hydraulics; (b) aerodynamics; or (c) hydrodynamics) IN THE DEPARTMENT OF FLUID MECHANICS—The Registrar, The University, Liverpool (July 23).

SENIOR LECTURER IN THE DEPARTMENT OF ELECTRONIC ENGINEERING—The Registrar, The University, Liverpool (July 28).

CHAIR OF PHYSICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER IN THE DEPARTMENT OF MATHEMATICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER (preferably with a special interest in the history and philosophy of science) IN PHILOSOPHY at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

SENIOR LECTURER (highly qualified in statistical theory and widely experienced in the application of statistics to practical problems) IN STATISTICS, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

ASSISTANT (with a degree in science, preferably honours) IN THE CHEMISTRY DEPARTMENT at Auchincruive, Ayr, for work relating to the spectrographic analysis of agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 10).

PROFESSOR OF EDUCATION and HEAD OF THE DEPARTMENT OF EDUCATION—The Registrar, The University, Leeds 2 (August 15)

LECTURER IN MATHEMATICS; and a LECTURER IN STATISTICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

SCHOLAR (with an honours degree in physics or mathematics) IN THE ASTRONOMICAL SECTION of the School of Cosmic Physics at Dunsink Observatory, for research in solar spectroscopy or stellar photometry—The Senior Clerk, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin (September 1).

LECTURER (with a good honours degree in zoology and preferably some research experience, not necessarily in the tropics) IN ZOOLOGY; and a LECTURER or SENIOR LECTURER (with a degree in agriculture (or equivalent qualification) and preferably some research experience in animal husbandry) IN ANIMAL HUSBANDRY, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (September 15).

ASSISTANT EXPERIMENTAL OFFICER (with experience in laboratory work, preferably biological) IN THE PHYSIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire

ASSISTANT LECTURER, Grade B (honours graduate) IN PHYSICS—The Principal, Brighton Technical College, Brighton 7.

ASSISTANT PHYSICIST (Basic grade) at the Regional Radium Institute, Bradford—The Secretary, Royal Infirmary, Bradford.

DEMONSTRATORS IN (*a*) AGRICULTURAL BOTANY (preferably with an interest in plant physiology); (b) MICROBIOLOGY (with interests in dairying or soil microbiology); and (c) AGRICULTURAL CHEMISTRY (with qualifications in agricultural chemistry or chemistry)—The Registrar, The University, Nottingham.

LECTURER IN CHEMISTRY—The Secretary/Treasurer, Royal Technical College, Glasgow.

MECHANICAL and ELECTRICAL ENGINEERS (with, or obtaining, a first- or second-class honours degree or equivalent in mechanical or electrical engineering), for important projects at Ministry of Supply Establishments in the South of England, which include research and development on ram-jet engines and gas turbine propulsive systems for supersonic speed; mechanical and electrical devices for projectiles and rockets; instrumentation; aircraft and aircraft equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.436/6A.

READER IN MARINE BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

RESEARCH ASSISTANTS IN CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

SCIENTIFIC EXHIBITIONS ASSISTANT, Assistant Experimental Officer grade (with G.C.E. (advanced) in two scientific subjects or equivalent, and preferably with drawing office experience and an interest in display work), for work in the Publicity Section of the Department of Scientific and Industrial Research in London—C.M.956, London Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1.

SENIOR LECTURER IN PHYSIOLOGY AND PHARMACOLOGY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR TECHNICIAN, Grade 1 (with a wide knowledge of histological techniques), IN THE MORBID ANATOMY DEPARTMENT, to be responsible for the routine work under the direction of a Chief Technician—The Secretary, St. Albans City Hospital, Normandy Road, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Zoological Society of London. Report of the Council and Auditors for 1955. Pp. iii+55+4 plates. (London: Zoological Society of London, 1956.) [184

Imperial Forestry Institute, University of Oxford. Thirty-first Annual Report, 1954–55. Pp. 32. (Oxford: Imperial Forestry Institute, 1956.) [184

Science Masters' Association. Report of Committee and Balance Sheet, 1955. Pp. 33. (London: Science Masters' Association, 1956.) [184

Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 36: Meranti, Seraya and Allied Timbers. By J. D. Brazier. Pp. vi+37+4 plates. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [184

Building Research Station Digest No. 86: Damp-proof Treatments for Solid Floors. Pp. 5. (London: H.M. Stationery Office, 1956.) 3*d*. net. [184

Admiralty Bulletin No. 76: The Tidal Branch of the Hydrographic Department of the Admiralty (Part 2). By Commander W. I. Farquharson, R.N. Pp. 5. (London: Admiralty, 1956.) [184

British Electrical and Allied Industries Research Association. Technical Report N/T71: A Study of Domain Structures in Alnico. By Prof. L. F. Bates and Dr. D. H. Martin. Pp. 5+5 plates. 7*s*. 6*d*. Technical Report Z/T100: Atmospheric Freezing, Pulsations and Evolutionary Progression in the Long-Period Variable Stars. By Dr. C. E. R. Bruce. Pp. 5. 4*s*. 6*d*. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) [184

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 1: Fluorocarbon Derivatives. By Dr. R. N. Haszeldine. Pp. ii+49. (London: Royal Institute of Chemistry, 1956.) [184

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 959, Vol. 249 (19 April 1956). The Asymptotic Solution of Linear Differential Equations of the Second Order in a Domain Containing One Transition Point. By F. W. J. Oliver. Pp. 65–97. 11*s*. No. 960, Vol. 249 (19 April 1956): A Matrix Analysis of Processes Involving Particle Assemblies. By S. R. Broadbent and T. G. Callcott. Pp. 99–123. 10*s*. (London: Royal Society, 1956.) [184

Flora of Tropical East Africa. Connaraceae. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Pp. 27. (London: Crown Agents for Oversea Governments and Administrations, 1956.) 3*s*. [244

Department of Scientific and Industrial Research: National Physical Laboratory. Notes on Applied Science. No. 13: Standard Capacitors and Their Accuracy in Practice. Pp. iv+10. (London: H.M. Stationery Office, 1955.) 1*s*. 3*d*. net. [244

Other Countries

East African Meteorological Department. Memoirs. Vol. 3, No. 4: Report on Experiments on Artificial Stimulation of Rainfall at Mityana, Uganda, September–December, 1954 By Dr. H. W. Sansom, D. J. Margman and G. England. Pp. 10. (Nairobi: East African Meteorological Department, 1955.) [64

New Zealand Forest Service. Bulletin No. 1: Forest Pathology in New Zealand. By J. J. de Gryse. Pp. vi+62+12 plates. Annual Report of the Forest Research Institute for the year ending 31 March 1955. By H. V. Hinds. Pp. 80. (Wellington: Government Printer, 1955.) [64

Administration Report of the Government Museum, Madras; the National Art Gallery, Madras; the Government Museum, Pudukkottai; and the Connemara Public Library (Exchange Section), Madras; for 1954–55. Pp. iii+46+2 plates. (Madras: Government Press, 1956.) [64

Western Region of Nigeria. Annual Report on the Forest Administration of the Western Region of Nigeria for the year 1953–54. Pp. 55. (Lagos: Government Printer, 1955.) [64

South Australia. Report of the Museum Board, 1st July 1954 to 30th June 1955. Pp. 11. (Adelaide: Government Printer, 1956.) [124

Testing of Agricultural Seeds Moving in International Trade: Proceedings of the Cambridge Conference, 18th June–3rd July, 1954. (Project No. 223.) Pp. 150. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 400 francs; 8*s*.; 1.25 dollars. [124

World Health Organization. Monograph Series. No. 30: Yellow Fever Vaccination. By Smithburn *et al.* Pp. 238. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 15 Swiss francs; 25*s*.; 5 dollars. [184

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Technique. No. 48: l'Alimentation Minérale du Bétail au Congo Belge. Par Prof. L. Hennaux. Pp. 115+6 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) 160 francs. [184

Carnegie Institution of Washington. Year-Book No. 54 (July 1, 1954–June 30, 1955), with Administrative Reports through December 9, 1955. Pp. xxxix+9+211+3 plates. (Washington, D.C.: Carnegie Institution of Washington, 1955.) Cloth, 1.50 dollars; Paper, 1 dollar. [184

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 37 (February 1956): Hospitalization of Men at the Working Ages. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [184

Survey of India. Technical Report, 1952 (From 1st April 1951 to 31st March 1952). Part 1: Topographical and Other Surveys. Part 2: Map Publication and Office Work. Pp. v+47+2 Index Maps. Rs. 6 9*s*. 6*d*. General Report, 1952 (From 1st April 1951 to 31st March 1952). Pp. xi+78+6 Index Maps. Rs. 18. 28*s*. 3*d*. (Dehra Dun: Survey of India, 1955.) [184

Eighth Annual Report of the Pacific Marine Fisheries Commission for the year 1955. Pp. 16. (Portland, Oregon: Pacific Marine Fisheries Commission, 1956.) [184

Council of Scientific and Industrial Research. Field Research Institute, Manbhum. Report of Director for the year 1954–55. Pp. iii+37. (Manbhum, Bihar: Fuel Research Institute, 1955.) [184

An Explanation of Gravitation. By Armand Lowinger. Pp. 2. (Brooklyn, N.Y.: Armand Lowinger, 1956.) [184

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Yale Medical Library. Annual Report including the Report of the Historical Library, 30 June 1955. Pp. 36. (New Haven, Conn.: Yale Medical Library, 1956.) [184

Sudan Government. Ministry of Agriculture: Forests Department. Report for the period July 1953 to June 1954. Pp. iv+71. (Khartoum: Ministry of Agriculture, Forests Department, 1955.) [184

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 36: Some Amphibians from the Lowlands of North Borneo. By Robert F. Inger. Pp. 389–424. 75 cents. Vol. 34, No. 37: Notes on a Collection of Fishes from Southeastern Venezuela. By Robert F. Inger. Pp. 425–440. 30 cents. (Chicago: Chicago Natural History Museum, 1956.) [184

United States Naval Observatory. Circular No. 64: Positions, Areas, and Counts of Sunspots, October–November–December, 1955. By Winifred Sawtell Cameron. Pp. 16. (Washington, D.C.: U.S. Naval Observatory, 1956.) [184

Transactions of the American Philosophical Society. (New Series.) Vol. 46, Part 1: The French Revolution Seen from the Right: Social Theories in Motion, 1789–1799. By Prof. Paul H. Beik. Pp. ii+122. (Philadelphia: American Philosophical Society, 1956.) 2 dollars. [184

Unesco. Scientific Institutions and Scientists in Latin America. Mexico (3er Volumen). Pp. iii+76. (Montevideo: Unesco Science Co-operation Office for Latin America, 1955.) [184

Author Index covering Lists of No. 7 to 12 of Scientific Papers published in the Middle East, 1951 to 1955. Pp. 40. (Cairo: Unesco Science Co-operation Office, 1955.) [184

Papers presented at the International Technical Conference on the Conservation of the Living Resources of the Sea, Rome, 18 April to 10 May 1955. Pp. xii+371. (New York: United Nations; London: H.M. Stationery Office, 1956.) 3 dollars; 22*s*. 6*d*.; 13 Swiss francs. [184

The Work of WHO, 1955. Annual Report of the Director-General to the World Health Assembly and to the United Nations. (Official Records of the World Health Organization, No. 67.) Pp. xii+241+16 plates. (Geneva: World Health Organization, London: H.M. Stationery Office, 1956.) 6 Swiss francs; 10*s*.; 2 dollars. [184

Institut Royal Météorologique de Belgique. Publications, Série B, No. 19: Le Temps en 1954. Par Dr. R. Sneyers. Pp. 46. Contributions. No. 22: Éléments de Météorologie. Chapitre 4: Éléments de Thermodynamique et de Statique de l'Atmosphère. Par A. Descamps et L. Dufour. Chapitre 5: Notions de Mécanique de l'Atmosphère. Par P. Defrise. Pp. 32. No. 24: Comparaison de Pluviomètres. Par Dr. L. Poncelot. Pp. 14. No. 25: Sur l'Analyse des Réparatitions Statistiques Discrètes. Par Dr. R. Aneyers. Pp. 16. No. 26: The Aeronomic Problems of Nitrogen Oxides. Par Dr. Marcel Nicolet. Pp. 19. No. 27: Nitrogen Oxides and the Airglow. Par Dr. Marcel Nicolet. Pp. 13. No. 28: Sur le Degré de Régularité des Ressources en eau Météorique. Par Dr. L. Poncelot. Pp. 15. (Uccle-Bruxelles: Institut Royal Météorologique de Belgique, 1955.) [184

Proceedings of the Symposium on Nutritive Aspects of Preserved Food, Swedish Institute for Food Preservation Research, Göteborg, Sweden, October 1954. (SIK Publikation No. 115.) Pp. i+173. (Göteborg: Swedish Institute for Food Preservation Research, 1956.) 30 Sw. Cr. [184

Union of South Africa. Council for Scientific and Industrial Research: Library and Information Division. Register of Current Scientific Research at South African Universities, 1955. Pp. viii+341. (Pretoria: Council for Scientific and Industrial Research, 1955.) [184

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Bulletin of the Florida State Museum, Biological Sciences. Vol. 1, No. 2: Systematics and Variation of the Endemic Florida Snake Genus *Stilosoma*. By Richard Highton. Pp. 73–96. (Gainesville, Fla.: Florida State Museum, 1956.) 35 cents. [244

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes Rendus de Recherches. No. 17, Avril, 1956: Travaix de la Commission pour l'Étude de la Construction Métallique. Recherches sur le flambement de colonnes en acier A37, à profil en double Té, sollicitées obliquement. Par Prof. F. Campus et Prof. C. Massonnet. Pp. 152. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1956.) 175 francs. [244

Coryndon Memorial Museum. Occasional Papers. No. 4: Reports on New and Little Known Insects from East Africa. Pp. 43+4 plates. (Nairobi: Coryndon Memorial Museum; Cambridge: Deighton Bell and Co., 1956.) 7*s*. 6*d*. [244

Durban Museum Novitates. Vol. 4, Part 14: Mordellidae and Scraptiidae in the Collections of the Durban Museum. 29: Contribution to the Knowledge of Mordellidae and Scraptiidae. By Dr. Mario E. Franciscolo. Pp. 215–244. 5*s*. net. Vol. 5, Part 15: Miscellaneous Taxonomic Notes on African Birds. By P. A. Clancey. Pp. 245–256. 2*s*. net. (Durban: Durban Museum, 1956.) [244

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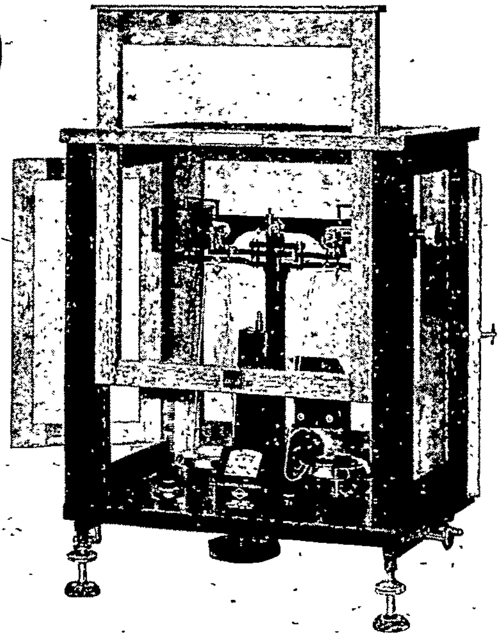

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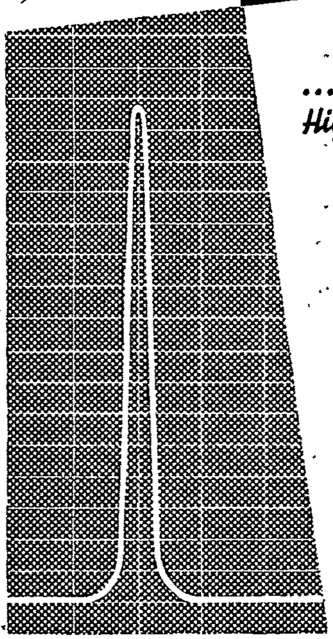

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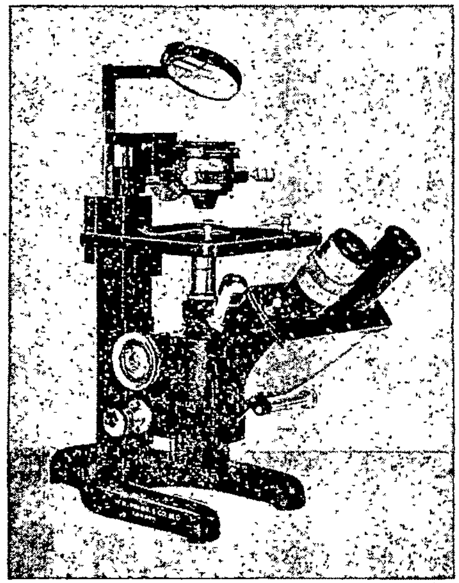

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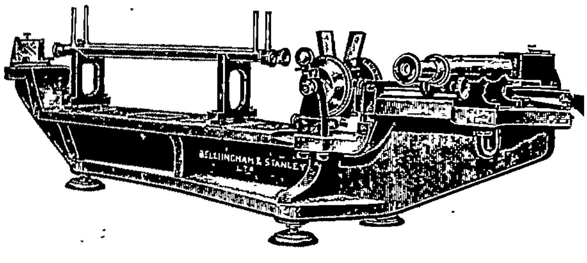

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ACADEMIC FREEDOM

N his recent book, "Academic Freedom in Our Time"* (see also p. 1190), Prof. R. M. MacIver akes a number of suggestions for the defence of ademic freedom which are intended for American aders. They require re-thinking and modification efore they could be applied in the British Commonealth; but there is much in the book that is of eneral interest and highly pertinent to issues which ave recently been raised in the Commonwealth. His atement of the intra-mural and extra-mural rights hich arise from consideration of the scholar's unction and consequent service to society have, owever, a general validity and apply in Britain and lsewhere in the Commonwealth as much as in the nited States. Three are intra-mural: the right rofessionally to decide matters calling for profesonal competence; the right to a status commenurate to his responsibility and consonant with his igh service to society and civilization; and the ght to conditions of tenure that secure him against ismissal or professional penalization save for proessional incompetence or conduct that in the udgment of his professional colleagues renders him nfit to be a faculty member. Extra-murally, there re the right to a private life free from controls that re not imposed on other citizens, and the right to xercise the same political and civil liberties that are njoyed by other citizens.

The validity of Prof. MacIver's general thesis and he application of these conditions were amply emonstrated by papers presented last August at a ymposium on the place of the Australian university n the community (see *Nature*, June 9, p. 1071), and y the difficulties in which the University of Tasmania as found itself involved in recent years, and which ave not been removed by the report of the Royal ommission of inquiry set up last year. It is abunantly clear that the main trouble and major ifficulties in Australia arise from the lack of a clear nd widespread public understanding of the nature nd purpose of a university, and perhaps especially rom the absence of any considerable nucleus among oliticians and industrialists of those who have themelves passed through a university and acquired a espect for it and understanding of the conditions ssential for its effective work. By and large, there s not that mutual understanding and respect between he university administrator and the Government, whether Minister or Civil servant, which, as American bservers have been quick to note, is one fundamental factor in the smooth functioning of the University Grants Committee in Britain.

In the symposium just noted, Prof. A. Boyce Gibson suggested that in certain respects the Australian universities stand nearer those of the United States than those of Great Britain, and for that reason alone it might well be that Prof. MacIver's book on the American universities, and also a related volume by Prof. R. Hofstadter and W. P. Metzger entitled "The Development of Academic Freedom in the United States"* (see also p. 1190), may be more effective in breaking down the parochialism which is one of the weaknesses of Australian universities, as both Prof. D. M. Myers and Prof. J. B. Polya have emphasized, than any corresponding volume from British sources. Moreover, by displaying the problem of academic freedom in its widest context, they should certainly promote the public understanding of the issues that is an essential step towards the resolution of these difficulties in Australia. Nor is Australia the only place in the British Commonwealth where excessive concern with the utilitarian or vocational aspect of a university to the neglect of its primary purpose is endangering the work of a university or the maintenance of standards.

Prof. MacIver points out specifically the danger to university work and standards inherent in any unqualified assertion that its business is to prepare the student for his place in society. In a society that practises racial segregation, for example, a university which accepts this view will tend to inculcate in the student the ideas of segregation, with the consequence that scientific knowledge regarding racial qualities would be rejected or distorted, and any university administrator or teacher who ventured to contradict the prevalent myths would be liable to be dismissed. The bearing of this observation on the situation in South Africa is obvious, and Prof. MacIver's volume should bring further support to the Universities of the Witwatersrand and of Cape Town in their stand against the policy of the Government.

It is no less relevant to the issues which have recently come to the fore at the new inter-racial University College of Rhodesia and Nyasaland. The College, which is to open its doors in March 1957—a year later than was originally hoped—will have both African and European students and, as now planned, the University College represents a compromise between the recommendations of the Carr–Saunders Commission and the original plans of the inaugural board of the Rhodesian University. Although it is a multi-racial institution, the two groups of students are to live in different hostels, but they will mix without distinction in their academic work, in sport and socially.

Concern has, however, been expressed in the House of Commons about these arrangements, the pertinent question being asked whether it was a contribution to multi-racial policy to separate the races in an educational institution like this; and on May 8 Lord Lucas asked the Government whether, in view of the Government's financial contribution to the establishment of the College, it is satisfied that the proposed residential arrangements are consistent with the principle of a multi-racial university. The Secretary of State for Commonwealth Relations, the Earl of Home, in his reply, pointed out that the Carr-Saunders Commission considered that separate hostels would be in accordance with the multi-racial principle. He believes that the University College should first concentrate on establishing conditions which will attract both Europeans and Africans to the College. When that is secured, many other developments will follow which we cannot as yet foresee.

---

* Academic Freedom in Our Time. By Prof. Robert M. MacIver. Pp. xiv+329. (New York: Columbia Univ. Press; London: Oxford Univ. Press, 1955.) 32s. net.

* The Development of Academic Freedom in the United States. By Prof. Richard Hofstadter and Walter P. Metzger. Pp. xvi+527. (New York: Columbia Univ. Press; London: Oxford Univ. Press, 1955.) 45s. net.

One of the most satisfactory features of the Government's reply is not the reassurance that the proposed residential arrangements are consistent with a multi-racial institution, but the clear understanding of the nature of a university institution and deep respect for its autonomy which are implicit in Lord Home's words. It was not merely that he had great confidence in Dr. Walter Adams, principal of the College, as a most enlightened and progressive man; he categorically refused to interfere from Whitehall with people who really know their business, and maintained that it is only right to leave the autonomous Council of the College to make the arrangements most likely to attract both Africans and Europeans to the College.

The question was worth asking for two reasons: as demonstrating the sensitiveness of public opinion in Britain to anything that approaches *apartheid*, and as promoting a clearer understanding of the nature of a university institution. The most disturbing feature of the whole episode is the extent to which the Labour Party, as shown by its criticism, has failed to grasp either the nature of a university or the extent to which the new University College already represents an important advance. As Sir Roy Wellensky, Deputy Prime Minister in the Central African Federation, recently observed, the fact that Africans and white people would be meeting and working at university-level is itself a great step forward. Rhodesians to-day are much more racially minded than people are in Britain, though less so than South Africans, and proposals for still closer relations might well have delayed indefinitely the establishment of the College. Account has to be taken also of the climate of opinion, and Dr. Adams was clearly right in commenting that the policy of separate residences and dining halls is not an issue of principle but a matter of practical convenience.

Dr. Adams added in his letter to Mr. Gaitskell that the Labour Party in Britain has made the task of the College Council doubly difficult by converting into a political and party issue a matter which it was proposing to solve by common sense and experience within the College community. It is fundamental to the success of the College, as he pointed out, that it should attract European students who, unlike the Africans, have the option of going to universities in South Africa. If they or their parents boycott the College, the opportunity for inter-racial co-operation within the common standards of university life would be lost.

What needs to be grasped is that segregation in living quarters is an entirely different matter if the races concerned are already close together than when, as in Rhodesia, they are far apart. In actual fact, the College will bring them a good deal close than they have ever been before, and the next step should come by growth from within rather than by pressure from without. If the autonomy of th College is respected, we may look forward to th impact on the intellectual level of Rhodesia of it academic staff. There are others on its staff beside Dr. Adams in whose integrity and judgment every confidence can be felt, and they will be helped mos in the task of rooting and spreading the academic spirit of Central Africa if they are encouraged to resist pressure from any external source. The attemp to put pressure on them can only defeat the very purpose of the College, and the lack of understanding of the issues which has been shown by political leaders in Britain is a further reason for welcoming any volumes such as those of Prof. MacIver and his colleagues referred to earlier. Such volumes can spread a clearer understanding of the nature o academic freedom, of its importance in any demo cratic society and of the ways in which it is best defended against the dangers that threaten it in ou time.

FREEDOM IN AMERICAN UNIVERSITIES

The Development of Academic Freedom in the United States

By Prof. Richard Hofstadter and Walter P. Metzger. Pp. xvi+527. (New York: Columbia University Press; London: Oxford University Press, 1955.) 45s. net.

Academic Freedom in Our Time

By Prof. Robert M. MacIver. Pp. xiv+329. (New York: Columbia University Press; London: Oxford University Press, 1955.) 32s. net.

IT is claimed in the preface to the scholarly and massive book on the development of academic freedom in the United States, which Prof. R. Hofstadter and Prof. W. P. Metzger have written under the American Academic Freedom Project, that academic freedom has become one of the central issues of our time. However, apart from Prof. Hofstadter's opening chapter on the European heritage, in which he traces the growth of the idea of toleration, and that in the second part, in which Prof. Metzger analyses with such discernment the German influence on the American universities, the book is concerned almost exclusively with the problem of academic freedom as it has presented itself in the United States from the founding of the first college to the Second World War. That is no less true of the other book, by Prof. R. M. MacIver, the director of the Project, which deals with academic freedom in our time and is also written under the auspices of the Project. Both books contribute to the clearer understanding of the issues at stake and of some of the failures that have surprised or disappointed observers outside the United States; they should help to prevent hasty judgments, as well as indicate where and how help can best be given to American universities in their defence of academic freedom, without arousing misunderstandings or making their struggle more difficult.

The book by Profs. Hofstadter and Metzger contains much that will be new to those in Britain who are interested in the question of academic freedom, and it has a wide interest in that it gives a very readable account of the development of the universities in the United States. While not purporting to present a systematic account, the book leaves the reader with a very clear understanding of the way universities have developed in the United States, of the differences in their government and organization which sometimes puzzle a British observer and of how American universities have been subjected to influences and pressures from which British universities have largely been free.

It is as a contribution to such understanding that the book is opportune. The immense range and variety of the American scene are displayed with scholarship; but detail is never allowed to become burdensome, and the primary concern with the freedom of members of a faculty is always evident. The issue of freedom for students is scarcely discussed, except where it converges on that of the freedom of the faculty. Prof. Metzger's chapter on the German influence is one of the most interesting and suggestive in the whole volume; it brings out not merely the manner whereby the conception of a university as a research institution contributed to the emergence in the United States of the modern university, in which research took a place along with teaching as a major function, the methods and concepts of science displaced the authority of religion, and in which the academic profession took on, for the first time in full measure, the character, aspirations and standards of a learned profession, but equally it makes clear the selective character of the American reaction to this German influence and especially in the matter of academic freedom. Even more than the influence of Darwinism, which itself contributed to a new conception of academic freedom, is to be noted from this chapter the vitality of the American university which constitutes one of the surest grounds for confidence that it will continue to find means to safeguard its freedom effectively, no matter from what quarter that freedom is threatened.

Prof. MacIver's book is mainly concerned with the past decade and a half and with the dangers arising from heresy hunts and the poisoning of American academic life in the name of security. His introductory chapter is a brilliant exposition of the ultimate issues involved in academic freedom both for the university and for the society of which it is a part. The ability of Americans to grasp what is at stake and to state the issues clearly has been repeatedly demonstrated by observers at the seventh Congress of Universities of the Commonwealth, in volumes such as "Government Assistance to Universities in Great Britain" and in the writings of Prof. Gellhorn, Prof. H. S. Commager and Alan Barth, as well as in earlier volumes of Prof. MacIver. Prof. MacIver's new book continues that tradition. While he describes objectively the nature of the present attack on academic freedom in the United States, the conditions and forces that constitute the real danger, his book is as valuable for the clear picture it gives of the relation between academic freedom and the ultimate function and purpose of a university—for example, its contribution to an understanding of the nature and danger of McCarthyism and the security problem in the United States. It should help to that clear understanding of the nature and function of a university which is no less essential for obtaining that support of public opinion on which it increasingly depends if its work is to be effective and the financial resources drawn increasingly from public funds are to be assured.

What Prof. MacIver brings out especially is that, in standing for academic freedom, the members of a university are doing no more than assert the essential condition under which the university is able to make its great contribution to the moral quality of society and to its spiritual as well as to its material advancement. Society as well as the university suffers if procedures are instituted which seriously affect the integrity of institutions of learning, the intellectual independence of the faculty, or the professional status of their administrators. Moreover, Prof. MacIver explains very clearly but trenchantly exactly how infringements of academic freedom are detrimental to a democratic society and why it is so important that the people as a whole should come to appreciate just what a university is and does; should learn how much of great and lasting worth it contributes to society and how essential it is that its freedom be sustained and its standards advanced; and should recognize how devoted and disinterested the work of the true scholar is.

Prof. MacIver's book is thus of interest to British readers both as a challenge to popular exposition of the meaning of a university and as a contribution to that work of assisting the community in general to regard the university not with suspicion from a distance but from near at hand with affection so that the community itself becomes the guardian of its integrity.

R. Brightman

PHYSICS OF STELLAR ATMOSPHERES

Physik der Sternatmosphären, mit besonderer Berücksichtigung der Sonne

Zweite Auflage. Von Prof. A. Unsöld. Pp. ix+866. (Berlin: Springer-Verlag, 1955.) 168 D.M.

THE first edition of Prof. A. Unsöld's book (reviewed in *Nature*, 142, 975; 1938) was a masterly achievement which presented a large field of astrophysics from a unified point of view, and for many years formed an invaluable foundation for study and research. By combining the results of physics and astrophysics, it played a particularly valuable part in developing the theory of the latter to a state where its consequences could be directly tested by observation.

The enormous advances of the past two decades have transformed the study of stellar atmospheres almost beyond recognition. Various aspects of this progress are excellently dealt with in monographs such as those by S. Chandrasekhar (1950), V. Kourganoff and I. W. Busbridge (1952), R. v. d. R. Woolley and D. W. N. Stibbs (1953), and L. H. Aller (1953 and 1954)—setting the stage for an up-to-date treatment of the field as a whole from a basically physical point of view. The new edition of Unsöld's book is therefore welcome.

The first part, on the general features of stellar atmospheres in thermal equilibrium (105 pp.), discusses the basic radiation laws, observational techniques and results regarding solar and stellar radiation, and the derivation of mean physical conditions in stellar atmospheres using the Boltzmann and Saha equations. Here there are relatively few changes.

Part 2, on the continuous spectrum and structure of a stellar atmosphere (132 pp.), has been thoroughly rewritten and more than doubled in length. The principal advances in this field have been the development of new methods of solution of the equation of transfer in grey and non-grey atmospheres, the discovery of the overwhelming contribution of the negative hydrogen ion to the continuous opacity in the atmospheres of the Sun and other stars of spectral type F and later, and the development of a more detailed understanding of the effects of convection. In addition, this section contains numerical results of calculations of continuous absorption coefficients and other quantities of great practical value in all research on stellar atmospheres.

Parts 3, 4 and 5 deal with Fraunhofer lines (293 pp.). After a detailed discussion of the practical measurement of line profiles and total intensities, the basic theory of spectral transitions is given, followed by a treatment of re-emission processes (scattering, absorption and non-coherent scattering) and the derivation of the absorption profile in the presence of damping and Doppler effects. The following chapters, on broadening by collision and Stark damping, and on the calculation and measurement of transition probabilities, represent a complete revision in structure and content; an extremely valuable new chapter gives a list of the literature on oscillator strengths up to 1954. In Part 5 (160 pp.) the physical theory is applied to the problem of line formation in an actual stellar atmosphere. After the development of the curve of growth, its application to the "Grobanalyse" determination of the mean temperature, surface gravity and composition of the Sun and of three early-type stars is described in detail. There follow discussions of "Feinanalyse" by the method of model atmospheres, and numerous other topics in the formation of stellar absorption lines are considered. No reference is made to emission lines, although it is likely that these may be formed under certain circumstances in normal stellar atmospheres, without requiring the presence of diluted radiation in extended envelopes—a subject specifically excluded by the author from his terms of reference. Part 5 concludes with a general discussion of the various systems of spectral classification.

Part 6 is devoted to solar physics (183 pp.), and begins by emphasizing the basic importance of hydrodynamics and hydromagnetics in this field. A brief summary of observational techniques is followed by an account of the solar cycle, granulation and the effect of photospheric temperature inhomogeneities on Fraunhofer lines, sunspots, faculæ and the question of a general magnetic field. A discussion of the elements of magneto-hydrodynamics precedes an account of solar and stellar flares. A further chapter deals with eclipses, the chromosphere, corona and prominences; the problem of the heating of the corona is treated in a very stimulating way, and the spectra of prominences and spectroheliogram phenomena are given a detailed interpretation.

Finally, there is an entirely new Part 7 on radio astronomy and cosmic rays (68 pp.). A historical introduction is followed by a summary of the fundamental quantities, the quiet Sun, solar bursts, radiation from the Galaxy and discrete sources, and (briefly) the 21-cm. line. The final chapter of the book deals with the problem of the relationship between radio noise and cosmic radiation.

Three appendixes give physical and astronomical constants, spectroscopic notation, and the properties of exponential integral functions. The very detailed bibliography (56 pp.) lists 1,781 references, compared with 691 in the first edition.

Prof. Unsold's gifts as an expositor of a field to which he has contributed so much are unique. The treatment of the subject is crystal clear, and the style is not only elegant and very personal, but also so lucid that even a reader with a limited knowledge of German can follow the argument without difficulty. The physically significant points are emphasized throughout, and mathematics for its own sake is avoided; close contact is maintained between theory and observation. The description is everywhere enlivened by the author's individual assessments, and his treatments of subjects on which other monographs are also available—such as solar physics—are so independent and interesting that their value is not at all diminished. On several topics, shortage of space prevents a detailed presentation of the case for certain conclusions that are perhaps controversial, and sometimes the impression is given that the subject is more 'cut and dried' than it really is.

The author's achievement in integrating into a coherent discipline a vast mass of scattered astrophysical research can scarcely be over-estimated. I venture to suggest that it would now be of the utmost value if Prof. Unsöld were to give a similar treatment (in a supplementary volume of about half the present size) of the other very closely related topics that remain, such as emission lines, shell stars, distended envelopes, novæ, variable-star atmospheres, planetary nebulæ, peculiar stars, and the interpretation of molecular spectra. Such a book, together with the present work—both written from a single point of view—would form a completed background to research on the radiation emitted from stars.

The book is very attractively produced and will be of immense value to celestial and other physicists concerned with spectroscopy, photometry, cosmic ray research and ionized gases. It places all astrophysicists incalculably in Prof. Unsöld's debt.

ARTHUR BEER

SERVICES' TEXT-BOOK OF RADIO

Electronics

By Dr. J. Thomson. Edited by the Technical Staff of *Wireless World*. (The Services' Textbook of Radio, Vol. 3.) Pp. ix+259. (London: H.M Stationery Office, 1955.) 12*s*. 6*d*. net.

THE increase in the importance and complexity of radio in the Armed Services and outside them can be measured by the changes that have taken place in Service literature on the subject. It is a far cry from the original "Admiralty Handbook of Wireless Telegraphy" to the "Services' Textbook of Radio" in seven volumes. The "Admiralty Handbook" was always good value for money to the ordinary purchaser, owing to the conditions of its publication, and this is true of the present "Services' Textbook". As stated in the foreword to the whole series, the books are intended for three distinct classes of readers—the beginner, the technician and the advanced reader. For the benefit of the beginner, more difficult sections (which do not break the continuity) are specially marked, while there are appendixes giving more advanced mathematical proofs for those able to follow them. In my opinion, this system has worked well in Vol. 3. It is a sign of the times that electrical engineers and technicians are now expected to have some knowledge of the structure of matter. The rapidity with which new materials and methods are being produced makes the acquisition of this knowledge very desirable. In this book, a very readable and accurate (to the best of my rather limited knowledge) introduction to this subject is given.

The author is, of course, an expert on valves and acquainted with recent developments. The chapters on valves are a happy blend of theory and practice, being illustrated by references to modern types, and numerical values are stressed throughout. A suggested explanation is given for the fact that oxide-coated cathodes can be used at high voltages and currents under pulsed conditions. After discussing high-frequency effects in 'conventional' valves, klystrons and magnetrons are described. Noise is given a fuller treatment than is usual in a general book of this kind. Space does not permit of more than a brief description of gas-filled devices.

This is one of the first general text-books to contain a treatment of transistors. The difficulties which beset an author writing on a subject like electronics can be seen from p. 199, where it is stated that the problems of quantity production of the germanium triode have not yet been solved'; and on p. 216 it is suggested that point-contact transistors are already in use experimentally, but the junction transistor "if it can be made in quantity, will have many important uses". I agree that there is much to be done to make cheaper and more consistent transistors in large quantities; but the above statements scarcely represent the present position. They can be understood, however, when it is observed that, although the book was published in 1955, the author's preface is dated April 1952. Interesting chapters on electron optics, cathode-ray tubes and photoelectric devices complete the book. The rationalized M.K.S. system of units is used and standard symbols, except that κ is still retained for permittivity. Needless to say, there are no 'jars'!

The book can be thoroughly recommended for any of the three classes of reader for whom it is intended. The style of writing is easy, the author seeming to be in close touch with the reader. The diagrams are clear and fulfil their purpose. C. R. Stoner

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OPTICAL INVESTIGATION OF DIAMOND SURFACES

The Microstructures of Diamond Surfaces

By Prof. S. Tolansky. Pp. viii+67+143 plates. (London: N.A.G. Press, Ltd., 1955.) 40*s.* net.

INVESTIGATIONS of the surface topography of crystals have yielded many results of fundamental significance in recent years. The observations of growth spirals on the surfaces of crystals of beryl and carborundum which were made in Prof. S. Tolansky's laboratory provided some of the first evidence to support Frank's theory of the role of screw dislocations in crystal growth. Since then, it has been realized to an ever-increasing extent that the study of the microtopography of the surfaces which result from the final stages of crystal growth and from subsequent controlled sublimation, thermal etching, chemical attack or progressive dissolution provides one of the most powerful means of deriving information about the distribution of dislocations and their behaviour in crystals.

By his development and application of a series of essentially simple—yet surprisingly powerful—optical techniques which permit the quantitative study of surface features from the coarsest down almost to molecular dimensions, Prof. Tolansky has made a valuable contribution to this aspect of the physics and chemistry of solids. He has taken advantage of the opportunity provided by the publication of this volume to demonstrate the application of his methods to the study of the structures of natural surfaces, of cleavage surfaces, and of etched, polished and indented surfaces of diamond crystals. Multiple-beam interferometry, the powerful crossed-fringes technique and the light-profile method are clearly and briefly discussed and their utility and limitations outlined. The application of each technique to a number of different problems is well illustrated, and one of the most impressive features of the volume is the inclusion of one hundred and forty-three photomicrographs of outstanding quality.

The distribution of trigons on natural surfaces of diamond and the microtopography of these features as determined by the different optical methods provides one of the main topics of the book. The author expresses the very definite opinion that the trigons have their origin in phenomena which occur during the final stages of crystal growth, and that they are not to be attributed to localized attack on the surface as a result of changing physico-chemical conditions in the medium surrounding the crystals after the conclusion of crystal growth. He illustrates the experiments on controlled oxidation with molten potassium nitrate which have been carried out in his own laboratory with a further series of fine photomicrographs. No evidence has been found for the participation of screw dislocations in the processes of crystal growth and controlled oxidation in diamond.

The cleavage of diamond is of considerable interest to the physicist, the mineralogist and the lapidary, and the observation that Type 1 diamonds which absorb below 3000 A. have an imperfect cleavage compared with Type 2 diamonds, which only begin to absorb below 2000 A., is noteworthy. It is suggested that this may be correlated with the supposed greater purity of the Type 2 diamonds. In other substances, there is also often a correlation between the perfection of cleavage surfaces and the purity of the specimens.

The chapters on the formation of ring cracks on diamond surfaces by the application of a relatively lightly loaded hemispherical diamond indenter and on the comparative properties of the different crystallographic surfaces of diamond and the state of polish which can be achieved on them, although representing only an interim report on work which is still in progress, will interest engineers and metallurgists who are concerned with industrial diamond tools and indenters.

With his adequate elementary introduction to the optical techniques, and his beautiful illustrations of their application, the author can scarcely fail in his main objective in writing this book, which was to interest as wide a variety of workers as possible in the methods for the investigation of the microtopography of surfaces which have been developed in his laboratory. J. W. Mitchell

Evolution of a Scientific View of the Universe in the Physics of the Seventeenth and Eighteenth Centuries

By B. G. Kuznetsov. (In Russian.) Pp. 344. (Moscow: Academia Nauk U.S.S.R., 1955.) 12 roubles, 25 kopecks.

THIS is the first of three volumes, published in the U.S.S.R., dealing with the emergence under the impact of science of a rational attitude in interpreting the universe. The present volume covers the age of Galileo and Newton. It is the result of careful studies of original writings: scientists of all nations are considered, and the story of their life and work is told with painstaking objectivity.

Unfortunately, the book is not so much concerned with the growth of scientific as distinct from pre-scientific thought as it is concerned with the political implications of this growth. The philosophical views of scientists are given undue prominence; they are placed side by side with the views of philosophers and other non-scientific writers and given good or bad marks by the way of appropriate quotations from Marxist authorities. All this is embedded in lengthy and incoherent narratives of political events and economic developments, submerging every finer and more subtle feature of scientific thought. The author, presumably an expert in historical documentation, seems to have only second-hand knowledge of science and is given to modes of pre-scientific thinking.

Science is presented in this book as a pitifully dull assemblage of trivial facts and outmoded speculations; unfortunately, this approach is not confined to Communist countries or to writers with Communist leanings. It is repellent to most scientists, who are in any event wary of history. Soviet scientists are not likely to take a more friendly view of a book of this kind than their Western colleagues. The present work could not even be recommended as a history of the social relations of science, although this is its main subject. R. EISENSCHITZ

Rufiji

By R. de la Bere Barker. Pp. 157+13 plates. (London: Robert Hale, Ltd., 1956.) 15*s*. net.

THIS is a simple and unpretentious account of life in the wilds of East Africa, with special reference to the birds and beasts, from hyenas scavenging around the native villages to the elephants that also come occasionally as unwanted visitors.

"One day," writes the author, "while I was resting in the shade of the high bank beside a water-hole from which we had drawn water for our tea, four elephants in file came striding up a path in the dry river bed of the Matandu River. They had a mighty thirst, and those who have experienced the scorching sun of the dry season in that land can sympathize with them. The tall elephants came right up close before they saw me and then they all made the neatest right-about-turn in complete silence. Off they went, one behind the other, just as they had come, perhaps reflecting gloomily to themselves that all the best places were being spoilt by trippers these days."

The illustrations are from most excellent photographs; for example, the plate facing p. 129, which is an aerial snapshot of a packed mass of hippopotami at rest on a mud bank. Such pictures bring home to one some idea of the teeming wild life of Africa, a wild life growing rapidly less before the advance of white settlements. Mr. R. de la Bere Barker is to be envied his long years among the creatures of this Rufiji area; the fish in the river, the snakes and other reptiles, the teeming insect throng, the innumerable birds, the many mammals, including the natives, are all described with a simple vividness that brings them to life on the printed page. FRANCES PITT

Organic Chemistry

By Prof. Lewis F. Hatch. Pp. vii+324. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 34*s*.

THIS very readable text-book is written for those, such as agriculturists and nurses, to whose main studies organic chemistry is ancillary. Prof. L. F. Hatch devotes thirteen of his twenty chapters to the more formal aspects of the science. He considers the simpler classes of compounds, the preparation of some prominent ones, and the behaviour of functional groups. His descriptions are clear and thorough, and he uses up-to-date reactions. Conforming to his plan, he does not account for chemical behaviour by the electronic theory or bring in quantitative work. His later chapters deal with such subjects as detergents, dyes, elastomers, enzymes, fats, fibres, medicinals, pharmaceuticals, and proteins. Each chapter ends with students' exercises and suggestions for further reading.

As is to be expected, much emphasis is laid on the economic and industrial application of the compounds. Whether he is discoursing on aspirin, rodenticides, or on chemicals to keep bread fresh, Prof. Hatch always makes his subject one of absorbing interest. His brightly written book, with its well-selected half-tone plates, is to be recommended to the class for whom it has been written. Moreover, the up-to-date reactions and the coverage of subjects such as petroleum and agriculture make this a suitable volume for a school science library. G. FOWLES

Bibliography on Hearing

Prepared by the Psycho-Acoustic Laboratory, Harvard University. (S. S. Stevens, Director; J. G. C. Loring, Compiler; Dorothy Cohen, Technical Editor.) Pp. vi+599. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1955.) 55*s*. net.

THIS remarkable compilation of more than ten thousand titles of publications on hearing up to the year 1952 inclusive represents a second edition of an earlier less ambitious "Bibliography on Audition", which was published in mimeographed form in 1950. In the first part of the work, titles are arranged alphabetically under the name of the first author, with cross-references in the case of multiple authorship. There is also a list of anonymous publications. Unabbreviated titles are listed in their original language, and are followed, if necessary, by a translation into English. The references are given in the abbreviations laid down in the "World List of Scientific Periodicals" (Oxford, 1934).

A classification of the subject under 315 headings is appended. The usefulness of this list is naturally limited, and its accuracy rather doubtful, as, in the majority of cases, the judgment of the compiler rests on titles only.

A glossary of abbreviations used in the references and definitions of relatively unfamiliar words, mostly from the Slavic languages, form a useful addition to a book which every worker in the field of hearing is bound to welcome as a guide to an alarmingly voluminous and widely dispersed literature.

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT

THE FIRST TEN YEARS

THE passing of the first ten years of the Atomic Energy Research Establishment, Harwell, was marked by a series of open days held in the last week of May. The last such occasion was in 1950, at which time the nuclear power programme was in its infancy and the work of the establishment was directed principally to helping the Industrial Group with the design problems of the production factories. As a result of the substantial relaxations in security classification made before the Geneva Conference on the Peaceful Uses of Atomic Energy last year, it was possible to show a large proportion of the work and the achievement of the Establishment in the first critical decade, much of it for the first time. Indeed, it proved possible to invite more than two thousand scientists and technologists from industry, government research establishments and universities to a 'University Open Day' on June 1, when visitors were able to move freely about the Establishment and select which of the exhibits they wished to see. Earlier in the week, members of both Houses of Parliament, correspondents of the international and technical Press and representatives of the surrounding district were invited to join parties touring the principal exhibits.

In the past five years the Atomic Energy Research Establishment has grown to be one of the largest research establishments in Great Britain. This rapid increase in size has been matched by a great increase in the available experimental facilities. New laboratories for the Chemical Engineering and Metallurgy Divisions have been built, and a new wing specially designed for the easy handling of highly active alpha-emitting materials has been added to the main radiochemical building. The Chemical Engineering Laboratory is of particular interest; it is a galleried building carefully designed for the speedy erection of large pilot-plant scale experiments involving active materials. In addition to BEPO and GLEEP, four other reactors are now in operation. All four new reactors are low-energy reactors primarily designed for research into the reactor physics of a particular system. Thus DIMPLE is a heavy-water reactor in which many different types of core can be built; for example, the basic design of the Materials Testing Reactor DIDO, now approaching completion at Harwell, was investigated in this reactor. Another reactor ZETR was built in order to determine the basic physics of simple types of low-energy homogeneous aqueous reactor. Of special interest are the reactors ZEPHYR and ZEUS, which are the low-energy precursors of the fast reactor experiment now under construction at Dounreay. It is especially interesting that, in the ZEPHYR reactor, experiments have revealed that, for each plutonium atom undergoing fission in the core, 1·7 atoms of uranium-233, another fissile nuclide, are produced in a thorium blanket by capture of neutrons escaping from the core.

In general, the work of the Establishment is now concerned with the basic science and technology of all the civilian aspects of atomic energy, although some assistance is given to the Weapons Group on specific problems. Thus for two years the Establishment carried out technology and feasibility studies on the prototype graphite-moderated gas-cooled reactors which are now being built at Calder Hall. The first reactor there became divergent just before the open days began, and the heat produced will be used for generating electricity for the National Grid in the autumn. Harwell has now a good deal of work to do in helping industry in the development and design of the improved power stations of this kind which are to be built by the Central Electricity Authority in Stage I of the government nuclear power programme. Among examples of this kind of work shown was the continued study of the reaction between carbon dioxide and graphite in a 'loop experiment' in the BEPO reactor.

Work is going on at Harwell and in the Research and Development Branch of the Authority's Industrial Group on the second stage of the nuclear power programme, when it is expected that plutonium from the Stage I reactors will be available to enrich reactor fuels. Reactors of two kinds are being considered for this stage: one uses light (that is, ordinary) water as both coolant and moderator; the other uses liquid sodium as coolant and graphite as moderator. The technical problems involved in either of these reactor systems require a good deal of development work, particularly on the acute corrosion problems which arise. Their main advantage over the gas-cooled type is that they have a lower initial uranium investment and may have slightly lower capital costs. It is expected that a prototype of the selected reactor will be built in about 1960, and, if they prove to be attractive economically, they might replace the gas-cooled stations in the later 1960's. The work shown on these competitive systems included the water and liquid sodium loops installed in BEPO.

Research and development work is also proceeding on reactors the potential large-scale use of which is still further off in time—the 1970's. The object here is to achieve 'breeding' in order to reduce the amount of uranium required to develop power by a hundredfold. The 'fast reactor' is the first of these. A large-scale fast power-reactor experiment is being built at Dounreay in the North of Scotland and two precursors, ZEPHYR and ZEUS, have been built at Harwell to study the breeding potentialities and the nuclear properties of fast reactors using plutonium and uranium-235 as fuel. ZEUS, which was on show during the open days, has the same physical size and design as the Dounreay reactor, but is operated at a very low power level in order to study the physical characteristics of the reactor system. A number of other advanced reactor systems are being studied. Among these is the homogeneous aqueous reactor which uses a liquid instead of a solid fuel; the liquid is likely to be a uranium salt in heavy water. Some of the work on the continuous processing problems involved in these reactors was shown in the Chemistry and Chemical Engineering Divisions. Work on other systems such as the liquid metal fuelled system and the high-temperature gas-cooled reactor was exemplified by current work in chemical engineering on the problems of dissolution in liquid metals, and in metallurgy on the fabrication of ceramic and cermet materials.

In order to carry out this programme, an extensive range of experimental and testing facilities is required. Typical of the extensive experimental facilities required for such a programme is the new wing which has been added to the Radiochemical Laboratory. This laboratory area is fully equipped for the handling of relatively high levels of alpha-activity. Flexibility, which is of great importance in such laboratories, is obtained by the use of free-standing glove-boxes. All the essential services are fed to these boxes from the roof void, and maintenance or replacement of components inside the boxes is performed in a specially designed area to which access may only be obtained in a protective rubber suit. The eight-year-old general-purpose BEPO reactor is currently being used for at least fifty experiments, and so several new reactors for specific purposes are being built. DIDO, models of which were on show, is a materials testing reactor which is expected to be completed in August. The neutron intensity thus made available will be forty times greater than that in BEPO, and development work will be enormously speeded up thereby. PLUTO is a similar reactor to DIDO except that there are extensive facilities for the testing of loop circuits installed in the reactor. LIDO is a swimming-pool reactor intended primarily to help solve the problems of reactor shielding design.

The isotope programme will also benefit from the increased flux available in reactors like DIDO and PLUTO. At the moment radioactive cobalt-60 is produced at the rate of about 12,000 curies per annum for hospitals and industry. It is expected that DIDO and PLUTO will produce about 50,000 curies of cobalt-60 per annum. Even then there will not be enough of this material to meet the rapidly expanding demand. In general the facilities for developing the applications of radioisotopes to industry are being expanded. An interesting feature of this expansion was the formation of the Technological Irradiation Group a short time ago, and some of the lines upon which the Group is developing were shown. An important feature of the work of this Group is the close collaboration with industry which is to be increasingly encouraged in the future. Stable isotopes are also produced in electromagnetic separators, two of which were shown by the General Physics Division. The latest of these to be developed has a specially designed high resolution for the heavier elements.

The very extensive supporting technology required for an atomic energy programme in all its stages was demonstrated by work going on in many of the laboratories. For example, it is very important to undertake a preliminary ore-separation at the mine, and the mineral-dressing laboratory at Harwell is investigating these difficult problems. The Electronics Division is concerned with the development of apparatus for radiometric geological survey to assist in uranium and thorium prospecting, and equipment for prospecting and assay was shown. New methods for the production of uranium and thorium metals from purified oxides are continuously under development, and work in this field and in the field of fabrication of prototype fuel elements for research reactors and reactor experiments was on view. The Reactor Division is primarily concerned with the setting up of experimental critical assemblies of uranium and moderators for all new-type reactors in the programme, and in this way the physics of the reactors can be studied. The chemists and chemical engineers were able to show a great deal of their work on the processing of reactor fuels and on the methods used in separation of the useful fission products and the disposal of the remainder. Among the most interesting examples of this kind of work were experiments designed to investigate the processing of reactor fuels by high-temperature melting, slagging and vaporization techniques. Such methods may in the long run eliminate the expensive dissolution and metal recovery stages necessary in wet reactor-fuel-processing methods. It is expected that large quantities of the recovered useful radioisotopes will be sold to industry in increasing amounts. There is also a considerable amount of co-operation with industry in the development of the important moderator and fuel element materials such as graphite, heavy water, zirconium and beryllium and in the development of the complex electronic instrumentation of the whole project. So far more than four hundred instruments have been developed by such collaboration.

In addition to the technological work of the Establishment, about 20 per cent of the staff work on fundamental research in nuclear physics, radiochemistry, solid-state physics and theoretical physics. The work in nuclear physics is concerned with the use and development of fundamental research tools such as the cyclotron and linear accelerators. The development work on proton linear accelerators and high-energy machines is, for example, concerned with the accelerator to be used as an injector, the magnet and radio-frequency power triode valve design. The first tank of a 50-MeV. proton linear accelerator with its auxiliary equipment has been completed. Other important work of the Establishment includes a long-term research programme on the possibility of controlled thermonuclear reactions. This programme is of great scientific interest since it combines the field of high-temperature and nuclear physics; but it is far away from any practical application.

A. H. S. MATTERSON

PROPULSION PROBLEMS IN HIGH-SPEED FLIGHT

By H. CONSTANT, C.B.E., F.R.S.

THE Parliamentary and Scientific Committee recently visited the National Gas Turbine Establishment, Pyestock, and inspected some of the research and development work proceeding there. The Committee was shown a general cross-section of the interests of the Establishment; but the greater part of the visit was devoted to work on the engine problems of high-speed flight.

The engines in production to-day, although basically designed for subsonic operation, are still quite suitable and effective at speeds up to about twice that of sound. All the old problems remain, of course, and many of these tend to get more difficult rather than easier. Thus, whatever the speed of flight, so long as we use a turbo-jet for propulsion, we shall have the aerodynamic problem of making compressor and turbine blading to give the greatest energy conversion for the lowest losses, with characteristics producing a stable and flexible engine; we shall have the problem of developing the greatest possible heat release in a combustion chamber of restricted frontal area, while maintaining a low pressure loss and a sufficient range of stable operation under all conditions of flight; and we shall have the problem of so disposing of the material with which the engine is made that every ounce of it is stressed right up to the maximum safe limit, bearing in mind all the vibratory and transient loads to which it may be subjected. We have, and always have had, these problems, to name but a few of the many which define the development background of the gas turbine. Examples of the work being done on these subjects were shown to the Committee.

Now, however, that the speed of flight is moving deeper into the supersonic range, a set of problems which are either quite new, or which have only so far given us a glimpse of their full capacity for causing trouble, are beginning to arise. Of these new problems, probably the most difficult to assess fully with our present limited experience is that of engine control. In the jet engine of to-day, the number of independent variables can be made sufficiently small to justify the practice of designing control systems by trial and error. But in an engine designed to operate over a wide range of speeds up to, say, three times the speed of sound, it will be necessary to introduce a number of new variables each of which will need controlling to suit the environment of the engine. In the first place, the swallowing capacity of the intake does not vary with aircraft speed in the same way as does that of the engine, It is, therefore, necessary to adjust the geometry of either the intake or the engine in order to match their capacity to pass air. Our present thoughts are that the intake should be adjusted as the flight speed changes, since an adjustment to the engine would be less easy to make. A similar adjustment to the capacity of the propelling nozzle to pass exhaust gases will have to be made when extra thrust is obtained by reheating, that is, by burning fuel in the exhaust pipe. This adjustment will involve the awkward process of changing the throat area of the nozzle. At high supersonic speeds it is necessary, if the highest thrusts are to be developed, to use a nozzle of a convergent–divergent shape, like an hour-glass in cross-section. If efficient and stable operation is to be obtained over a wide range of flight speeds, the outlet area of this nozzle must be made variable. This quite complex mechanism must be so designed that leakage past the movable parts is small, and cooled so as to operate satisfactorily when passing gas at a temperature of 2,000° C.

Thus a movement of the pilot's throttle, in addition to regulating the rate of admission of fuel to the main engine, and to the reheat system separately, must also control the air-intake and, in two degrees of freedom, the exhaust system as well. These controls will need to be cross-linked to a function of the aircraft speed. One of the principal difficulties anticipated here is likely to occur as a result of a sudden movement of the pilot's throttle. For if the rate of response of the engine to the various changes being made to its environment has not been correctly judged, complete loss of control may result. The Committee was given a demonstration of an engine being operated so as to give the response-rates on which a rational control system could be based.

Another difficulty that we know will become formidable at the higher flight speeds arises from the fact that the intake air will, at these speeds, be becoming uncomfortably hot. Due to the motion of the aircraft there is a rise in temperature of the air in the intake which is proportional to the square of the speed of flight. As a result of this, the temperature of the air at the engine intake increases rapidly with speed, and at 2,000 m.p.h. in the stratosphere will be as much as 350° C. After entry the air will be further compressed and would enter the combustion chamber at around 500° C. The thrust that can be obtained from an engine depends very much on how much heat can be added to the air after it has entered the combustion chamber, and this is controlled by the limits set to the temperature at exit from this chamber. At present this exit temperature is limited to about 900° C. by the materials used in the blading of the turbine. Thus the temperature rise in the combustion chamber in the example quoted above will be only 400 deg. C. This would result in a very inadequate output of thrust. The most effective way of overcoming this disability is by cooling the turbine so that the limit of gas temperature at present fixed by the properties of the material used can be raised. If, for example, the turbine can be cooled by air so that the temperature of the gases entering it can be raised from 900 to 1,200° C., then the temperature-rise in the combustion chamber would go up from 400 to 700° C. and a very considerable increase in thrust would result (about 70 per cent).

Thus, as the speed of flight increases, although the thrust requirements of the aircraft also increase, the thrust available from the engine would actually decrease if its maximum gas temperature were maintained constant. This limitation can be overcome by cooling the blades and other surfaces of the turbine so that the gas temperature can be raised without the temperature of the metal exceeding a safe limit. This process can be continued until the temperature of the cooling air, which has to be drawn from the engine, becomes so high that it can no longer act effectively. It is difficult to cool with air at 500° C. when this imparts a dull red heat to the surfaces which it scrubs ! When this limit is reached, further progress can be made by refrigerating the air before it is used for cooling; but this process involves an increase in both weight and drag. The Committee was shown a heat-transfer cascade tunnel, which has been used for providing the basic data on cooling, and a turbine designed in the light of these data, which has been operating during the past few years at temperatures as high as 1,100° C.

No very clear picture of the behaviour of a gas turbine can be obtained until its major components —its compressors, turbines and combustion chambers —have been tested separately under as wide a range of conditions as possible. From the results of such tests of components, it is possible not only to predict the performance of the complete engine but also to visualize profitable lines of development for improving the performance. Such tests as these have already become routine for engines designed for subsonic flight. They will be all the more necessary under the more arduous conditions already being experienced at high speeds. The Committee was shown tests being made for industry on compressors and combustion chambers destined for jet engines for high-speed flight, and was given demonstrations of some of the hazards involved in the testing of complete engines under simulated conditions of high-speed flight at altitude.

There is no doubt that the attainment of speeds of around 2,000 m.p.h. will pose plenty of problems for the propulsion engineer; but clear ways through these difficulties are already beginning to open up.

WHY LABORATORY ANIMALS DIE

DURING April 11–13 there were two meetings at the Royal Veterinary College, London. On the first two days the Laboratory Animals Bureau held its ninth annual congress of animal technicians ; and on the third day a symposium on infections in laboratory animals attempted to summarize current problems in this field.

The symposium was the fourth to be held, and its main audience consisted of graduates, in contrast to the congress. The fact that such meetings continue to attract attention each year is of interest in itself, indicating that the animal house is no longer considered unworthy of scientific consideration, although in many cases it still attracts too small a proportion of the laboratory budget.

To compare laboratory animals with chemical reagents is an analogy that has become hackneyed and, if followed too far, is misleading. Reagents they may be to the biologist, but they have characteristics distinguishing them sharply from the inanimate substances with which the chemist has to deal. They are not inanimate but living ; and they are not a homogeneous mass but distinct individuals, however nearly the ideal of individual similarity or uniformity may be approached.

Laboratory animals are thus exposed to one especial hazard, namely, accidental intercurrent infection. As a result of this hazard the animal may die, or the group lose any degree of uniformity it may have possessed before infection or might be expected to possess without it, and then its value as a reagent is diminished or destroyed. The deaths from intercurrent infection are not accurately known except in those laboratories where careful records are kept—and there are too many where they are not. A. A. Tuffery, speaking at the symposium on epidemiology and laboratory mice, and Dr. J. S. Paterson, in his paper on the control of infection in rabbits, both indicated that such losses are far from negligible, and may on occasion be disastrous ; nor can a remedy be proposed in the absence of more detailed recording of incidental losses and their analysis and investigation. This point is to-day widely, if not universally, appreciated, and to recognize a problem is the first stage towards its solution.

The problem is not an exclusively veterinary one. The emphasis in every paper was not so much on the treatment of infection as an untoward experience of individual animals, but on its prevention, control and elimination. Prof. W. L. Weipers, in his paper on the control of infection in laboratory cats and dogs, particularly stressed this approach, as did Dr. R. F. Gordon, speaking on the control of infection in laboratory poultry. A more particular approach was indicated by Dr. M. H. Salaman, who has examined vaccination as a method for the control of ectromelia in mouse colonies ; and by Dr. Joan Taylor, who dealt with the commonest, and therefore the most important, of all infections—*Salmonella* infection in laboratory animals. Dr. B. Moore and Dr. A. P. Goffe spoke respectively on infection in laboratory guinea pigs and infections in laboratory monkeys. Indeed, four out of eight titles included the word 'control', and all had a decidedly epidemiological twist. The same theme was emphasized by the chairman, Prof. J. W. Howie, who also added that non-bacteriologists might perhaps with advantage learn to attribute some of their losses, if recorded, to infection rather than to the natural tendency of animals to die.

That laboratory animals do die when they are required to stay alive is beyond dispute. The proportion of those born that fail to survive to weaning age may in some species, for example, rats and rabbits, be as much as one-fifth, or more. Nor are serious losses confined to the nursing period ; disease may take its toll on occasion at any age. That the wastage should be so high in rats is alarming ; yet very little was mentioned at the meeting about infection in rats, for the reason that very little appears to be known. Something is known about rabbit diseases, but not enough to prevent serious infantile losses. Mouse colonies have been the subject of many classical epidemiological experiments, and some thirty or more incidental infections of mice have been described, four of which are of outstanding importance (ectromelia or mouse pox, salmonellosis, focal necrosis of the liver or Tyzzer's disease, and infantile diarrhœa). Yet, of two out of these four the ætiology is unknown or uncertain, in one the infection is extremely widespread if not universal, and in one only is there any prospect of real control through vaccination.

The situation with regard to guinea pigs is better, for their bacterial diseases at least have been studied in some detail ; but new light has been thrown on their possible mode of transmission through the conjunctiva or, possibly, the upper respiratory tract. Nutrition and other environmental factors probably play an important part in the diseases of monkeys, which in any event are too numerous and serious for any degree of complacency. The problem of keeping a considerable number of cats in one place without the serious risk of devastating outbreaks of disease is still unsolved, although much is known about the commoner diseases of this species. Dogs present fewer such problems, perhaps because of the great competence of the veterinary profession with respect to them.

A decade ago, certainly two decades, meetings of this kind might have passed unattended and unnoticed. To-day, the Laboratory Animals Bureau does not lack encouragement to continue to make both the symposium and the congress annual events.

The attendance at the congresses numbers regularly nearly two hundred, and the high standard of contributions by technicians is maintained year after year. Of particular interest this year was the paper by Dr. J. F. D. Frazer on some aspects of the breeding of laboratory animals, in which he pointed out the effect on the natural functions of the animal, especially on breeding, of such environmental factors as light, heat, diet, cage-size and design, quality of care and much besides. He was addressing technicians, animal technicians for the most part, and he seemed to be inviting them to make their own contributions to knowledge of animal care and good husbandry.

This brings up a point of more than trivial interest. The term 'animal technician' first achieved formal status six years ago, when the Animal Technicians Association was founded. After six years it is time for it to be generally adopted and for the older terms applied to animal house staff to be dropped. The grade of animal technician is recognized by many employing authorities, such as the Medical Research Council, which have undoubtedly learned that good animal technicians mean good animal material for research and investigation. Some universities recognize the grade, but others do not; the National Health Service does not, nor is the animal technician represented on the Whitley Council. Where recognition has occurred, it has been found to pay in terms of better animals, better work and (if costs are known) less extravagance through avoidable wastage. Why, then, are some employing bodies reluctant to follow the excellent lead given by others? No animal houses in Great Britain are so bad that they could not be worse; but many are not so good that they could not be better if unskilled labour were to be gradually replaced by qualified animal technicians.

Although we may regard our standards in Britain with some satisfaction (but with no complacency), too many laboratory animals still die of infection. Some of this wastage could be prevented by more skill employed in their care and management; by the application of existing knowledge of laboratory animal diseases, and by the investigation (mainly epidemiological) of diseases still imperfectly understood.

The symposium will be fully reported in Laboratory Animals Bureau Collected Papers, Vol. 4 (obtainable from the Bureau at the Medical Research Council Laboratories, Holly Hill, London N.W.3). The Congress will be fully reported in the *Journal of the Animal Technicians Association* (obtainable from the honorary secretary of the Association, Mr. A. E. Mundy, 5 Ouse Bridge Drive, Carlton, Notts).

W. LANE-PETTER

FOOD TECHNOLOGY AND NUTRITION

THE 101st meeting of the Nutrition Society (the 46th meeting of the Scottish Group) was held in the Biochemistry Department of the University of Edinburgh on April 28, under the chairmanship of Prof. G. F. Marrian, when the subject of "The Impact of Food Technology on the Nutrition of Man and Animals" was considered. In opening the meeting, Prof. Marrian stressed the enormous importance of the topic under discussion, since so much food is processed. As one speaker pointed out, if it is accepted that food processing includes all treatment received by a foodstuff from its point of origin to the point in space and time when it is consumed, then barely 2 per cent of our food expressed in terms of calories receives no processing. Prof. Marrian also referred to the bigger and almost frightening problem of world food production, and suggested that the topics to be discussed that day warranted consideration over at least several days.

The first paper, on food processing and nutritional values for man, was by Dr. H. R. Barnell and Miss D. F. Hollingsworth, of the Ministry of Agriculture, Fisheries and Food. Miss Hollingsworth, who read the paper, pointed out that the application of heat to starch is essential for its digestion; that excessive heating of fat may cause production of acrolein; and that proteins are sensitive to the application of excessive heat and to the removal of heat. Starch, sugars and proteins in foods are not normally affected by atmospheric oxygen; but powerful oxidizing agents may have an effect. Fats may become rancid on storage, particularly in the presence of air. Rancidity may also be caused by the activity of micro-organisms. Development of oxidative rancidity is affected by temperature, light, moisture and by traces of various minerals (cobalt, copper, iron and manganese) and can be controlled by addition of antioxidants. Rancidity, besides reducing the value of fat, has adverse nutritional side-effects. Of the fat-soluble vitamins, vitamin A is relatively stable to heat if oxygen is excluded. Light also accelerates oxidation. Vitamin D is moderately stable to heat, light and oxygen. Vitamin E is fairly stable to heat but is destroyed during development of oxidative rancidity in fats. Riboflavin and nicotinic acid are more stable to heat than vitamin B_1, which is the most labile of the B complex. Riboflavin is unstable to heat and light. Vitamin C is unstable in presence of oxygen and is destroyed in sunlight.

It is possible that a combination of light, heat treatment and a radiation sterilization treatment will give eventually more attractive products than those produced by present methods. While on the whole it is true that the effects of processing on the nutrients in foods tend to give an impression of losses of nutrients whenever a food is given any form of treatment, it was emphasized by Miss Hollingsworth that the processing of foods is to a large extent a necessity to make them edible and palatable, transportable and storable. The final result is therefore greatly to increase the supply of nutrients to the world's populations.

Dr. J. M. Barnes, of the Medical Research Council's Toxicology Unit, followed next with a paper on the potential toxicity of chemicals used in food technology. He mentioned that many of the substances used as food additives possess no outstanding toxic property; others which may be used as adjuncts in processing or preservation may be toxic, but are present in the food only in very small quantities. The study of non-toxic substances resolves itself into the problem of trying to prove a negative.

Food manufacturers and allied commercial interests are so aware of the problem of toxicity that Dr. Barnes considered it unlikely that any material with demonstrable toxic properties will ever be included in food prepared in accordance with reputable trade practices. However, these may appear in food in trace quantities as the result of current practices such as compounds with well-marked toxic properties and active as insecticides, fungicides, germicides or endowed with other special properties. A safe dose is one which the body can dispose of without harm to its normal metabolism. Difficulties arise when no clear-cut toxic response occurs with larger doses. There are some who suggest that in some unspecified way the prolonged consumption of such substances over long periods may injure health. It has been shown that, in the case of certain toxic substances, the disposal of small non-toxic doses may be quite different from that used when larger quantities are given.

Dr. Barnes illustrated the biological complexities by reference to maleic hydrazide, a potato sprout depressant which produces inhibition of plant growth at concentrations of a few parts per million, and yet rats and other animals will grow and thrive on a diet containing as much as 1 per cent of it. When used properly, residues of 10–15 p.p.m. may remain in the potatoes at the time they are consumed. It has been suggested by the work of Waggoner and Dimond that maleic hydrazide exerts its effects on plants by stimulating the enzymic hydrolysis of indole acetic acid, so depriving the plant of this auxin. But cytological changes include chromosome splitting. As many carcinogenic substances have a similar effect on mammalian cells, it has been suggested that maleic hydrazide should be tested for its carcinogenic effects before being used for human consumption. The uniformly negative result of tests on mammals suggests that maleic hydrazide on potatoes in 10–15 p.p.m. would not be harmful, though it does not amount to *proof* that it would be entirely safe. The steam volatility of another sprout depressant, tetrachloronitrobenzene, during cooking indicates that the physical and chemical properties of substances added to food play as important a part as the biological properties in determining whether a health hazard will be associated with their use.

While there are comparatively simple acute tests which seem adequate for distinguishing powerful carcinogens, a definition of a 'weak carcinogen' has not been provided. Surface-active agents may have interesting biological effects; but whether or not these effects will be shown if the emulsifiers are added to bread has not yet been determined.

Not only may the chemicals added to food become altered, but so too may the food itself and the products of such reactions might be toxic. The classical example is the agene process of improving flour. Agenized flour is toxic to dogs, cats, rabbits and ferrets, but rats and monkeys are relatively insensitive. Dr. Barnes quoted experiments in the United States on nineteen humans, including five epileptics, who were given flour treated with 20–30 times the usual quantity of agene but without showing any change in behaviour, general physiology or electro-encephalogram. The monkey requires at least a hundred times the dose of the active toxic agent, methionine sulphoximine, needed to induce fits in the dog. A man eating 2.000 Cal. per day as agene-treated flour ingests a dose of 1 mgm./kgm. methionine sulphoximine; the sensitive dog requires a dose of 2–4 mgm./kgm. to produce fits and kill the animal. The nature of the toxic action of methionine sulphoximine has not been defined: species differences may be due to speed and ability to dispose of the toxic substance.

Where no positive effects can be observed on animals with a given substance, then a hypothetical risk may be incurred if such a chemical is added to food. In Dr. Barnes's view, this should in some way be balanced by the simultaneous conferment of some benefit to those who incur this risk.

Mr. N. W. Pirie, of the Rothamsted Experimental Station, in his paper on unexploited technological possibilities, pointed out that the three outstanding possibilities for increased food are: the synthesis of food, the more economical use of crops of the type we already grow, and the exploitation of new primary sources of food. In his opinion we would continue to rely mainly on photosynthesis rather than on synthesis of the bulk foods. Few people get less than half their energy from vegetable sources, and most of the world's population gets nearly all its energy in this way. One solution of the food problem would therefore be to increase the amount grown.

Diets eaten in many parts of the world are inadequate, having many faults; protein deficiency being a common one. Some legume seeds contain adequate amounts of protein; but many tubers such as cassava contain very little. Many leaves, which can now be stored by refrigeration, contain as much nitrogen as the legume seeds. Investigation of systems of husbandry that would ensure large yields of protein-rich and fibre-poor leaves is a technological possibility that deserves fuller exploitation. Even normally despised grasses would be useful if grown regularly with 25–30 per cent of protein.

The protein in the leaf is already there and valuable, needing only separation from dilute carbohydrate. Since the time of Rouelle (1773) it has been extracted from leaves and coagulated. The pulper described by Mr. Pirie is the end-product of much experiment, and is reasonably satisfactory in separating juice from fibre. The protein can be precipitated from the juice by letting it age, by heating to 75° C., by adjusting *p*H to about 4 or by shaking it with a variety of water-immiscible liquids. Different preparations vary somewhat in digestibility, and the reasons for this are being investigated. Mr. Pirie thinks it wise to postpone careful feeding-trials until this phenomenon is more fully understood; but he stresses the need for a much more adequate scale of research in this important field. He considers it illusory to believe that algae, such as *Chlorella*, are peculiarly efficient at trapping light and giving a greater return per acre-year than other crops.

The sea is an under-exploited environment, and both the harvesting of marine microflora and the use of the material harvested are ripe for technological investigation. Mr. Pirie believes that, if Britain cannot continue to buy its food from the rest of the world, it must come to live on its own acres and then it must change its style of eating.

In his account of some technological developments of importance in animal nutrition, Dr. J. Duckworth first pointed out that most of the common energy sources are often too low in protein for productive purposes and must be supplemented to secure appropriate ratios of metabolizable energy to digestible protein. All protein-rich supplements are expensive, relative to the basic energy sources, and thus minimum feeding costs are realized only when supplements are added at the level that justifies the animal's needs. In practice, a margin of safety must be added, and the greater the uncertainty about the dietary protein the greater this margin must be. Sources of uncertainty are: variation in protein content among different batches of individual feeding-stuffs, variation in amino-acid composition within the total protein content, natural variation in protein digestibility, and variable effects of processing on protein quality, defined in terms of digestibility and of metabolic availability of certain important amino-acids of the digested protein. An independent source of uncertainty is variation in the metabolizable energy of feeding-stuffs disturbing the nutritive ratio.

Important features of research and technical development are studies on processing to obtain by-products of uniformly high protein value, of the inheritance of desirable amino-acid levels in feed proteins, of the synthetic production of amino-acids and of applying nitrogenous fertilizers to raise the protein content of crops of high-energy content.

In Britain there is the problem of making efficient rations for the livestock with feeding-stuffs of diverse and fluctuating origin and kind. The nation is dependent on the technological capacity of manufacturers abroad; for example, half the national supply of protein concentrates was imported in 1953 and 1954. In 1955 there was a large increase in supplies, mainly of imported oilseed meals. So far, continued Dr. Duckworth, little research on the nutritive value and still less on local processing methods has been published from most sources of these feeding-stuffs. Processing has generally a profound effect on the nutritive value of protein concentrates and, if inadequately controlled, yields highly variable products. Only on fish, herring, soya-bean and cotton-seed meals has extensive research been done, and then almost entirely from the point of view of suiting the products to non-ruminant needs. A recent trend has been to process oil-seed meals for high solubility of protein. Such materials are contra-indicated for ruminants under preferred British feeding systems. Attention is now being given to developing rapid laboratory tests of protein quality. If success is attained, an appropriate amendment of the Fertilizer and Feeding Stuffs Act would give protection against low-value protein concentrates of domestic or imported origin, and thus lead to more efficient compounding of rations.

Many members and visitors took part in the discussion which followed.

SCIENCE HOUSE, PAKISTAN

The visitor to Pakistan cannot fail to be impressed by the rapid scientific development which is taking place there. The science departments in the older universities are expanding; new universities have been created in Sind, Karachi, Peshawar and Rajshahi; the Central and three Regional Laboratories of the Pakistan Council of Scientific and Industrial Research have been established, and important research institutions, such as the Cotton Research Institute, the Jute Research Laboratory, the Pakistan Standards Laboratory and others, have come into being during the past three years. The new buildings, many of which have been completed, are very impressive. The sites are spacious and convenient, and the buildings, of pleasing design, have been planned with imagination and foresight. There is ample accommodation for many years to come, and expansion will not be hampered by considerations of space. These institutions have been provided by the State, and are a reflexion of the importance attached by the Government to the part which science must play in the development of the country.

The Pakistan Association for the Advancement of Science was founded in 1947, and has been very active, having started the publication of Pakistan's first scientific journals—the *Pakistan Journal of Science* and the *Pakistan Journal of Scientific Research*—and organized the annual All-Pakistan Science Conferences.

A new development of great importance has just been launched. The foundation stone of the Ismail Aiwan-i-Science (Science House), Lahore, was laid on January 27, 1956, jointly by Mr. Nasser Ahmad Shaikh, and the representatives of science associations from Australia, China, India, Pakistan, the U.S.S.R., the United Kingdom and the United States.

Science House will be the integrating centre for science in Pakistan. It will contain a large science library and a bibliographic, translation and documentation centre equipped for microfilming and duplication. There will be an auditorium to seat a thousand persons. There will be accommodation for a Human Relations Research Centre, which will be concerned chiefly with social science research. Science House will also contain office accommodation for the various scientific societies, together with seminar and committee rooms, and a press and publications section for the various scientific societies and organizations. There will be residential accommodation for visiting scientists, club rooms and a cafeteria.

The building is situated in the new modern residential centre of Lahore, adjacent to the new Regional Laboratories of the Council of Scientific and Industrial Research, and close to a number of important educational institutions and the proposed new site for the University of the Panjab.

This magnificent project was conceived by Dr. Bashir Ahmad and his colleagues, and has been made possible through the generosity of Mr. Nasser Ahmad Shaikh, a leading industrialist in Pakistan, who has provided the funds for building Science House.

The new building will be completed early in 1957, and the next annual meeting of the Pakistan Association for the Advancement of Science will be held in it.

George Allen

OBITUARIES

Dr. Walter Sydney Adams, For.Mem.R.S.

Walter Sydney Adams, the son of a missionary, was born in Antioch in northern Syria on December 20, 1876. He was educated at Dartmouth College and the Universities of Chicago and Munich, and was appointed an assistant at the Yerkes Observatory under Hale in 1901. In 1904 he was one of the small staff which went with Hale to Mount Wilson to start the new Observatory in California. As assistant astronomer, as assistant director, as acting director during Hale's illness, and from 1923 onwards as director, he devoted his life to the Observatory until his retirement in 1946. As a research associate of the Carnegie Institution of Washington and of the California Institute of Technology, he continued working on astrophysical problems, his last paper on the shell star α Orionis appearing in the March issue of the *Astrophysical Journal* this year. He died on May 11, 1956.

Adams's earliest publications were on line-of-sight velocities of stars, on spectroscopic binary orbits, on stars of variable velocity and on details of spectrographs and allied instruments in use in the Observatory. He showed an early interest in the spectra of novæ, in the characteristics of sunspot spectra and in the comparison of centre and limb spectra in the Sun. His measurement of solar rotation at different levels in the solar atmosphere showed that the higher strata rotate faster and with a smaller equatorial acceleration than the lower strata. His next major contribution to astrophysics, the one for which the Gold Medal of the Royal Astronomical Society was in large part awarded in 1917, was the spectroscopic determination of stellar parallaxes. The first paper with Kohlschütter on the criteria provided by varying relative strengths of spectral lines for determination of absolute magnitudes of stars appeared in 1914. Afterwards Adams extended the work to cover a much wider range of spectral types and he published spectroscopic parallaxes of thousands of stars. His work led to a direct probing of the galaxy to far greater distances than had hitherto been possible except by statistical methods.

Among much other work of his mention must be made of his analysis of high-dispersion spectra and the calibration of Rowland's scale of intensities; in novæ he noted the simple 1 : 2 : 3 relations between the velocity displacements of successive outbursts: high-dispersion spectra enabled him to detect as many as five clouds of interstellar gas in the same direction in space moving with different line-of-sight velocities. Adams also both detected the white dwarf nature of the companion to Sirius and afterwards the relativity displacement to the red of the lines in its spectrum—a displacement of +19 km./sec. as compared with Eddington's predicted value of +20 km./sec. at λ4500.

Adams was president of the Astronomical Society of the Pacific and later of the Astronomical Society of America. He was vice-president of the International Astronomical Union during 1935–49, keeping the Union alive during the Second World War. He was the senior associate of the Royal Astronomical Society, a foreign member of the Royal Society and a corresponding member of many other national academies. He was awarded the Draper Medal and the Bruce Medal in America, the Prix Janssen and the Janssen Medal in France as well as the Gold Medal of the Royal Astronomical Society. In his death the astronomical world has lost a much loved and widely revered leader. F. J. M. Stratton

Mr. P. W. Wood

It would seem strange to anyone in Cambridge to speak of Philip Worsley Wood in any other way than as "P. W.". His passing is a great loss to Cambridge and especially to Emmanuel College, as was that of his namesake Alex. a few years ago. Born in April 1880, he matriculated and entered Emmanuel in 1899.

To one who was his exact contemporary, the passing of "P. W." comes as a reminder that the ranks of those who took the Mathematical Tripos Part I in the days when there was an order of merit are becoming very thin. In 1902 he was Third Wrangler, bracketed with H. A. Webb. In 1903 he was placed in Class I, Division 2 in Part II of the Tripos, and in the next year was awarded a Smith's Prize.

"P. W." had in a high degree that facility in the solution of ingenious problems which counted for so much in the Tripos of that day. But it was not the kind of outlook for which the times were asking. With the passing of the old Tripos, mathematical fashion was for connected theory, ever widening in scope and in new points of view. Thus Wood became one of that band of teachers who held the fort for that wide range of students for whom mathematical research lay beyond their reach. As such he was an outstanding member of his College and of the Faculty. To his pupils he was devoted, meticulous and challenging. Though he retired at the age of sixty-five under the age limit, he went on teaching for the love of it until the day when he was overtaken by the illness which led to his death ten days later.

Being what he was, his original work was limited. The best known was his Cambridge Tract on "The Twisted Cubic". Not so well known was a series of papers in the London Mathematical Society *Proceedings* on algebraic invariants.

His activities turned early to College administration. A Fellow of Emmanuel for fifty-one years, he served for thirty-five years as lecturer in mathematics, for twenty-six years as librarian and for seventeen years as senior tutor, besides acting for some periods as vice-master. In University affairs he was not so prominent, though he was a junior proctor in 1917–18 and was for many years a much-valued member of the Local Examinations Syndicate.

As a man, "P. W." cannot be put into any class. He was just himself—kind and appreciative but caustic and terse in conversation, diligent in all that he undertook, working hard for little reward. Having no ambition but to serve well, he lived to serve.

Some would say that his hobbies were lawn-tennis and gardening. But truly his College was his hobby and his absorbing pursuit. His home and garden were places of renewal in the companionship of his wife, his two sons and his daughter. Is it possible that he shared with them, as he did with me, in the year 1944, the discovery that that number is just $3^5 \times 2^3$? Ebenezer Cunningham

Dr. M. A. Whiteley, O.B.E.

Martha Annie Whiteley was born on November 11, 1866, and received her early scientific training at Royal Holloway College, London, where she graduated in 1890. During the following twelve years she held appointments as science mistress at Wimbledon High School, lecturer in science at St. Gabriel's College, Camberwell, and lecturer in physical chemistry at Royal Holloway College. During the last few years of this period, from 1898, she also carried out part-time research at the Royal College of Science, and in 1902 she obtained the D.Sc. degree of the University of London (her examiners at the oral examination being Ramsay and Frankland), and in 1903 the diploma of associateship of the Royal College of Science. In the following year Tilden appointed her to be a teaching scholar on the staff of the Royal College of Science, and she was promoted assistant in 1905, demonstrator in 1908 (by which time the College had become part of the newly constituted Imperial College of Science and Technology), lecturer in 1914, and assistant professor of organic chemistry in 1920.

Her first paper, in 1900, on "The Oxime of Mesoxamide", set the pattern of her research activities on derivatives of malonic acid and barbituric acid. During the First World War, her specialized knowledge in this field enabled her to play an important part in the development of methods for the synthesis of urgently needed drugs, and she also carried out investigations on lachrymatory war gases ; for these services she was made O.B.E. She will, however, be particularly remembered for her teaching, which she greatly enjoyed. At the time of her retirement from Imperial College in 1934 she said, "When I first came to the College in 1898 I little thought to find my life's work here as a member of the teaching staff, but my love for teaching has made it seem all too short. No one who has not passed through an experience such as mine can understand the fascination which is involved in the constantly changing types of students and the human interest attaching to them". She took a particular interest in the women students, and was largely responsible for the foundation, in 1912, of the Imperial College Women's Association, of which she was president for many years. Earlier (1904–8) she had taken a leading part in efforts, unsuccessful at the time, to secure the admission of women to fellowship of the Chemical Society ; it was highly appropriate that in due course she should become the first woman to be elected to its Council (1928–31).

During the many years she spent at Imperial College, Dr. Whiteley formed a connexion with "Thorpe's Dictionary of Applied Chemistry" which in later years was to become a source of great happiness to her. She had been associated with Sir Edward Thorpe and with Sir Jocelyn Thorpe in the production of the second and third editions, and after her retirement in 1934 she continued to work on supplementary volumes and on the preparation of the fourth edition, the first volume of which appeared in 1937. After the death of Sir Jocelyn in 1940, she became editor-in-chief, and despite inevitable war-time restrictions and personal difficulties, which included the destruction of her home in an air-raid, the work went on. In the years since the War, her physical health deteriorated, but her mind remained as clear and alert as of old, and with her indomitable will she continued to edit scripts and to read every word of galley and page-proof ; it was rarely that an error escaped her. Volume XI, which, apart from a general index, was the last of the fourth edition, appeared in 1954, and the completion of this considerable undertaking gave her much satisfaction, inevitably tinged with some sadness. Her health now became progressively worse, and she died on May 24, 1956, in her ninetieth year.

Martha Whiteley's concepts of duty and service, and her way of life, were sustained by her Christian beliefs ; her memorial is in the respect and affection which she engendered in generations of students, colleagues and friends. L. N. Owen

NEWS and VIEWS

Royal Meteorological Society : Napier Shaw Memorial Prize

At the meeting of the Royal Meteorological Society on June 20 the president, Dr. R. C. Sutcliffe, announced that the first award of the Napier Shaw Memorial Prize of the Royal Meteorological Office had been made to Dr. Norman A. Phillips, of the Institute for Advanced Study, Princeton, for his paper, "The General Circulation of the Atmosphere : a Numerical Experiment", which was published in the April issue of the Society's *Quarterly Journal*. This Prize has been established as a result of an appeal to the members of the Royal Meteorological Society and to scientific instrument manufacturers for a memorial fund to commemorate the unique position achieved in meteorology by Sir Napier Shaw, the centenary of whose birth fell on March 4, 1954. It was decided to use this fund for the regular award by competition every two or three years of a Napier Shaw Memorial Prize of £100 for original essays on meteorological topics. The first competition was announced in 1954, the topic selected being "The Energetics of the General Circulation", and entries were open to anyone without restriction of nationality.

Chemistry at Hull : Prof. N. B. Chapman

With the appointment of Prof. Brynmor Jones to the vice-chancellorship of the University of Hull (see *Nature* of January 21, p. 116), the G. F. Grant chair of chemistry at Hull which he has vacated has been filled by Dr. Norman B. Chapman, reader in chemistry in the University of Southampton. Dr. Chapman was educated at the Holgate Grammar School, Barnsley, and Magdalene College, Cambridge, where he was successively scholar, research student and bye-Fellow, being University demonstrator during 1945–46. While at Cambridge he carried out research on oxidation by peroxidase systems, and on chemical warfare and anti-malarial agents. Early in 1947 he went to Southampton, becoming successively lecturer in organic chemistry, senior lecturer and, in 1955, reader. In Southampton he has built up a strong school of research with two principal lines of work : a study of the kinetics of many organic reactions, including the substitution of halogens in aromatic and heterocyclic ring systems ; and the synthesis of nitrogen-substituted halogeno-ethylamines, histamine derivatives, and other substances of potential pharmacological importance. He has a wide knowledge of physical as well as of organic chemistry, and among many other interests are cricket, rugby football and opera. The warmest wishes of his many friends at Southampton and elsewhere go with him and his wife to Hull.

Chief Colourist of the Dyestuffs Division, Imperial Chemical Industries, Ltd. : Dr. T. Vickerstaff

Dr. T. Vickerstaff has been appointed chief colourist of the Dyestuffs Division of Imperial Chemical Industries, Ltd., in succession to Mr. G. O. Mitchell, who has retired after thirty-seven years of service with the company. After leaving the University of Manchester, Dr. Vickerstaff joined Imperial Chemical Industries, Ltd., in 1935, and was at first engaged in work on problems of dyeing wool, which was carried out in the University of Leeds. This was followed by a short period at the Huddersfield Works of the Dyestuffs Division, and then in 1937 he was transferred to the Dyehouse Department at Hexagon House, which is the administrative headquarters of the Division in Blackley, Manchester. He became closely associated with the work of the newly formed Dyeing Research Section of the Dyehouse Department and was appointed head of the Section in 1942. During this period he made valuable contributions to the study of colorimetry and became a leading member of the Colour Group of the Physical Society. Overlapping with his work on colorimetry he has made a number of fundamental studies of the physical chemistry of dyeing. His text-book, "The Physical Chemistry of Dyeing", is now in its second edition, and moves are afoot to translate it into German and Japanese. In 1942 Dr. Vickerstaff was awarded the Research Medal of the Society of Dyers and Colourists as senior author of the paper "The Dyeing of Acetate Rayon with Dispersed Dyes". He was appointed an assistant chief colourist of the Dyestuffs Division in 1949.

Colleges of Advanced Technology

An extensive building programme, to start next year, in connexion with technical studies in the universities, estimated to cost about £4,500,000, was announced during a debate on technical education by Mr. R. A. Butler, Lord Privy Seal, in the House of Commons on June 21. The new buildings are to be dedicated not only to engineering and branches of technology, but also to basic sciences, especially physics and chemistry. The sum announced represents only the contribution of the Exchequer, and does not include other sums which might be contributed by industry or by the universities themselves. These colleges are in future to be designated colleges of advanced technology, and conditions for such designation were circulated on June 21 by Sir David Eccles, Minister of Education, to local authorities. The circular outlines the present organization of technical colleges, and suggests how each kind of college can best contribute to the Government's five-year plan for technical education. Regional co-ordination is essential to the success of this policy, and the Minister asks the local education authorities to co-operate fully with one another. He considers it important that the smaller technical colleges should develop as speedily as possible into colleges of technology.

In the House of Commons on June 21, the Minister named those colleges which will be recognized as advanced colleges of technology. They are: Birmingham College of Technology, Bradford Technical College, Cardiff College of Technology and Commerce, Loughborough College of Technology, The Royal Technical College, Salford, The Battersea Polytechnic, London, The Chelsea Polytechnic, London, The Northampton Polytechnic, London. Some of these colleges do not fulfil the necessary conditions at present, but it is hoped that they will do so in the near future. Among the conditions for designation as a college of advanced technology are strong direct representation of industry, besides representatives of local education authorities, universities and professional technological interests. Teaching conditions must approximate to those of equivalent standard at universities, and the staff must have opportunities for research and consulting work. The Minister lays considerable stress on the provision of residential accommodation. The circular which the Minister has sent to local authorities also describes the three kinds of existing technological colleges, referring to them as local, area and regional colleges.

Frederick D. Edwards Trust for Financial Help for Technical Students

Mr. F. D. Edwards, founder and managing director of Edwards High Vacuum, Ltd., has recently formed the Frederick D. Edwards Scholarship Trust, the purpose of which is to give financial aid to technical students pursuing or intending to pursue a course of training in science and technology. The capital of the Trust is £12,000, and Mr. Edwards has stipulated that the whole of this and its associated income must be spent within ten years. Otherwise, the trustees have a completely free hand to dispose of the money as scholarships, bursaries, prizes, small-scale grants, or in any other way they think fit. Although three institutions are specifically mentioned in the Trust deed—the Northampton Polytechnic, the National College of Instrument Technology and the Crawley Technical College—a student at any institution "giving training courses or facilities for research in any branch of science or technology" is eligible. Inquiries about the Trust and applications for grants should be made through college principals to either of the two trustees: Mr. F. S. B. Murrells (director and secretary of Edwards High Vacuum, Ltd.), at Tresco, Nevill Court, Tunbridge Wells, Kent; and Mr. A. J. Philpot (retiring director of the British Scientific Instrument Research Association), at Cranley, Bressey Grove, London, E.18.

Rain-making in Tanganyika

In a written answer in the House of Commons on May 31, Mr. Lennox-Boyd, Secretary of State for the Colonies, said that because of partial failure of the seasonal rains, the level of the reservoir at the Kazima Dam, which provides Tabora, the railway junction and administrative centre in the Western Province of Tanganyika, was dangerously low at the end of March. A new 'cloud-seeding' technique, involving the use of 2-in. naval rockets, modified to incorporate particles of sea salt, which had been evolved by the East African Meteorological Department in conjunction with the Admiralty and the Ministry of Supply, was accordingly tried out, and thirty-seven such rockets were fired between April 12 and May 2. Under the conditions prevailing, the best results were obtained when the rockets burst at about 3,000 ft., and 1·5 miles downwind of the catchment area of the Kazima Dam. The results are still being studied, but there was definite evidence that under suitable conditions cloud-seeding produces rain. A significant feature of the experiments was the repeated occurrence of rain over the catchment area some 12 minutes after seeding, and at the end of the experiments the level of the reservoir had risen by 2·5 inches, despite a daily consumption of 250,000 gallons and a high loss through evaporation. Rainfall in the catchment area during April was about one to one and a half inches higher than that measured at stations near but outside the catchment area.

The Houldsworth School of Applied Science, Leeds

The Council of the University of Leeds has approved a re-organization of the Department of Coal Gas and Fuel Industries with Metallurgy and Chemical Engineering. Under this re-organization the present Department will be replaced by a School, to be called "The Houldsworth School of Applied Science". Sir Hubert Houldsworth, the late pro-chancellor of the University, had been for some years a member of the staff of this Department, and through his work as fuel controller and with the National Coal Board was very familiar with its activities. The Houldsworth School of Applied Science will be constituted of three Departments: Gas Engineering and General Fuel Science with Ceramics, directed by the Livesey professor, Prof.

A. L. Roberts; Chemical Engineering, directed by the Brotherton professor—a newly established chair; Metallurgy, directed by the reader in metallurgy, Dr. N. J. Petch.

The European Coal and Steel Community

The Broadsheet issued by Political and Economic Planning on the "European Coal and Steel Community" (No. 389. November 21, 1955) is of some current interest in view of the possibility that institutions which have served the Community well so far may be taken as a model for the development of the peaceful uses of atomic energy. The Treaty establishing the Community was signed on April 18, 1951, and the Broadsheet briefly describes the evolution of what is the only truly supra-national organization in Western Europe which seeks to unify markets and control basic resources by eliminating six obstacles: customs duties and quantitative restrictions on coal and steel movements between the member countries; discriminatory transport rates; price discrimination for domestic and export sales within the Community area; cartels and agreements on restraint of trade; government subsidies; and government control of prices. The organization for achieving these objectives consists of an executive body, the High Authority, to establish and maintain the common market and answerable to the Common Assembly, a Consultative Committee, a Council of Ministers and a Court of Justice. The development of the Community has already passed through what may be called the opinion-forming stage and has now entered a second phase of long-term policies, European rather than national in character. As an economic experiment, the Community has been a success so far as the six countries are concerned, and Britain set up in July 1952 a joint committee for the exchange of full information of common interest and has maintained cordial relations with the High Authority ever since. What happens next in the Community depends on political rather than economic policies, and the Broadsheet points out that the view is widely held that progress is most likely in the integration of the production of atomic energy but that rejection of the European Defence Community has left it high and dry as the sole trophy of the federalist movement.

U.S. National Science Foundation: Senior Postdoctoral Fellowships

Applications are invited for the second group of senior postdoctoral fellowships to be awarded by the U.S. National Science Foundation during the current calendar year. These will be awarded in mathematical, physical, medical, biological, engineering and other sciences, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and areas of convergence between the natural and social sciences. To be eligible for these awards, candidates must be citizens of the United States. Annual stipends of 2,000–10,000 dollars, adjusted to match as closely as feasible the regular salaries of the award recipients, may be applied toward study or research in an accredited non-profit institution of higher learning in the United States or abroad. A limited allowance to aid in defraying costs of travel for a Fellow and his dependants will also be available. Further details can be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

Review of Czekoslovak Medicine

The quarterly journal *Review of Czekoslovak Medicine* (1, No. 1; 1955. Praha: Státní Zdravotnické Nakladatelství (Sokolská tr. 31)), which is printed in English only, fulfils, to quote the words of its introductory article by B. Špaček, vice-chairman of the Scientific Council of the Czechoslovak Ministry of Health, "a natural and earnest desire of all Czekoslovak medical scientists to bring their work before a truly international audience. Czekoslovak physicians have regretted that, no matter how significant or valuable their work it has for the most part, because of language difficulties, been insufficiently known in foreign countries . . ." and "too often . . . the priority of outstanding work by Czekoslovak investigators" has been "denied, incorrectly, by scientists of other nations. . . ." This introductory article then mentions Czech investigators whose work is insufficiently known outside their own country and explains that "Czekoslovak science passed through its most arduous trials during the Hitler occupation", when its universities were closed and its workers were persecuted. "Only with the establishment of our People's Democracy, which is building socialism on a scientific basis, is a foresighted policy being pursued . . ." and "publishing facilities . . . have been enlarged . . ." until nowadays "fifty medical and health journals are published". The article concludes with an appeal for a friendly reception of this new journal, which is "an expression of our deep conviction that mutual understanding can bring about both lasting peace between the nations and the prosperity of all mankind".

The rest of the first issue of the journal contains scientific contributions, with annotations, abstracts and reviews. The leading article, by F. Burian, describes the development of plastic surgery in Czechoslovakia. Other contributions are: research on the pathophysiology and some symptoms of hysteria (J. Černáček); sodium citrate—one of the main causes of cardiac overloading and failure in rapid blood transfusion (P. Firt and L. Hejhal), and ascorbigen—the bound form of ascorbic acid (Z. Procházka). An annotation by K. Hubschmann deals with the venereal disease campaign in Czechoslovakia, and another, by F. Démant and T. Prehop, with acute infectious hepatitis. A note by the editor points out that references appended to the individual papers quote only the work of Soviet, Czech or Slovak authors, this being an effort to economize space and to acquaint English-speaking readers with work "less easily accessible to them"; but if it "should prove desirable to quote fully all work cited", an effort will be made to do this in future issues. The subtitle of the journal is "Journal of the Czekoslovak J. E. Purkyně Medical Association" and this commemorates one of the world's very great histologists and physiologists.

British Hat and Allied Feltmakers Research Association: Report for 1955

The eighth annual report of the Director of Research of the British Hat and Allied Feltmakers Research Association, covering the year ended August 1955 (pp. 23; from the Association, Manchester, 1955), notes that, besides continuing work on the technology of carrotting of fur, a better picture of the initial reactions in the carrotting process appears to be obtained by studying the absorption of mercury from solutions of mercuric sulphate in sulphuric acid by animal and man-made protein fibres, as there is no incipient decomposition, such as occurs with nitric acid solutions. Line tracings of magnified fibres have given an adequate demonstration of the theory that directional felting is to be attributed to orientation of fibre units in the form of loops, in a preferred direction at right angles to that of the impulsive forces, and the anisotropic properties of felt produced by directional felting accord with this conception. A study of the physical and chemical properties of different samples and grades of lac has been commenced, and the foundations have been laid for a detailed study of wool hardening. The examination of the fastness properties of various classes of dyestuffs for fur felt indicates that the wet fastness on fur felt tends to be lower than that listed by the manufacturers for wool. The metal-complex type of dyestuff appears to possess excellent fastness properties, but in the laboratory attempts to apply them satisfactorily without undue degradation failed. Practical trials have been made of the influence of temperature in dyeing fur felt in the cone type of machine and in the free circulatory type, while studies of the effect of increases in acidity and temperature of treatment of a series of non-mercuric carrotted furs, prepared with a hydrogen peroxide–nitric acid carrotting agent, showed losses of protein remarkably similar to those for mercuric carrotted furs. Interest in the application of showerproofing agents and work on the assessment of physical properties and dimensional characteristics of felt were maintained during the year under report. An attempt is being made to separate compression from felting by studying a series of experimentally compressed felts, and an apparatus has been constructed for giving a non-destructive measure of air-permeability of wool hoods.

Computing Service at the Franklin Institute, Philadelphia

It is reported in the *Journal of the Franklin Institute* (261, 384; March 1956) that a contract has been signed for the installation of a complete UNIVAC computing centre and an integrated computation exhibit in the Franklin Institute in Philadelphia. The centre, which will be operated by Institute personnel under the supervision of Mr. D. Houghton, section chief of the Analysis Section, Division of Electrical Engineering, of the Institute, will be the largest of its kind for public use and the first to be installed in a private institution. The computations to be performed will be either for the Institute's laboratories, in which case they will relate to scientific or engineering problems, or for the public. The exhibition section will portray the historical evolution of the art of computation from the earliest calculating machine, the abacus, to the most modern electronic computer, and a guide will explain in simple and non-technical language how the ultra-modern devices operate. UNIVAC large-scale computer systems, the product of the Remington Rand UNIVAC Division of the Sperry Rand Corporation, are in use in several industrial and government institutions in the United States, and their particular value lies in the great speed of operation, the large amount of information digested and the accuracy of the results obtained because of the automatic self-checking features. In the UNIVAC computer, for example, the high-speed printer sets down the final results at the rate of 78,000 characters a minute.

Sondes Place Research Institute

The Sondes Place Research Institute has published an attractive illustrated booklet (pp. 16; from the Institute, Dorking, Surrey; 1955) describing the organization and services for sponsored research and development in chemistry, chemical engineering and mechanical engineering offered by the Institute. Some twelve hundred problems have been handled by the Institute during its first seven years, and nearly three thousand copies of its occasional bulletin, entitled "Report", are distributed in thirty-nine countries throughout the world, each issue being devoted to a single subject of general interest to industrialists and directors of research. The Institute has developed from a consulting chemical and chemical engineering practice founded in London in 1936 and incorporated as a limited company in 1947, when the present premises on the outskirts of Dorking were acquired. These include laboratories for the chemical, chemical engineering and mechanical engineering departments, a library, stores, administrative offices and drawing office. The pilot-plant house at Sondes Place has a floor area of 2,000 sq. ft., with an annexe of 700 sq. ft. for special investigations, while a further area of 1,680 sq. ft. is now available in the outbuildings of the adjacent property of Milton Heath. The services offered include technical and economic assessment of projects, laboratory research, the development of pilot plant, and the design of full-scale plant.

Museum of Applied Arts and Sciences, Sydney: Annual Report for 1954

The annual report for 1954 of the Museum of Applied Arts and Sciences, Sydney, outlines the requirements and hopes for the future of this progressive museum—probably the foremost of its kind in the southern hemisphere. Urgent needs include a new Spitz planetarium and an orrery, while the long-term policy makes provision for a new site and a new building of some 200,000 sq. ft. to replace the present one of about 27,000 sq. ft. The report states that many valuable and historic exhibits are now confined to storage, and that the limited accommodation for the public makes it almost impossible at peak periods for the exhibits to be appreciated intelligently. Exhibition activities include the display of an important collection of footwear, musical boxes and gramophones, a modern television unit and a transparent plastic woman. As usual, many scientific reports on particular problems, often of national importance, have been prepared by members of the staff.

Museum of Applied Science, Victoria: Report for 1953–54

The report for 1953–54 of the Museum of Applied Science, Victoria (pp. 15; from the Museum, Melbourne, 1955), indicates that the outstanding event was the special display arranged to commemorate the fiftieth anniversary of the achievement of powered flight. The display was in a chronological sequence and included numerous charts on the performance of aircraft, photographs, documents and relics. The exhibition included about ninety different aircraft models ranging from the age of the kite and glider to the modern period of the jet and rocket. The Fleet Air Arm displayed a Sea Fury outside the building. It is also reported that a radiocarbon dating service with the necessary apparatus is being set up by the Museum.

Turbulence above the Ozone Layer

In a paper dealing with turbulence above the ozone layer (*J. Brit. Interplanetary Soc.*, 15, 1; Jan.–Feb. 1956), Alan E. Slater gives a very comprehensive account of the subject, leading to the conclusion that the region of the atmosphere from 50 to 80 km. may not be turbulent, as is usually accepted. Discussing temperature distribution with height, patterns of convection and speed of vertical currents, he shows that there is no consistent evidence for instability in the upper regions of the atmosphere from 50 to 80 km. In addition, even if turbulence exists there, it is doubtful whether the vertical currents would be strong enough to affect significantly the passage of a winged vehicle through them. The discussion of the probable pattern of convection currents leads to the conclusion that uniform heating should give a regular pattern with the spacing between up-currents equal to two and a half times the thickness of the convection layer. Changes of wind with height in the region between 50 and 80 km. would cause the cells to be distorted and drawn out lengthwise in the direction of the wind shear, and it would be possible for a vessel flying parallel to the shear to remain in an up-current or a down-current for a long time. A discussion of the speed of the vertical currents leads to the conclusion that a winged vessel travelling at 6 km./sec. would not be affected to any noticeable extent unless the currents had a speed of several hundred metres a second. A rough calculation shows that for an up-current to reach a speed of 100 m./sec. after rising through 30 km., it would be necessary for it to be and to remain about 10 deg. C. hotter than its surroundings. It is considered unlikely that such a large temperature excess exists, and the conclusion is that there is some doubt whether the vertical currents are able to affect significantly the passage of a winged vehicle through them.

Diagnosis of Amoebiasis

An illustrated article on the diagnosis of amoebiasis, by Sir Philip Manson-Bahr (*Central African J. Medicine*, 1, No. 6; November 1955), is one of great interest to all those who have to undertake the difficult task of laboratory diagnosis of this form of human dysentery. It explains, in simple language, all the pitfalls and difficulties that await the microscopist whose duty it is to decide whether or not *Entamoeba histolytica* or its cysts are present in the material he has to examine —material which may come from the intestine, the liver, the brain or from other organs. A useful plate gives line-drawings of most of the objects that may resemble the cysts of *E. histolytica*, and other drawings show the harmless amoebae which may be present on human faeces. This is, in fact, just the kind of article that the diagnostician needs, and it gives him much detailed information that text-books omit.

Sitka Spruce and Douglas Fir in America and Great Britain

A considerable proportion of the plantations undertaken in Britain by the Forestry Commission during its early years was made with Sitka spruce and Douglas fir, chiefly the former. These conifer species come from the Pacific coast of North America. In order to make a comparison of the growth of these species in their natural habitat with that in Britain, Mr. R. F. Wood, an officer of the Forestry Commission, with the help of a Nuffield travelling scholarship, paid a visit to the forests of British Columbia and the neighbouring territories to carry out field studies, and has recorded his investigations in Forestry Commission Bulletin No. 25, "Studies of North-West American Forests in relation to Sylviculture in Great Britain" (pp. 43+35 photographs. London: H.M.S.O., 1955; 6*s.* net). A study was made of climatic zones comparatively similar to those in Great Britain from the point of view of seed collection for use in Britain. This referred more especially to the Douglas fir, which even in coastal forests occupies areas that are far more continental than those in Britain. But the results of the study showed that we still lack first-hand evidence of the advantages to be gained from close matching, and perhaps there are hints that flexibility in Douglas fir is most likely to be found in regions one step removed from the most oceanic conditions. This does not apply to the Sitka spruce, which is largely confined to regions of some oceanity and therefore more comparable to Great Britain.

Identification of an Endotrophic Mycorrhiza

An account has been given by B. Mosse (*Ann. Bot.*, N.S., 20, 78, 349; 1956) of the identification of a hitherto undescribed species of *Endogone* which she found in organic connexion with mycorrhizal strawberry roots grown in pots in a greenhouse. By inoculating sterilized soil with these fructifications and with spores excised from them, it was possible to produce typical vesicular-arbuscular infections in strawberry, apple and a number of other plants. These inoculation experiments constitute the first record of the establishment of endotrophic mycorrhizal infection in plants raised under aseptic conditions.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division: J. Bowden (senior specialist, Department of Agriculture, Gold Coast), principal specialist, Department of Agriculture, Gold Coast; H. A. Darby and R. E. Osborne (senior agricultural officers, Jamica), chief agricultural officers, Jamaica; D. F. Edwards and D. R. Goodrich (agricultural officers, Gold Coast), senior agricultural officers, Gold Coast; E. J. Gregory (deputy director of agriculture, Jamaica), assistant director of agriculture, Northern Region, Nigeria; F. E. Luscombe (agricultural officer, Tanganyika), chief agricultural officer, Nyasaland; E. R. H. Martin, A. G. Naylor, R. K. Richardson and L. K. A. Swaby (agricultural officers, Jamaica), senior agricultural officers, Jamaica; W. B. Collins (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; M. Dinning and D. M. Duggie (assistant conservators of forests, Gold Coast), senior assistant conservators of forests, Gold Coast; G. J. Leggat (assistant conservator of forests, Uganda), conservator of forests, Uganda; E. W. March (conservator of forests, Eastern Region, Nigeria), chief conservator of forests, Eastern Region, Nigeria; G. Webster (assistant conservator of forests, Uganda), conservator of forests, Uganda; N. J. Guest (geologist, Geological Survey Department, Tanganyika), senior geologist, Geological Survey Department, Fiji; B. O. L. Duke (medical research officer, grade III, British Cameroons), medical research officer, grade I, West African Council for Medical Research, Western Region, Nigeria; A. M. Orhan (veterinary officer, class II, Cyprus), veterinary officer, class I, Cyprus; H. Batten (senior pharmacist, Western Region, Nigeria), chief pharmacist, Western Region, Nigeria; D. R. Glendinning, scientific officer, plant breeder, West African Cacao Research Institute, Gold Coast; D. Dow, assistant cacao propagation officer, Jamaica; M. Sanders and B. M. Savory, assistant conservators of forests, Northern Rhodesia; A. E. Wright, geologist, Tanganyika; D. G. Godfrey, scientific officer (parasitologist), West African Institute for Trypanosomiasis Research, Nigeria; N. A. Hancock, veterinary parasitologist, Northern Region, Nigeria; R. M. Mackenzie, veterinary officer, Eastern Region, Nigeria; B. A. V. Peacock, curator of museums, Federation of Malaya.

Plastic Theory of Engineering Structures: Symposium in Cambridge

A SYMPOSIUM on "The Plastic Theory of Structures" will be held in the Engineering Department of the University of Cambridge during September 18–21. For twenty years a research team under the direction of Prof. J. F. Baker has been at work, at first in Bristol and since 1943 in Cambridge, investigating the behaviour of steel structures in the plastic range and developing a plastic method of designing structures. The stage has now been reached where a new branch of the theory of structures of considerable educational value is available together with a practical method of design of wide application. The symposium is therefore designed to bring together those who teach engineering and those who are practising members of the profession. The fee for the symposium is ten guineas. which will cover all living expenses, a preliminary set of the papers, and a final set of reprints, including the discussions. Further information can be obtained from the Secretary of the Department of Engineering, Trumpington Street, Cambridge.

Dilogarithms and Related Functions

MR. L. LEWIN, 33 Wellington Road, Enfield, Middlesex, writes: "I am in the course of preparing the manuscript for a book on dilogarithms and related functions and would appreciate the opportunity to appeal to readers who have encountered these functions in the course of their work. Any information on their occurrence in practical problems, and which I could incorporate, with due acknowledgment, would be welcome. The functions concerned arise from the series $\sum_{1}^{\infty} x^n/n^r$ and the integral $\int \log^n (x)\, dx/(1+x)$, and include the log sine integral".

The Night Sky in July

NEW moon occurs on July 8d. 04h. 37m., U.T., and full moon on July 22d. 21h. 29m. The following conjunctions with the Moon take place: July 6d. 17h., Venus 3° S.; July 7d. 05h., Mercury 2° N.; July 11d. 07h., Jupiter 7° N.; July 17d. 15h., Saturn 11° N.; July 27d. 14h., Mars 11° S. In addition to these conjunctions with the Moon, Jupiter is in conjunction with Regulus on July 2d. 09h., Jupiter being 0·6° N., and Mercury is in conjunction with Regulus on July 3d. 20h., Mercury 3·3° N.; also, on July 3d. 20h., Mercury is in conjunction with Venus, Mercury 3·3° N. Mercury rises at 2h. 40m., 3h. 30m. and 4h. 45m. on July 1, 15 and 31, respectively, but is too close to the Sun for favourable observation. Venus rises at 3h. 20m., 2h. 20m. and 1h. 40m. at the beginning, middle and end of the month, respectively. The close approach of Regulus, Jupiter, Venus and Mercury (though Mercury may be difficult to see) on July 3 should be an interesting phenomenon. Mars rises at 23h. 20m., 22h. 40m. and 21h. 50m. on July 1, 15 and 31, respectively, and is visible during the later hours of the night and the morning hours before twilight. Its eastward movement in Aquarius is easily detected, though it lies too low for good observation. Jupiter sets at 22h. 35m. and 21h. 45m. on July 1 and 15, respectively, but later in the month is too close to the Sun for favourable observation. Saturn lies low in the constellation Libra and towards the end of the month is a little south of γ Librae. It sets at 1h. 30m., 0h. 30m. and 23h. 30m. on July 1, 15 and 31, respectively. Occultations of stars brighter than magnitude 6 are limited to c Cap., magnitude 5·3, which disappears on July 25d. 0h. 05m., observation being made at Greenwich. The Earth is in aphelion on July 5d. 01h., its distance from the Sun being then 94½ million miles.

Announcements

THE University of Minnesota has recently made the Elvin Charles Stakman Award to Prof. W. L. Waterhouse, of the University of Sydney. This award consists of a medal, a scroll and a nominal monetary grant, and has been given for outstanding contributions to the biology of the cereal rusts and to basic concepts useful in the production of disease-resistant plants.

THE title of reader in physical chemistry in the University of London has been conferred on Dr. J. A. Kitchener, and that of reader in acoustics in the University of London on Dr. R. W. B. Stephens, both being in respect of posts held at the Imperial College of Science and Technology.

THE following awards have been made by the Lady Tata Memorial Fund for research on leukæmia and allied diseases during the academic year 1956–57: *Grants for Research Expenses*, Dr. Morten Simensen (Fibiger Laboratories, Copenhagen) and Prof. B. Thorell (Caroline Institute, Stockholm); *Scholarships* (*whole-time or part-time*), Dr. Giuseppe Marinone (University Medical Clinic, Pavia) and Dr. A. J. Therkelsen (Institute for General Pathology, University of Aarhus). Various awards made to the following in previous years (see *Nature*, 175, 1067; 1955) have been renewed for a further year: Dr. J. Kieler, Dr. J. Ringsted and Dr. J. Rygaard (Copenhagen); Dr. J. Nordmann (Paris); Dr. A. Sreenivasan (Bombay); Prof. H. G. Teir (Helsinki); Dr. C. G. V. Wasastjerna (Vasa, Finland); Dr. M. Seligmann (Paris); and Dr. Alice Stewart (Oxford).

THE seventh Canadian High Polymer Forum will be held at the Guildwood Inn, Sarnia, Ontario (postal address: P.O. Box 912, Point Edward, Ont.), during November 8–9. The Forum is sponsored by the National Research Council of Canada and by the Chemical Institute of Canada and is devoted to all aspects of polymer science. The guest speaker will be Prof. J. J. Hermans, of the University of Leyden. Abstracts and titles of papers should be sent by August 31 to the programme chairman, Dr. D. G. Ivey, Department of Physics, University of Toronto, Toronto 5, Ontario. All other communications regarding the Forum should be addressed to the chairman, Dr. H. Leverne Williams, Polymer Corporation, Ltd., Sarnia, Ontario.

ERRATUM. In a communication entitled "Muscular Dystrophy of Beef Cattle and Unsaturated Fats" in *Nature* of April 28, p. 792, the heading for col. 3 of Table 1 should read "Mean tocopherol content of milk fat (μgm./gm.)".

IMPROVEMENTS IN SEISMIC PROSPECTING

A GEOPHYSICAL Discussion of the Royal Astronomical Society was held at Burlington House, London, on April 20, when three papers were read on "Improvements in Seismic Prospecting". Mr. B. C. Browne (University of Cambridge) was in the chair.

The first communication, by F. W. Hales (Seismograph Service, Ltd.), dealt with the development and applications of continuous velocity logging. With the trend towards greater resolution and more detailed interpretations of seismic data, the need for a continuous record of seismic velocity against depth has become desirable. The continuous velocity logger has been developed to fulfil this requirement, and it has already demonstrated its ability to provide data on velocity and the delineation of reflecting horizons to such a degree as to make it a useful exploration tool.

The borehole instrument consists of an ultrasonic pulse generator and receiver suspended by a cable and separated from one another by a length of acoustic insulator. The pulses are radiated at a frequency of twenty per second, and both the times of transmission and reception are recorded at the surface. The time-delay, recorded continuously as a function of depth, is a direct measure of the seismic velocity in the materials forming the borehole walls. In addition, the recorder performs a mechanical integration of this velocity profile which gives the total time of travel from the surface to the depth of the instrument. In practice, the recorder-trace is calibrated by directly observing the time of travel from a surface shock by means of a pressure-sensitive detector fastened to the instrument.

It soon became apparent when using the instrument that it provided a picture of the lithology of the borehole walls as it concerns the seismologist, since the record demonstrated discontinuities in the acoustic impedance of the formations traversed. Hitherto, the geological log has provided a guide to the interpretation of seismic data, and the seismologist has naturally tried to associate reflecting surfaces with geological discontinuities. The continuous velocity logger reveals many discontinuities unsuspected by the geologist. From comparing such velocity profiles with the results of seismic reflexion shooting, the following observations have been made: (1) There are as many interfaces where there is a decrease of velocity with depth as there are where the reverse is true, and reflexions may originate at either type of interface. (2) Reflexions frequently originate from a group of thin layers with alternating strata of high and low velocity, the reflected signal being synthesized from the waves produced at each bed; this particular type of reflexion delineates a zone rather than a discrete interface. (3) Geological divisions established from palæontological considerations are frequently not characterized by any marked discontinuity in acoustic impedance.

Difficulties in the interpretation of seismic records caused by multiple reflexion have also been resolved by the synthesis of seismic data from the continuous velocity log. The details of this method of record synthesis have been given by Peterson, Fillippone and Coker[1]. They show that the reflexion coefficient may be approximately related to the incremental change in the logarithm of the acoustic impedance. If the assumption is made that the rock density and velocity are related by a simple power law, the reflexion coefficients may be determined directly from the continuous velocity log.

The derived record of acoustic impedance is used for calculating the amplitudes of reflected pulses, which are proportional to the reflexion coefficients; and after passing through shaping filters which simulate the absorption in the Earth and also through geophone and amplifier equivalent circuits, the recorded output has the nature of the seismic record which would be expected from the disposition of reflecting layers.

The log of interval velocity is more directly associated with the physics of the formation of layers rather than their chemistry, and it is therefore of great value to the geologist wishing to trace the lithology of a borehole. When used in a number of boreholes in the same district, it has often been possible to correlate the profiles from the separate holes. Unlike resistivity measurements, the measurements are not seriously affected by the use of highly saline drilling fluids. It has also proved possible to correlate velocity and porosity measurements within the same formation. In general, layers with low density (determined in the laboratory) have low velocities.

Work is also in progress which appears to demonstrate that when continuous velocity logging is supplemented with conventional radioactivity and electrical logs, it is possible to differentiate in some instances between the presence of gas, oil and water. In his paper, Mr. Hales showed some continuous velocity records obtained in the wells of the D'Arcy Exploration Co., Ltd., and the Compagnie d'Exploration Petrolière.

Discussing the paper, the chairman asked what ultrasonic frequency is used and whether the observed velocities are dependent on the signal frequency; Mr. P. G. Lazenby, who was joint author of the paper, said that 50 kc./s. is the pulse frequency, but no measurements have been made on the frequency dependence of velocity. Dr. T. F. Gaskell commented that measurements that have been made on coal showed no change of seismic velocity with frequency. When asked if the mud path would greatly influence the travel time, Mr. Hales said that it has been discussed, and an improved instrument is to be made having two receivers.

The second paper, read by Dr. R. Raitt, of the Scripps Institution of Oceanography, La Jolla, California, described the seismic refraction work that has been done in the equatorial Pacific Ocean on the Mid-Pacific and Capricorn Expeditions in 1950 and 1952–53, respectively. Some improvements have been made in the utilization of explosive energy for seismic waves and decreasing the noise picked up in the hydrophones. When the shot is fired at a depth corresponding to half a wave-length at the bubble pulse frequency and the hydrophones are suspended at a similar depth in a state of neutral buoyancy, the following relationship is found between the average maximum range at which signals can be observed (Δ in km.) and the shot weight (W in lb.)

$$\Delta = 7\,W^{1/2}$$

There was a wide scatter from this formula; signals have been received from an 80-lb. shot at 190 km.

In making measurements with two ships, the split-profile type of record was most often taken; the firing ship drops charges continuously and steers an approximately straight course, passing the stationary recording ship and its hydrophones at the middle of its run. The reverse profile technique was also used occasionally; but owing to drift and navigational difficulties the full value of a reverse profile was never completely realized. For the interpretation of the seismic refraction data, the assumptions of constant-velocity layers, the velocity of which successively increased with depth, were used. In addition to the topmost layers of sediment, three distinct velocity layers were observed having velocities of 4·0–6·0, 6·5–7·0 and 8–8·5 km./sec., respectively. Changes in these velocities in a lateral direction were observed; but whether these are always real is uncertain. The velocity in the upper sediments was not determined by refraction; but a few reflexion measurements gave an average at 2·15 km./sec.

Dr. Raitt presented a slide showing the thickness of the crust defined by the depth at which the velocity reaches 8 km./sec. as found by several workers on the continents and by his work in the Pacific Ocean. The mean thickness for the Pacific Ocean is about 6 km., which contrasts with the 30 km. for the continents.

Questioned on the dependence of arrival time on frequency, Dr. Raitt said that only at short distance was it possible to observe waves of different frequency travelling over the same path. In these cases, no dependence on frequency was observed. When asked by the chairman if he had any views on the composition of the layer below the unconsolidated sediments, Dr. Raitt said that it is in doubt whether they are volcanic or sedimentary. The answer to this problem would tell us much about the history of the oceans. If the 4·0–6·0 km./sec. layer is lithified sediment, the oceans are probably very much older than would be expected if the layer were igneous.

Dr. S. Wyrobek (British Petroleum Co.), who read the third paper, said the refraction method has been used in some areas to give a fairly comprehensive picture of the variation of velocity in both the lateral and vertical directions and to reveal sub-surface structural features. It is known that the method is most successful where velocity contrasts are pronounced, but it has been perfected to the extent of delineating layers where the velocity contrast is less than 2,000 ft./sec.

The guiding principle in deciding the disposition of geophones and shots is to cover continuously all the important refractors in the area and especially the shallow refractors, since these greatly influence the shape of the deeper layers. A refraction line consists of several spreads. Each spread may have twenty-four geophones 250–1,000 ft. apart and several main shot points outside the spread at distances of 5,000–10,000 ft. At each geophone station or every alternate one, smaller shots are fired, which elucidate the weathered layer and any low-velocity layers. Continuous time profiles are obtained in both directions of shooting, and these are used for obtaining half-intercept time values and hence the values of the refracting velocities and their lateral variations. By the method of interpretation used, individual refractors are discriminated by ensuring that the reciprocal times are equal, that the intercept times match in each direction of shooting, and that both the direct and reverse time profiles match the half-intercept time values if one deals with the same refractor.

The aim of the method is first to convert the time–distance curve into a time section, that is, into a section in which the vertical scale gives the delay-time of a point on the refractor below the datum; this is achieved by producing the so-called half-intercept time profiles. From the latter, by using information obtained from well surveys or assuming the seismic velocities determined for the upper refractors to be uniform in a vertical direction, or introducing a velocity distribution characteristic of the area, a depth profile for each refractor is easily obtained.

Mr. D. R. Brown asked what velocity variations and dips could be encountered before the method broke down, to which Dr. Wyrobek replied that the complications would appear where lateral variation of velocity along a refractor approached the variation in the vertical direction. The method has proved satisfactory in areas of dips up to 8°. It will be published in a subsequent number of the *Geophysical Prospecting Journal of the European Association of Exploration Geophysicists*.

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[1] Peterson, R. A., Fillippone, W. R., and Coker, F. B., *Geophysics*, **20**, No. 3, 516 (1955).

ELECTRICAL EQUIPMENT OF AIRCRAFT

THE convention, as a means of bringing to a focus widely scattered knowledge of a particular subject, has gained a great deal of popularity in recent years, and that on "Electrical Equipment of Aircraft", held in London at the Institution of Electrical Engineers during May 2–4, proved to be no exception; the accommodation of the lecture hall of the Institution was strained to the utmost, and additional chairs were placed wherever possible. The chair at the opening session was taken by the president of the Institution, Sir George H. Nelson, and the proceedings began with a short address by the Minister of Supply, Mr. R. Maudling.

Mr. G. R. Edwards, general manager and chief engineer (aircraft) of Vickers-Armstrongs, Ltd., followed with a most entertaining talk, in which his humorous sallies provided some light relief for the serious matter of his address, which was the problem of the aircraft designer, wishing and indeed compelled to use electricity to an ever-increasing extent for a multitude of purposes in connexion with the functioning of the aircraft, and yet faced with the reduction of useful load-carrying ability involved in the weight and drag of electrical equipment and its cooling auxiliaries. The only electrical equipment on the earliest aircraft was a magneto generator to supply the ignition system, and this was both light and reliable. Modern large civil and military aircraft are equipped with about 150 kW. of electrical power and, with developments likely in the near future, the power provided may rise to 400 kW., or even, according to some estimates, to 700 kW. The weight of the equipment, with the additional fuel required to drive it, is of the order of 3 per cent of the total aircraft weight. If the pay-load of a civil aircraft is 10 per cent of the total aircraft weight, the electrical equipment reduces the pay-load by one-quarter, and the importance of saving weight is apparent.

Important as it is to save weight, it is still more important to achieve reliability. Moreover, the increase in speed and flying height of modern aircraft introduces new problems of cooling and brush-wear which are generally adverse to saving weight. The designer is at a disadvantage compared to his land-based colleagues in every respect except cost, which he may largely ignore if a saving in weight may be achieved by the use of costly materials or special apparatus.

Nineteen papers* were presented at the convention covering the uses of electrical power, the means to obtain it and the methods and equipment necessary to obtain reliability. The last session was devoted to a discussion of the problems of installation and maintenance, which often influence the choice of equipment for a particular aircraft.

The importance of weight-saving would appear to justify the design of the electrical equipment as a single unit, each element being planned to give minimum total weight to the equipment rather than to have minimum weight itself. This ideal has not yet been achieved, and the choice of supply system, for example, is often governed more by the availability of consuming apparatus of a given design than by a rigid assessment of the optimum system for minimum weight.

The most popular generating systems at present are 28 volts and 112 volts d.c., and 200 volts three-phase a.c. with 115 volts between line and neutral. The frequency of a.c. supplies may be variable from 200 c./s. to 500 c./s. according to engine speed; or generation may be achieved at a fixed frequency of 400 c./s., 1,600 c./s. or 2,400 c./s. either by a differential speed drive between the engine and the generator or by a separate power unit. It is unfortunately not practicable to design all consuming apparatus to operate from the same supply system; and, whichever system is adopted, means have to be provided, usually by additional motor generator sets, to provide auxiliary supplies.

The 28-volt d.c. system is popular on account of ease of maintenance and reliability. Fewer cells are required in a standby battery, and heater filaments for this voltage are of adequate section so that they fail less frequently. Transmission losses and the weight of cable required become serious in large aircraft, although this aspect is complicated by the large number of cables the dimensions of which are fixed by considerations of mechanical strength rather than by current-carrying capacity. Aluminium conductors offer the possibility of reduced weight for the same current-carrying capacity, but at the expense of increased volume. It is not always practicable to accommodate the larger aluminium cable.

The 112-volt d.c system generally yields a reduction of weight both of the generators and of the cables, although the reduction of weight is not as striking as might be expected, since the additional insulation increases the weight of cables of minimum section.

The a.c. systems gain flexibility from the use of transformers; but the transformer weight is not economically used in the variable-frequency system. Moreover, some constant-frequency supplies are necessary for some of the consuming apparatus, and this has to be provided by motor generators. These additions of weight have to be balanced against the reduction achieved by a direct engine drive. The constant-speed hydro-mechanical drive or the auxiliary power unit to give constant frequency is gaining in popularity.

A serious problem for high-altitude flying is brush wear. This problem is less serious with slip-rings than with commutators, so that a.c. supplies have an advantage in this case. The development of satisfactory silicon rectifiers which can be operated at higher temperatures than germanium rectifiers makes possible the design of brushless alternators and also enables d.c. supplies to be obtained with a reasonable weight penalty from a.c. generators.

The most popular frequency system is 400 c./s. Transformer weights are reduced at the higher frequencies; but this advantage is counterbalanced to some extent by increased eddy-current losses in cables. The higher frequencies may be essential for some consuming apparatus.

The cooling of electrical equipment is a major problem, especially at high altitudes and speeds. Designs of minimum weight of electrical equipment tend to be inefficient, and this increases the weight of cooling equipment and the drag it exerts on the aircraft. In many cases, it is preferable to increase the efficiency of the electrical equipment at the expense of its weight in order to reduce the cooling problem. So far as practicable, engine fuel should be used for absorbing heat: additional cooling is usually air cooling, either by natural convection and radiation, or by blast cooling. Limits are set by ambient air temperature which rises with the speed of the aircraft on account of adiabatic compression at the intakes. When the ambient air temperature is higher than that of the electrical equipment, refrigeration must be employed in order to dissipate the heat.

Striking developments of batteries have taken place in the search for weight reductions. The lead–acid battery has been reduced about 40 per cent in weight by improved materials and construction, while the newly developed nickel–cadmium battery and zinc–silver oxide battery give a better discharge performance than the lead–acid battery.

Finally, the smooth functioning and reliability of the equipment is vitally dependent on satisfactory frequency and voltage regulators and on a good protection system, including adequate switchgear. Switch performance is generally adversely affected at high altitudes by the change in the arc characteristics; although research has shown that this deterioration is not as severe as early experiments had suggested, it is clear that alternating currents are likely to be more easily interrupted than direct currents, and this is a further argument in favour of the a.c. system.

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* S. F. Follett: electrical equipment in aircraft—survey of past and present practice and future trends in design. H. Zeffert: factors in the utilization of electrical power in aircraft. B. J. O'Kane: aircraft radio power supplies—a survey. J. F. Lewis and E. Lloyd: the airworthiness and reliability of aircraft electrical systems. A. Ball and R. N. Lake: the medium-voltage d.c. system in aircraft and its application in the "Princess"-class flying boats. P. L. Cronbach: rectified-a.c. generating systems in aircraft. P. C. Finucane: a constant-frequency a.c. system for aircraft. D. C. Flack: future trends in aircraft electrical systems. R. G. Woodall, P. J. Daglish and V. A. Higgs: trends in the development of airborne electrical equipment, with particular reference to constant-frequency a.c. systems. B. Adkins, W. Philipp and A. Hossle: electrical machines for aircraft. C. S. Hudson: the cooling of aircraft electrical equipment. K. J. Payne: electrical characteristics and protection of aircraft power systems. W. G. Bourne and A. Grieve: aircraft switchgear. D. W. Bird, D. C. Hancock and D. B. McKenzie: aircraft electrical cables. C. W. Cooper: the development of voltage and frequency regulators for aircraft electrical systems. G. A. Earwicker: aircraft batteries and their behaviour on constant-potential charge. A. H. M. Arnold and L. H. Ford: d.c. circuit interruption and arc characteristics at low air pressures. I. A. Mossop and F. D. Gill: the current and voltage relationships of a stable d.c. arc between copper and silver electrodes in air at 1–760 mm. of mercury. N. C. Adcock and A. W. Ford: excitation systems for a.c. aircraft generators.

Most aspects of aircraft electrical equipment were thoroughly covered by the papers presented, and these, together with the discussions on them, should provide a useful work of reference for those concerned with the design or utilization of such equipment. An interesting point made was concerned with the adverse effect of standardization on the weight of electrical equipment, and a plea was entered for an increase in the number of standard sizes in order to reduce the weight penalty.

MARINE BIOLOGY

SYMPOSIUM AT THE SCRIPPS INSTITUTION

A SYMPOSIUM on "Perspectives in Marine Biology" was held in the Scripps Institution of Oceanography, La Jolla, California, during March 24–April 2, under the auspices of the International Union of Biological Sciences and jointly sponsored by the University of California and the Office of Naval Research of the United States Navy. Owing to generous financial help and to the co-operation of the Military Air Transport Service of the United States, a large and representative body of marine biologists attended from all parts of the world, eight being from Great Britain. The programme of prepared papers covered the whole range, and indeed more than is usually regarded as the whole range, of the composite science of marine biology. Certain of those invited to participate came to give accounts of work of very wide biological implication, and they also made major contributions to the discussions which followed the papers. Very adequate provision had been made in the time-table for such discussions.

It is undoubtedly true to say that no such broad survey of the field of biological investigation in the marine environment has hitherto been held. Observation and discussion ranged from the factors of the marine environment to the study of bottom fauna and of plankton communities, through problems of biochemistry and regulation, both chemical and in respect of timing and rhythms, to problems of production and productivity, notably in relation to both phytoplankton and bacteria. The importance of ethology was stressed, and both the sensory equipment and effector mechanisms of marine organisms were discussed. Problems of speciation and of genetics formed the subject-matter of the concluding sessions of a programme that had been organized by Prof. A. A. Buzzati-Traverso, to whose distinction as a geneticist must certainly be added high ability as an organizer.

An experiment of great interest was made during the symposium, the participants in which were organized into a series of 'idea groups' of very mixed membership where the subject-matter of the papers and general matters appertaining to marine biology were informally discussed. The concluding session of the symposium took the form of a meeting at which spokesmen of the various groups gave some account of their deliberations and answered certain leading questions which had been put to them. In the opinion of the writer, himself one of the spokesmen, profitable use could probably be made of such a scheme in future, although perhaps in this instance both subject-matter and participants were somewhat too heterogeneous. A doubt was left as to whether those who organized the symposium would obtain any major lead from the deliberations of the idea groups.

But there can be no doubt that, as a result of the discussions, both formal and informal, all who attended the symposium left it with increased knowledge both of their science and of their colleagues from many countries. Regret was widely expressed at the absence of the delegates expected from the U.S.S.R. The Scripps Institution of Oceanography now has the possibilities, through a major grant of money from the Rockefeller Foundation, to develop greatly the biological aspects of its work. Those responsible for the symposium must certainly have gained an idea of the extent and diversity of modern investigations in marine biology. The majority of these, outside the field of fishery research, are the achievements of individual workers, although naturally such work is being increasingly aided by the facilities of modern marine biological laboratories and research vessels. Along what lines of research money might most fruitfully be spent would, at this stage, seem to depend more on the quality of the people employed than on the actual programme, and it is to be hoped that the Scripps Institution will be successful in its endeavours to obtain workers of the highest quality to develop its biological programme.

C. M. Yonge

SCIENTIFIC HUMANISM

It is a commonplace of discussions on the universities that there is an ever-widening gap between the arts and the science graduates: this usually takes the form of a most often unjust attack on the 'narrow scientist'. S. J. Tester, a lecturer in classics at the University of Bristol, suggests that the 'narrow arts graduate' is a commoner phenomenon and represents a more serious problem (*Univ. Rev.*, 28, No. 2; Feb. 1956).

Most graduates in one of the special sciences will, in a time of films and theatres, radio and television, "Penguins" and "Pelicans", imbibe something of what the arts man so often describes as 'culture'; but most arts graduates leave the universities with practically no conception of the revolution that took place in science between the seventeenth and nineteenth centuries, and the further revolutionary developments which have occurred since 1900. Unfortunately, they leave not feeling ashamed of this ignorance but either proud of it or indifferent to it; they consider it irrelevant to their being 'cultured' or 'educated'. Tester suggests a way in which both these problems—that of the science graduates' lack of contact with the minds of the great thinkers of the past and that of the arts graduates' blindness on the side of science—might be at least partly solved.

The way in which the universe in all its physical aspects is now regarded is largely due to developments in science between the seventeenth and nineteenth centuries; it is to be expected that new developments in physics, physiology, psychology and electronics will produce changes in men's commonplace opinions in the future. It is possible to draw up a list of half a dozen or so books which would epitomize the 'scientific revolution', all, or nearly all, books written for the educated public of their day by men of generally acknowledged genius or importance, and all readable by any intelligent student.

A suggested list is: Harvey's "De Motu Cordis" (1628); Galileo's "Dialogue concerning the Two Chief World Systems" (1632), selections; Boyle's "Sceptical Chymist" (1661); Newton's "Principia" (1687), selections, but at least the early chapters of Books 1 and 3; John Ray's "The Wisdom of God" (1691); James Hutton's "A Theory of the Earth" (1785), or possibly selected parts of Lyell's "Principles of Geology"; Darwin's "Origin of Species" (1859); Einstein's "The Theory of Relativity" (1926). All university students, whatever their faculty, should be required to read these books and to take an examination on them at the end of the first term of their final year.

Such a course of reading would not be intended to make science students philosophical, nor to introduce them to the philosophy of science. It would give them real contact with greatness, such as the classic student has in reading Aeschylus or the philosophy student in reading Kant.

There is no question here of 'broadening' the scientist, of providing a humanist background for his studies. Nor is this proposal intended to provide the arts student with an outline of modern science or a 'potted' history of science. The way in which the scientist, and even the ordinary non-scientist, regards the physical universe has been largely determined by these works or the movements they epitomize; to think as we do and yet be ignorant of them is like being ignorant of the teachings of the New Testament while living in a Christian society.

Most of these are very old books, and much of their matter is long out of date. It would therefore be necessary to explain to what degree the facts and theories given in these works are still accepted, and how far they have been modified or discarded. It would also be necessary to make it plain to the students precisely why these works are important. This would mean putting each in its context, describing the state of each particular science before the work in question, the revolution affected by it, and its influence and importance in later scientific thought. This could be done in a course of lectures; but Tester believes this could be better done in a book prepared by experts in the several fields.

ECOLOGICAL ANALYSIS OF THE INTERBREEDING OF CRESTED TITMICE IN TEXAS

ECOLOGY and behaviour during the early phases of the nesting cycles have been compared by Keith L. Dixon in two superficially distinct forms of titmice. A grey-crested bird, the tufted titmouse (*Parus bicolor*), is a characteristic inhabitant of deciduous forests of the humid eastern United States. Its distributional-range meets that of the black-crested titmouse (*Parus atricristatus*) at a few points in central Texas. The latter bird is found commonly in openly spaced plant associations of arid north-eastern Mexico and adjacent parts of Texas. Interbreeding occurs wherever populations of these non-migratory forms are in contact.

Field work in central and western Texas was carried out during February–April 1951 and in January and February 1952. Each of the forms was studied first in areas remote from any influence of the other form; this study was used as a basis for evaluating conditions in areas where interbreeding was known to occur (University of California Publications in Zoology, 54, No. 3).

Tufted and black-crested titmice are similar in their habitat relations, especially in nesting requirements and foraging. The preferred habitats of these birds merge at the points of contact which lie in a transition from humid to arid climates. The call notes of the western form seemed louder and more nasal, and the songs were of longer duration. The only difference in display was the more erect carriage of the crest in the black-crested form. As the nesting cycle advanced, tufted titmice tended to be more secretive, whereas black-crested pairs were not so difficult to locate. Defence of territory appears more vigorous in the tufted titmouse. These differences in behaviour are more apparent later in the breeding cycle than they are at the time when pair formation is believed to occur. Detailed studies in the field, correlated with examination of specimens, suggests that mate selection is random where the populations overlap. No evidence of reduction in the vitality of birds of intermediate character was found. The evidence suggests that these two varieties diverged from a common ancestor, but that the changes which developed were not accompanied by the evolution of mechanisms which would ensure reproductive isolation. Since free interbreeding between black-crested and tufted titmice occurs, Dixon suggests that they should be considered conspecific.

The three principal areas where contacts between populations of the two kinds of titmice exist or have existed were studied. In each area the junction was permitted by extension of woodland vegetation across prairies otherwise uninhabitable by these titmice. The upland timber of these areas is controlled by factors operating through the soil. This fact points to the permanence of the distributional relations, and the suggestion is made that the interbreeding of these titmice antedates the environmental disturbances brought about by the settlement of Texas by the white man.

The genetic constitution of one intermediate population, near the Aransas River, is shown to have changed towards that of the black-crested during the past century. The spread of woody vegetation is believed to have favoured the increase in numbers of titmice of the black-crested type in this area, and hence to have permitted increases in frequency of its genes in the intermediate population, while the contribution from the grey-crested populations was being reduced.

STANFORD RESEARCH INSTITUTE, CALIFORNIA

REPORT FOR 1955

THE report of operations for 1955 of the Stanford Research Institute, California*, records an increase in staff from 914 to 1,163, of whom 630 have technical training and 125 Ph.D. degrees. Contract research is being conducted at the rate of 10 million dollars a year, and in the nine years of the Institute's existence has totalled about 35 million dollars. Of the 532 research projects undertaken in 1955, 132 were for government agencies; but in terms of dollars the ratio of commercial projects to government projects was 56·6 : 43·4. Following a final decision as to the site, rapid progress was made in developing building programmes for offices and research activities. The Associate Plan was further extended, and by the end of the year 116 firms or individuals had pledged or contributed one or more units of 15,000 dollars, totalling 2,266,525 dollars, to this fund for improving the Institute's research facilities.

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* Stanford Research Institute. Report of Operations, 1955. Pp. 47. (Menlo Park, Calif.: Stanford Research Institute, 1956.)

Progress was made in the solar energy programme, including a study by the Institute of flat-plate collectors, in which a solar-heat pump from the Somor Company of Italy was used, studies of the feasibility and design of extremely large solar furnaces for high-temperature research, and the production of a directory and bibliography of research in this field. A reflector-type furnace for temperatures in the range 2,000°–3,000° C. has been designed which can be used interchangeably with three sources of radiation-solar, flame and the electric arc. A feature of the activities during the year in this field was the international symposium on applied solar energy, held in Arizona during November 1–5. A new phase of activity in the field of nuclear energy was to assist companies contemplating entering this field by evaluating possible markets and analysing the need for development work and associated manufacturing, marketing and financial problems. A Nuclear Energy Service was established to provide a source of up-to-date information on developments, and a study of the most suitable design of industrial reactor led to the selection of a reactor of the heterogeneous type, moderated by heavy water, with a 10-MW. heat output and a maximum neutron flux density of 2×10^{14} neutrons sq. cm./sec. Its power-level is at least ten times that of most research reactors, and it is proposed that the co-operative reactor laboratory should be owned by a non-profit corporation, subsidiary to the Institute, and that the reactor would also be available for use on a contract basis for applied research. Nuclear engineering studies included radiation studies of food products and of chemical reactions induced by radiation, while the possibilities of radiation as an industrial tool were being explored.

An extensive study was made of the research needs of the forest industries, particularly of the West, and in a new physical sciences laboratory reactions of hydrocarbons and their derivatives were being studied at pressures up to 10,000 lb./sq. in. in a new type of reaction chamber providing complete operating safety at low test. A new wing in the chemical engineering laboratory contains high-temperature electric furnaces, a spray dryer, a high-pressure air system and kindred equipment for the development of high-temperature alloys and other materials. The enlarged laboratory is also being used for trials of new processes on a scale sufficient to provide information for the design of pilot plant. In a classified study of ballistic and physical properties of solid propellants, special equipment has been provided for measuring the rate of burning of propellants in strand form, ignition time, and tensile strength at high rates of strain application. The television and vacuum-tube laboratory has been approximately doubled in capacity and has been concerned with research on video recording, the more efficient utilization of television channels and industrial applications of television techniques. From a study of existing air-modulated loudspeakers and of the principles and factors affecting efficiency, the Institute has been able to design a prototype loudspeaker—the Stanford airstream modulator—costing about a fifth as much to build as other units of this type, with about 80 per cent of the theoretical efficiency and which, with only 10 watts of air energy and 10 watts of air control, can be heard about 1·5 miles away. The addition of a new electronic computer greatly increased the ability of the Computation Centre to handle large problems, and in a single afternoon an operations research team obtained data on a complex study of the most economic method of dispatching empty freight cars that normally would have taken one man two years to procure. New equipment has also been installed in the control-systems laboratory for studies of surface physics and materials, and a new laboratory established for research on special problems in the graphic arts. The Poulter laboratories have made contributions to the understanding of detonation and hydrodynamics of shock-pulse phenomena, with consequent severalfold improvement in the efficiency of military and civil explosives, and are also engaged in combustion and general high-pressure research. An irradiation study initiated by the Sequoia Process Corporation led to a new type of polyethylene resistant to 150° C. and suitable for high-temperature application in aircraft and electronics; and, with the Bank of America, the Institute has designed an electronic recording machine which automatically does all checking of customers' accounts.

FUTURE NUMBERS OF UNIVERSITY STUDENTS IN BRITAIN

AN address on the number of university students, which Lord Simon of Wythenshawe delivered to the Court of the University of Manchester on November 16, was afterwards published in a revised and extended form in the February issue of the *Universities Quarterly*, and a reprint of this article has been issued entitled "Future Numbers of University Students: the Desperate Need for Technologists"*. In his original address, Lord Simon discussed separately both the national problem and the particular contribution Manchester could be expected to make alike in respect of the general need for expansion and the shortage of technologists; he expressed the view that no expansion should be contemplated at Manchester beyond the five thousand students for which the new buildings would provide, except that, in addition, the College of Technology should expand to reach a student population of fifteen hundred within a decade. In the pamphlet now issued, Lord Simon looks at the question of student numbers purely from a national point of view and, after reviewing the expansion since 1911, considers more particularly the measures which should be taken to meet the situation likely to arise in the next ten years. He assumes that university standards will not be raised, that the universities will continue to accept approximately the present proportion of sixth-form pupils and that accordingly they will expand to the extent necessary to admit the increased number of those attaining present standards which will be forthcoming when the increased population passing through the schools reaches the university stage from 1962 onwards. He estimates that entrants in 1965 are likely on these assumptions to be 40–100 per cent above the present level, and that it is imperative to begin at once to erect the necessary buildings.

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* Future Numbers of University Students: the Desperate Need for Technologists. (Reprinted from *Universities Quarterly*, February 1956.) By Lord Simon of Wythenshawe. Pp. 15. (London: Turnstile Press, Ltd., 1956.) 1*s*.

Lord Simon lays his main stress on technology. Pointing out that the number of degrees and diplomas in technology awarded by the universities in Great Britain has been decreasing since 1950 (from 3,593 to 3,359), he emphasizes that both the U.S.S.R. and the United States are already producing each year about twice as many graduates in science and technology per thousand of population as Great Britain, and that in the U.S.S.R. the output during the past five years has increased by more than 10 per cent a year. The Federal Institute of Technology at Zurich, he points out, has at present 2,700 full-time degree students, which is more than the three largest technological institutions in Britain put together, and the totals of 3,600 and 3,400 graduate engineers produced in Britain in 1950 and 1954, respectively, compare with 50,000 and 20,000, respectively, in the United States and 28,000 and 54,000 in the U.S.S.R. He urges that the rate of building for universities should be increased at once to provide reasonable accommodation for a 50 per cent increase in the number of students by 1965, and immediate and energetic action should also be taken to increase the output of graduates in technology by 10 per cent a year, with an ultimate output of at least ten thousand engineers a year. As a contribution to this end, he suggests the appointment of a small Royal Commission to report on the situation within six months.

MATING SYSTEMS OF FUNGI

In a paper under this title, J. H. Burnett (*New Phytol.*, 55, 1, 50 ; 1956) has attempted to classify the principal kinds of mating systems, to devise an appropriate terminology for them, and to describe how they operate and are controlled. He points out that, so far, there is no adequate and agreed terminology for describing fungal mating systems.

The terminology now proposed includes the following. Under the term 'heteromixis', he would include those instances, or imply the condition, where sexual reproduction only results from the fusion of genetically different nuclei normally derived from different thalli. Heteromixis includes : (1) 'dimixis', the condition where there are two, and only two, types of complementary nuclei which control mating, the nuclear types being determined by two allelomorphs at a single locus ; (2) 'diaphoromixis', the condition where several types of complementary nuclei occur which control mating, the nuclear types being determined by multiple allelomorphs at one or two loci, the bipolar and tetrapolar conditions, respectively ; and (3) 'homo-heteromixis', this being an essentially heteromictic condition where sexual reproduction results only from the fusion of genetically different nuclei derived normally from the same thallus ; such forms are derived from dimictic or diaphoromictic forms, hence the derived terms, 'homo-dimictic' and 'homo-diaphoromictic'.

'Homomixis' is defined as the condition where sexual reproduction can result from the fusion of genetically similar nuclei, these being usually derived from the same thallus. 'Amixis' is defined as the condition where the essential events of sexual reproduction are lacking but where the pre-conjugation and post-meiotic events normally associated with sexual reproduction may occur. The author prefers this term to 'apomixis' since the condition described is one in haploid organisms. It is so defined as to cover a wider range of conditions than does apomixis as used for conditions in higher plants. The author describes how the principal mating systems operate, and concludes that the factors which control compatibility are pleiotropic in their effects. This suggests that mating-type factors are, in fact, groups of closely linked genes.

From a review of the evolution of mating systems, he concludes that it is not possible at present to give a general account of this phenomenon. It is, however, possible to make suggestions concerning the origin and evolutionary processes involved in some of the systems, and some hypotheses are developed. A general conclusion is that mating systems have arisen in a variety of ways and that, in the first instance, selection of potential mating-type factors may not have been for their effects upon compatibility.

RESEARCHES IN THE ARCTIC OCEAN

The arctic, up to the North Pole, might be an open sea for part of each year if it were not for the piling up of pack ice into thick ridges by storms. Otherwise, ice formed during the intensely cold winter nights would be thawed completely by September. This speculation is advanced by Prof. G. E. MacGinitie, of the California Institute of Technology, in a technical report on arctic life just published by the Smithsonian Institution. Prof. MacGinitie was principal investigator at the Navy's Arctic Research Laboratory at Point Barrow, Alaska. It is highly improbable that the sea surface as a whole ever freezes during the winter to a depth of much over 6 ft. Thousands of lakes and ponds in the country behind the arctic coasts freeze to depths of more than 7 ft., yet this ice melts entirely during the summer.

During the storms of gale force that sweep over the arctic basin, the surface ice is piled up into windrows which may be several times 6 ft. thick. These drift together and constitute the great arctic pack. Summer melting is more than compensated for by the increased thickness of windrowed ice. Ice over offshore areas which has not been piled up by wind and wave disappears completely by September. The movement of the ice pack itself may have some influence on animal distribution. This pack constitutes about 70 per cent of the arctic ice. It is never stable. Previous investigations have shown that it may move as much as 1,000 miles in nine months. There is good evidence, Prof. MacGinitie says, for considering the pack as a great, moving field, the general direction of which is from north-east Siberia to the east of Greenland.

Prof. MacGinitie has also made some observations about Eskimo life.

The Eskimo birth-rate is increased as much as threefold when the arctic people eat "white man's food" instead of their traditional pure animal diet of whale, fish and seal. When hunting was the only means of subsistence, Eskimo women became pregnant only once in several years; but with the new diet they bear a baby about every year.

Of primary importance in the old Eskimo culture is the bowhead whale. Several are taken in the spring of each year and the flesh stored underground in cellars, where it remains edible for three or four years. The whales feed on euphausiids, mysids, pteropods and copepods. Baleen whales probably lead the easiest life of any mammal. These enormous creatures have only to swim slowly through water, which has about the same specific gravity as themselves, opening and closing their mouths and swallowing food. To an Eskimo the most delectable food is whale muktuk, which consists of whale skin with about an inch of underlying blubber. After freezing, the muktuk is cut into small pieces and eaten raw. Next in importance in the native economy is the bearded seal. This marine animal, which reaches a weight of 500–600 lb., feeds almost entirely on amphipods. In winter these seals are hunted in offshore leads. Unlike most seals, they float when shot, so they can be taken easily. In summer they are hunted in boats.

ANAEROBIC DEAMINATION OF D-GLUCOSAMINE BY BACTERIAL AND BRAIN EXTRACTS

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THE discovery that D-glucosamine is phosphorylated by adenosine triphosphate in the presence of brain hexokinase[1] and of yeast[2], glucosamine-6-phosphate being produced[2,3], and the demonstration[4] that competition may take place between glucose and D-glucosamine in metabolic events in the cell, led to investigations[5] on the possible inhibitory influence of D-glucosamine on the growth of cells developing at the expense of glucose breakdown. While D-glucosamine proved to be an inhibitor of growth of sarcoma 37[6], and of human epidermoid carcinoma[7], in tissue culture, it is ineffective in suppressing tumour growth in animals and man, though a positive effect was once reported[5]. The failure of D-glucosamine to act as a tumour inhibitor *in vivo* seems to be linked with its relatively rapid breakdown in the body. For this reason, experiments have been carried out to learn the details of D-glucosamine degradation in the cell. This phenomenon has been the subject of investigations by Lutwak-Mann[8], who studied the metabolism of D-glucosamine in presence of animal tissues, yeast and bacteria, and by Rosenberg[9], Rogers[10] and Oka and Murachi[11], who have studied the degradation of D-glucosamine in presence of bacteria. Biosynthesis of D-glucosamine has been demonstrated by Leloir and Cardini[12], who have shown that an interaction of hexose-6-phosphate and glutamine takes place in presence of extracts of *Neurospora crassa* to yield D-glucosamine-6-phosphate and glutamate.

Our experiments have been directed to an investigation of D-glucosamine deamination and have been carried out with extracts of *E. coli* and of brain tissue. The following is a preliminary statement of the results that have been obtained; full details will be published elsewhere. Many of the findings presented here have been reported in a thesis by one of us[13].

About 3·5 gm. wet weight of *E. coli* grown overnight in a yeast extract – peptone medium, and washed with distilled water, using a Sorvall high-speed centrifuge, were crushed in a Hughes bacterial press[14] which had been cooled to –20° C. The frozen crushed material was extracted with 20 ml. water. The debris was removed by high-speed centrifuging in the cold, and the cell-free supernatant was used for the study of D-glucosamine breakdown. Brain tissue extract was prepared by centrifuging in the cold, for 10 min. at 20,000 *g*, a rat-brain homogenate made up in isotonic potassium chloride solution (1 gm. brain tissue to 10 ml. potassium chloride), the supernatant being used as the D-glucosamine deaminating enzyme system.

Incubations were carried out in the conventional Warburg manometric apparatus at 37° under anaerobic conditions, the gas phase being a mixture of 93 per cent nitrogen and 7 per cent carbon dioxide. D-Glucosamine was estimated by a modification of the method of Elson and Morgan[15], ammonia by the method of Braganca *et al.*[16], hexosediphosphate by that of Roe[17] and phosphates by that of Fiske and Subbarow[18]. Sugar phosphates were separated by paper electrophoresis (Durrum[19]), the dried papers being sprayed with the aniline hydrogen phthalate reagent of Partridge[20] to detect the position of the sugars.

Deamination of D-glucosamine and N-acetylglucosamine takes place anaerobically in an extract of *E. coli*, the process being dependent on the presence of adenosine triphosphate and magnesium ions. Little or no breakdown of D-glucosamine takes place in the bacterial extract under anaerobic conditions; in the presence of adenosine triphosphate, however, utilization of glucosamine may be readily demonstrated. For example, 2·8 μmoles of D-glucosamine were removed from the system when 10 μmoles of the amino-sugar were incubated anaerobically with 1 ml. of *E. coli* extract at 37° C. for 45 min. in the presence of 6·7 μmoles adenosine triphosphate. Further results, in which the rates of deamination of D-glucosamine and N-acetylglucosamine are compared, are shown in Table 1. They demonstrate that glucosamine is deaminated at a slower rate than N-acetylglucosamine; but when mixtures of glucosamine and N-acetylglucosamine are incubated with adenosine triphosphate, a more than additive rate of ammonia production takes place.

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Table 1. DEAMINATION OF D-GLUCOSAMINE AND N-ACETYL-D-GLUCOSAMINE IN THE PRESENCE OF *E. coli* EXTRACTS

Present: bicarbonate, 0·028 *M*; magnesium sulphate, 0 0033 *M*; *E. coli* extract, 1 ml. Where added. sodium adenosine triphosphate, 0 0033 *M*. Total vol. 3 ml. Incubation time, 55 min.

	Ammonia formed (μmoles)	Ammonia formed from amino-sugar (μmoles)
Exp. 1		
Adenosine triphosphate	2 2	0
+ D-glucosamine (0·01 *M*)	3·7	1·5
+ N-acetyl-D-glucosamine (0·01 *M*)	4·6	2 4
+ D-glucosamine (0 01 *M*) + N-acetyl-D-glucosamine (0 01 *M*)	7 5	5 3
Exp. 2		
Adenosine triphosphate	0 6	0
+ D-glucosamine (0·01 *M*) + N-acetyl-D-glucosamine (0 0003 *M*)	3 2	2 6
Adenosine-5-phosphate	1·2	0
+ D-glucosamine (0 01 *M*) + N-acetyl-D-glucosamine (0 0003 *M*)	1·5	0·3
Exp. 3		
Adenosine triphosphate		
+ 30 μmoles D-glucosamine	—	0·4
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0 2 μmole)	—	0·9
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0 4 μmole)	—	1 9
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0·8 μmole)	—	2 9

The virtual necessity of the process of anaerobic deamination of D-glucosamine for adenosine triphosphate makes it likely that the substrate for deamination is D-glucosamine-6-phosphate. A similar conclusion applies to the anaerobic deamination of N-acetylglucosamine, the phosphate ester of which is also formed in the presence of adenosine triphosphate and *E. coli* extract.

Soodak[21] has recently noted that extracts of *E. coli*, prepared by sonic rupture of the cells, phosphorylate D-glucosamine and N-acetylglucosamine in the presence of adenosine triphosphate and magnesium ions.

It is easy to demonstrate by the manometric technique[1] that dialysed *E. coli* extracts bring about the phosphorylation of glucose and D-glucosamine in the presence of adenosine triphosphate, the same hexokinase being apparently involved as shown by competitive experiments. The phosphorylation of N-acetylglucosamine requires a separate kinase as shown by the additive rate of phosphorylation which is exhibited when a mixture of glucose and N-acetylglucosamine is incubated in the presence of an *E. coli* extract and adenosine triphosphate.

Glucosamine breakdown in an *E. coli* extract is inhibited by the presence of glucose. Thus, the addition of 0·01 *M* glucose to a system containing 0·005 *M* D-glucosamine, 0·0005 *M* N-acetylglucosamine, 0·003 *M* adenosine triphosphate, 0·003 *M* magnesium sulphate and *E. coli* extract brought about almost a complete cessation of the disappearance of D-glucosamine. This phenomenon is doubtless due to competition between glucose and D-glucosamine for the same hexokinase. Lutwak-Mann[8] and Oka and Murachi[11] have reported that glucosamine deamination by resting *E. coli* is inhibited by a number of sugars.

Adenosine triphosphate cannot be substituted by adenosine-5-phosphate for the anaerobic deamination of D-glucosamine in an *E. coli* extract (Table 1). A mixture of acetyl phosphate and adenylic acid, however, can effectively replace adenosine triphosphate.

The D-glucosamine anaerobic deaminating system in *E. coli* is unaffected by the presence of either diphosphopyridine nucleotide or by L-glutamate or by pyridoxal phosphate.

Electrophoresis on filter paper of a mixture of D-glucosamine, a trace of N-acetylglucosamine, magnesium ions, adenosine triphosphate, and dialysed *E. coli* extract, after anaerobic deamination at 37° has been allowed to proceed for one hour, shows the presence (after treatment of the paper with aniline hydrogen phthalate) of two products. Their positions are identical with those taken by authentic samples of D-glucosamine-6-phosphate and of hexosediphosphate. Soodak[21] has reported that, in the degradation of N-acetylglucosamine by *E. coli*, fructose-6-phosphate is formed. It is possible that the hexosediphosphate formed in our experiments is produced secondarily by phosphorylation of fructose-6-phosphate by excess adenosine triphosphate present. Thus the evidence would indicate the existence of the following reaction sequence in an *E. coli* extract:

$$\text{D-glucosamine} \xrightarrow{\text{ATP}} \text{D-glucosamine-6-phosphate} \rightarrow$$

$$\text{fructose-6-phosphate} + \text{ammonia} \xrightarrow{\text{ATP}} \text{hexosediphosphate.}$$

Stimulatory effects of N-acetyl glucosamine with E. coli. A noteworthy feature of anaerobic D-glucosamine deamination by *E. coli* extracts is the stimulatory effect of small quantities of N-acetylglucosamine. Although N-acetylglucosamine is itself phosphorylated and deaminated by *E. coli*, its presence in low concentrations greatly increases the rate of D-glucosamine deamination. For example, the presence of 0·0005 *M* N-acetylglucosamine doubled the rate of disappearance of D-glucosamine in an *E. coli* extract containing 0·005 *M* D-glucosamine and 0·003 *M* adenosine triphosphate. Results of a typical experiment showing the stimulatory effect of N-acetylglucosamine on D-glucosamine deamination are given in Table 1.

Crude *E. coli* extracts deaminate D-glucosamine anaerobically so long as adenosine triphosphate and magnesium ions are present. Dialysed *E. coli* extracts bring about little or no anaerobic deamination of D-glucosamine in the presence of adenosine triphosphate and magnesium ions unless a small quantity of N-acetylglucosamine is added.

The stimulatory action of N-acetylglucosamine on D-glucosamine deamination cannot be brought about by such acetylated substances as N-acetylmethionine, acetylcholine or N-acetylglycine.

Inhibition of E. coli phosphatase by N-acetylglucosamine. The stimulatory action of N-acetylglucosamine may be due in part to the remarkable effect of this substance in inhibiting hexosemonophosphate breakdown in *E. coli* extracts. At concentrations of 0·001–0·002 *M*, N-acetylglucosamine will secure inhibitions of 50 per cent or more of hydrolytic breakdown of hexosemonophosphates. Typical results are shown in Table 2. Inhibitions of this order are not found with hexosediphosphate breakdown.

D-Glucosamine at 0·002 *M* shows no inhibition of glucose-1-phosphate hydrolysis with an *E. coli* extract under conditions where N-acetylglucosamine shows 94 per cent inhibition. Neither glucose nor

Table 2. EFFECTS OF N-ACETYLGLUCOSAMINE ON PHOSPHATASE ACTIVITY OF DIALYSED *E. coli* EXTRACT

Substrate (0 01 *M*)	Concentration of *N*-acetylglucosamine	Percentage inhibition of phosphatase
Glucose-1-phosphate	0 001 *M*	50
	0 002 *M*	76
	0 01 *M*	88
Glucose-6-phosphate	0 002 *M*	50
Fructose-6-phosphate	0 002 *M*	33
Hexosediphosphate	0 001 *M*	2

fructose is as effective an inhibitor of glucose-1-phosphate breakdown as N-acetylglucosamine.

In view of this phenomenon, it is suggested that the stimulatory or catalytic action of N-acetylglucosamine on anaerobic D-glucosamine deamination may be due in some measure to an inhibitory effect on the hydrolysis of a phosphate ester formed during the course of D-glucosamine breakdown. Conceivably, however, the phosphate ester of N-acetylglucosamine may play a part in the catalytic reaction.

Deamination of D*-glucosamine by brain extracts.* D-Glucosamine is deaminated anaerobically by a dialysed brain extract in the presence of adenosine triphosphate and magnesium ions. This process is not, however, stimulated by the addition of N-acetylglucosamine. It should be noted in this connexion that N-acetylglucosamine at 0·01 *M* has no inhibitory effect on animal phosphatases, for example, prostate acid phosphatase, intestinal alkaline phosphatase, kidney phosphatase. N-acetylglucosamine is not deaminated in brain extracts, nor does it undergo phosphorylation in the presence of adenosine triphosphate[1]. The presence of glucose inhibits anaerobic deamination of D-glucosamine in a brain extract, this probably being due to competition between glucose and glucosamine or between their respective esters.

The evidence would indicate that D-glucosamine-6-phosphate is the substrate of the anaerobic deaminating enzyme in brain tissue as in *E. coli*, but that the factors in *E. coli*, operating with N-acetylglucosamine and which account for the effects of this substance in the bacterial deaminating system, are not present in the brain extract.

We are indebted to the National Cancer Institute of Canada for a grant-in-aid.

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FACTORS AFFECTING THE VERNAL PHYTOPLANKTON OUTBURST IN THE ENGLISH CHANNEL

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WHEN in 1923[1] a systematic survey was begun of the seasonal variation in phosphate in the waters of the English Channel, it soon became clear that the time of the phytoplankton outburst, as indicated by phosphate consumption, might vary by eight or ten weeks[2].

The phosphate is at a maximum about the end of January. Thereafter increasing light intensity favours growth and cell multiplication, though vertical circulation, which brings cells down to badly lighted depths, slows the processes. Warming of the surface water progresses until a stable layer is maintained above a colder deep layer. Since the group of the phytoplankton which predominates in these waters—the diatoms—takes up silica for the valves, the changes in this were also ascertained[3].

The delays in the spring outburst were puzzling and not easily accounted for by any alteration in the seasonal increase in light, though, of course, the influence of vertical mixing is difficult to assess. It was suggested by Harvey[4] that some minor constituent of sea water might be lacking for growth. Sverdrup, Johnson and Fleming[5] also suggested that some conditioning of the water was necessary. It was then pointed out by Atkins[6] that this seemed unlikely as it was so early in the year, and complete regeneration of phosphate, and presumably of other constituents, had just occurred. Furthermore, a lag in phosphate consumption, well beyond that expected from the illumination, was a mathematical necessity. Only after repeated cell divisions could the phosphate consumption come within the limit detectable by our most sensitive methods. Once detectable, repeated doublings in consumption soon led to exhaustion.

There were, however, other questions behind this: How great had the winter reduction in the number of the diatoms been? Multiplication of a smaller stock required, of necessity, a longer period to become perceptible. There might be an inflow of a water mass with a lower population; but against this was a uniform phosphate content and a uniform salinity over an area in which meteorological conditions were reasonably constant. We finally approached the problem through the neglected study of the algal cells themselves[7]. Filtering water on collodion disks, we extracted with 80 per cent aqueous acetone and examined the clear liquid by spectrophotometer, measuring in the chlorophyll absorption bands. Volumes of the water were also placed in diffuse light, after enrichment with nutrient salts, and the development of many algal species was studied by repeated examination. In time we came across a year in which the low chlorophyll yield found in January was followed by a slightly lower yield in February. Even March was low. At first it seemed impossible. But phosphate determinations in 1925 [2] had indicated very similar late development. The routine phosphate and silicate determinations were at this period made by Armstrong[8] and, as always, the salinity by the Government Chemist's Laboratory. Neither temperature nor salinity suggested that the water mass at our station, *E*1, was in February or March different from what it had been in January. Both pointed to identity, as did also the phosphate, which even rose very slightly in February. But the silicate analyses were startling; from February on they were at a much lower level, having fallen from 4·70 to 2·83 μgm. atoms of silicon per litre. This, unaccompanied by a fall in phosphate, was clear proof that we had to deal with a different water mass, in which the chlorophyll values indicated a sparse plankton. The cultures, too, showed certain differences in the predominant species.

It thus appears that the lateness of the phytoplankton outburst was, in 1954 at least, due to a change in the water mass, which was undetectable by the usual criterion, salinity. This does not, however, demonstrate that mere changes in the vertical circulation may not, in other years, be of importance. We hope shortly to publish elsewhere the full account of such yearly changes.

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ELECTROMAGNETIC PHENOMENA OF NATURAL ORIGIN IN THE 1·0-150 C./S. BAND

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ALTHOUGH electromagnetic activity of natural origin has been intensively studied in geomagnetic work, the frequencies involved usually have been no higher than 0·1 c./s. However, Willis[1] has reported the detection of magnetic noise fluctuation signals in the 5–800 c./s. band; and Aarons and Henissart[2] have reported observing signals with equipment of band-pass of 0·5–20 c./s.

To determine some of the characteristics of natural activity at low audio and sub-audio frequencies, the University of Oregon, with the assistance of the Research Corporation, has conducted a series of observations of geo-electromagnetic activity in the 1·0–150 c./s. band. The observations were carried out during the summer of 1955 at an isolated place in eastern Oregon (lat. 43° 27′ N., long. 120° 35′ W.) where no interference by power lines was observable.

For detecting signals, two air-core detector coils were used. One, of effective area 12,800 sq. m., was arranged to observe the vertical magnetic field component; the other, with an effective area of 5,500 sq. m., was arranged to observe the horizontal north–south component. The signals from the coils were amplified with an amplifier having a band-pass of 1·0–150 c./s. Coil voltage wave-forms, proportional to the time-rate of change of the magnetic field, were studied by mean of a photographically recording cathode-ray oscilloscope. Oscilloscope recordings depicting the wave-form of the inducing field itself were obtained with the aid of equalizing networks, adjusted so that the response of an entire observing system, including the detector coil, was proportional only to the instantaneous value of the field. Coil-voltage signal-level was continuously recorded by means of a rectifying, ink-recording milliammeter with linear response.

Activity in the low-frequency bands was found to be due to disturbances which are almost all of a predominantly burst-like form. Fig. 1, a photograph of an oscilloscope display of the wave-form of the

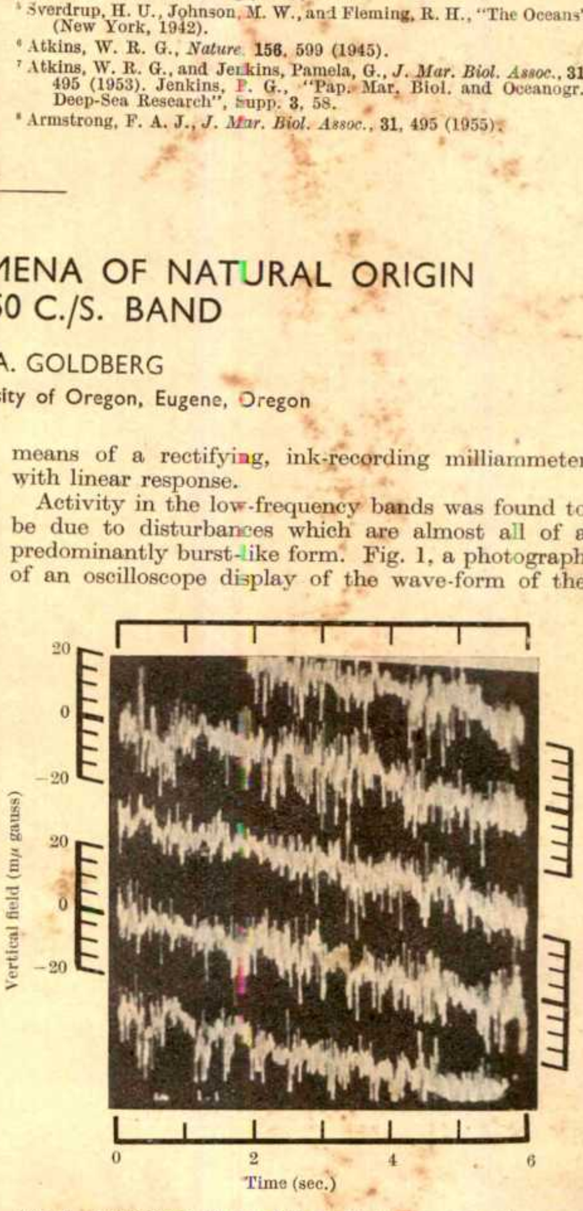

Fig. 1. Oscilloscope display of the vertical component of super low-frequency magnetic fluctuations, 16 : 34, Aug. 18, 1955, L.M.T. In the five-sweep raster, each sweep represents a time of 6 sec.

vertical fluctuating magnetic field, shows this principal feature of the activity in the 1–150 c./s. band. The magnitude of the vertical field bursts are of the order of 10^{-8} gauss. The rate of countable bursts is of the order of 20 bursts per second. Expanded scale-sweeps show the bursts to have durations ranging from 4 to 10 m.sec. (It should be noted that, in Fig. 1, long-period fluctuations, of duration greater than about 0·1 sec., are due to system noise, the low frequencies of which are emphasized by the equalizing network. Also, the broadening of the sweep base-line, when the inducing field is apparently quiescent, is due to small unresolved bursts.)

Both the north–south and vertical magnetic components of the activity are, so far as could be determined, similar as regards rate and duration of bursts. The north–south component is, however, much the stronger, having a magnitude of the order of 3×10^{-7} gauss.

Coil signal voltage, a typical wave-form of which is shown in Fig. 2, was used as a basis for continuous 24-hr. monitoring of the level of activity of burst disturbances. Coil voltages were amplified without equalization, full-wave rectified and then recorded on a recording milliammeter. The five-second response time of the recorder was sufficiently long to give an easily readable smoothed indication.

The level of the super low-frequency disturbance activity, recorded in this manner, varies considerably during a 24-hr. period, but in a highly systematic fashion. Fig. 3. which is a plot of quarter-hour values of rectified coil-signal voltages, due to north–south field activity, indicates the highly regular and diurnal nature of the variation of the activity.

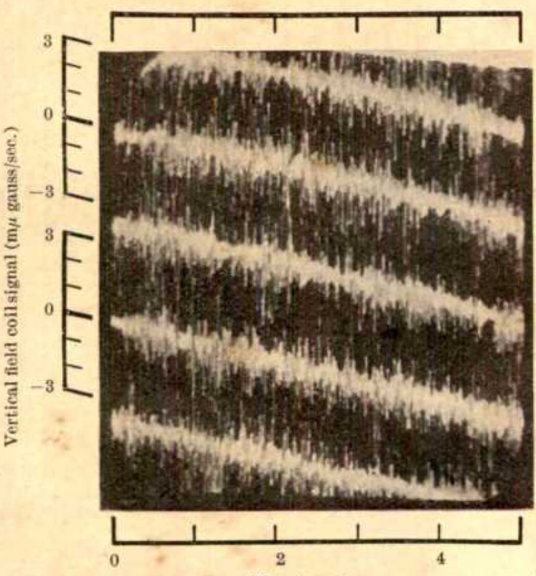

Fig. 2. Oscilloscope display of coil voltage wave-form due to vertical component of fluctuating magnetic field, 16 : 11, Aug. 19, 1955, L.M.T.

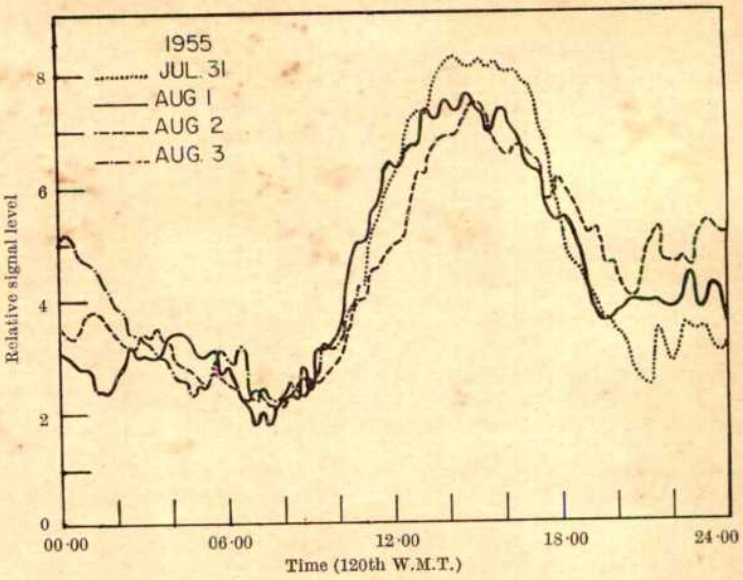

Fig. 3. Daily variation of coil signal-level due to north–south horizontal component of super low-frequency magnetic fluctuations

The 24-hr. variation of the signal level as observed with the vertical-component coil has a similar form, and for both components the level varies by a factor of about 4 during a typical day.

Analysis of some additional results confirms the regular and pronounced diurnal variation, although there are differences in minor details from day to day. However, the features of a principal minimum occurring at 0700 hr. L.M.T., a secondary minimum at 2100–2200 hr., a very strong major maximum at 1400–1600 hr., and a minor maximum at 2300–0100 hr., were always strongly present during the summer observations.

The burst character of the super low-frequency disturbances is suggestive of atmospherics such as are observed on the radio-frequency bands, and which are attributed to lightning activity. Simultaneous comparison with radio-frequency atmospherics at 500 kc./s. usually showed a correspondence; and so the super low-frequency activity is probably largely, if not entirely, due to lightning activity. However, the daytime maximum of super low-frequency activity as contrasted with the daytime minimum of medium radio-frequency atmospherics signals indicates that different features of propagation are involved.

The general form of the curve of Fig. 3 is taken to represent the manner in which the variation of sources of disturbance is modified by daily variations of the earth–ionosphere propagating system. Because of the extremely long wave-lengths characterizing the super low-frequency activity, it is the variations of the lowest level of the ionosphere which should be important in this connexion. An important feature of the curve in this regard is the regular morning minimum, which for the summer observations occurred at 0700 hr. L.M.T. The indication then is that for the daytime ionosphere the lowest level of ionization affecting super low-frequency propagation between points on the sunlit hemisphere begins to be effective about two hours after ground sunrise.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Investigation of Monochromatic Radio Emission of Deuterium from the Galaxy

The possibility of monochromatic radio emission from galactic deuterium has been well known for some time, and the frequency of such an emission line predicted by Shklovsky[1]. The expected maximum intensity is such that any attempt to detect the line must rely on extremely long integrations in time. In practice, this requires either direct electrical integrations over a long period or the manual summation of a series of individual records. One attempt to detect the line using manual methods has already been published[2].

The radiometer used in our experiments was of a type used by van de Hulst, Muller and Oort[3]. One major difference was the use of a reactance tube switch rather than two oscillators. A filter bandwidth of 16 kc./s. was used, and the spacing between the filters was 48 kc./s. These parameters were derived from considerations based on the hydrogen line profiles in the direction of the galactic centre.

The receiver input stage was a simple crystal converter, which was used mainly for obtaining uniform sensitivity and maximum reliability. The single band noise factor of the receiver was measured at 6, and this noise factor also checked for uniformity over the frequency sweep. A commercial co-axial diode was used for checking the noise factor, and this instrument was in turn checked against laboratory receivers.

Frequency calibration of the second local oscillator (37 Mc./s.) was checked by an interpolation from a 2 and 5 Mc./s. crystal oscillator. These crystal units were in turn checked against *WWV*. The drift of this oscillator was found to be less than 1 kc./s. over a period of a month; consequently no check was kept on it during an observation, and calibration was limited to immediately before and after a record. The first local oscillator was set on 296 Mc./s. and a constant check was kept on the heterodyne beat note during an observation with the harmonic of a 2 Mc./s. crystal oscillator.

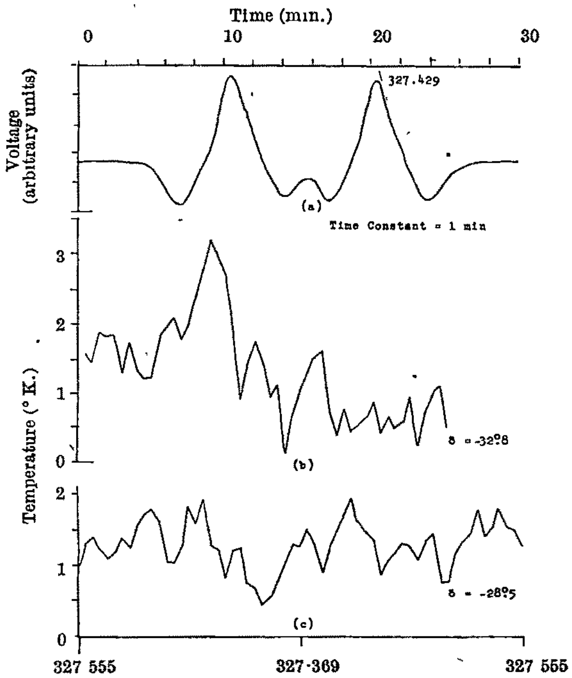

Fig. 1. Integration of five records

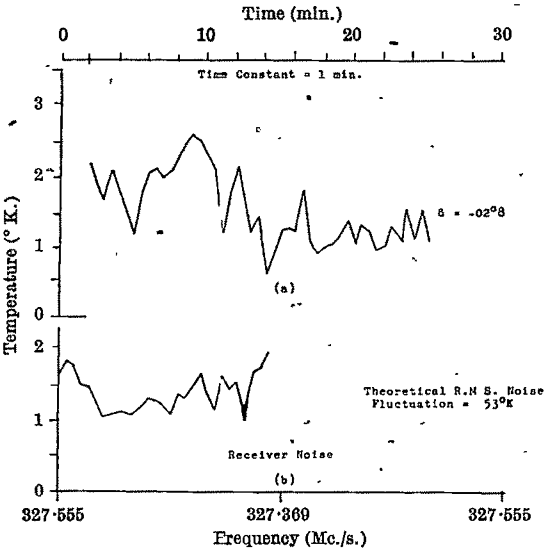

Fig. 2. Integration of eight records

The antenna system was a paraboloid of 80 ft. diameter, described by McGee, Slee and Stanley[4]. To maintain the frequency response as flat as possible, a cylindrical dipole was used as the primary feed. An overall calibration of the antenna system was difficult due to the limited angular movement of the beam. However, measurements of solar radiation, which were possible only near the summer solstice, were in good agreement with those made on the same day with other solar equipment. A relative check was set up at the same time, consisting of a known signal radiated from a dipole placed near the antenna.

Observations were limited to the region about the galactic centre and the region in the galactic plane at l — 220°. All observations were reduced to the local standard of rest.

Early observations were made by automatically scanning with the receiver through 200 kc./s. as the direction of the galaxy passed through the antenna. Such methods failed to detect any radiation. In the later records graphical integration was performed to increase the sensitivity.

A complete frequency scan occupied 15 min., and to compensate partially for the observation with a fixed antenna the phase of the frequency with respect to sidereal time was staggered on successive runs. The time constant of observing was 1 min. Fig. 1(*a*) shows the profile expected from a monochromatic line and Figs. 1(*b*) and (*c*) the results of five integrations at declinations — 32·5° and — 28°. Fig. 2 shows eight integrations at declination — 32·8°, together with a sample integration of noise alone for the same number of records.

As there was still some doubt about Fig. 2, a further series of four observations with a time-constant of 3·5 min. and a scan of 50 kc./s. was made at declination — 32·8°, and the results are given in Fig. 3.

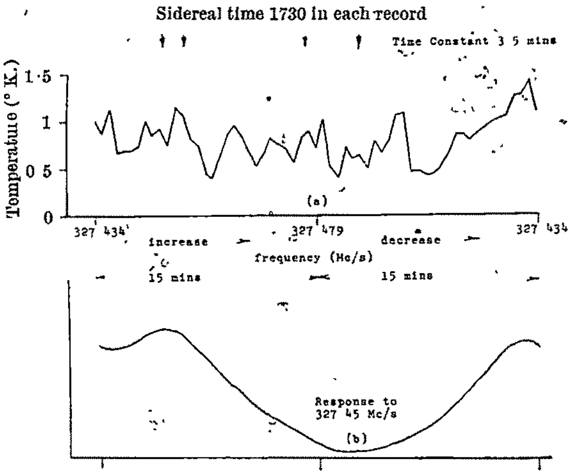

Fig 3. Integration of four records

We conclude that a monochromatic radiation from deuterium could not be detected at the galactic centre to a limit of better than 1° K. aerial temperature. Shklovsky has estimated that 1/500 of the aerial temperature of the continuous radio radiation from the galaxy at this frequency seen in absorption corresponds to a concentration of deuterium equal to 10^{-3} of the concentration of hydrogen in the galaxy. For the antenna used the aerial temperature of the central source is approximately 800° K. The abundance of deuterium should therefore be less than 10^{-3} that of hydrogen.

This work was carried out during 1954 at the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization, Sydney, Australia.

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A Simple Method of studying Winds in the Ionosphere by using Continuous-wave Radio

Systematic study of horizontal movements in the ionosphere has been made during the past few years by using the spaced-transmitter technique developed by Munro[1], which is applicable only for the F_2 region, and the spaced-receiver method first employed by Mitra[2]. However, both these methods require elaborate and expensive ionospheric pulse-sounding equipment. We present here a simple method of studying winds in the ionosphere using continuous-wave transmissions and a simple receiver with a recording system.

The method is essentially similar in principle to the spaced-receiver pulse technique and involves the use of continuous-wave transmissions from a distant short-wave transmitter arriving at the receiving site by way of single reflexion from the ionosphere. Simultaneous records of the variations of signal strength at three spaced points due to these transmissions showed fading patterns which are almost identical but displaced in time. The wind velocities and directions are then estimated from these time displacements using a method of calculation similar to that in the spaced-receiver pulse method.

Continuous-wave transmissions from Madras on the 31-metre band have been used in this investigation for obtaining the simultaneous records of variation of signal strength at the spaced-receiver points. Three simple vertical aerials R_1, R_2 and R_3 each of length 8 ft. are placed at the corners of a right-angled triangle such that R_1 and R_2 and R_1 and R_3 are along the north–south and east–west directions with separations of 64 and 60 metres respectively. The signals induced in all these aerials are brought to a central recording station by using coaxial shielded cable. In the earlier part of this investigation we used three galvanometers which are suitably damped, and three communication receivers connected to these aerials, for obtaining the simultaneous record of the variations of signal strength. Light spots reflected from these three galvanometers trace out the variations of signal strength side by side on the same photographic paper moving with a speed of 12 in. per min. The photographic paper is rolled on a special drum recording-camera driven by a synchronous motor at the rate of one revolution per min. With the view of eliminating the variations, if any, in the signal-strength records for all the aerials, we afterwards simplified the technique still further by using only one communication receiver, National *HR* 07, and a specially designed two-pole three-way rotary switch driven at 1,420 r.p.m. by a 1/8 h.p. motor. The switch consists of two sections each of which has a rotating vane moving over three insulated brass contacts of equal length arranged in a circle. The input and automatic volume control terminals of the receiver are connected to the movable vanes of the two sections of the rotatory switch in such a way that during the rotation each galvanometer is connected to the amplified signal from one of the aerials only during one-third of the rotation. The rate of rotation of the movable vane of the switch being quite high, a smooth fading record is obtained though it is an interrupted signal that is fed to each galvanometer.

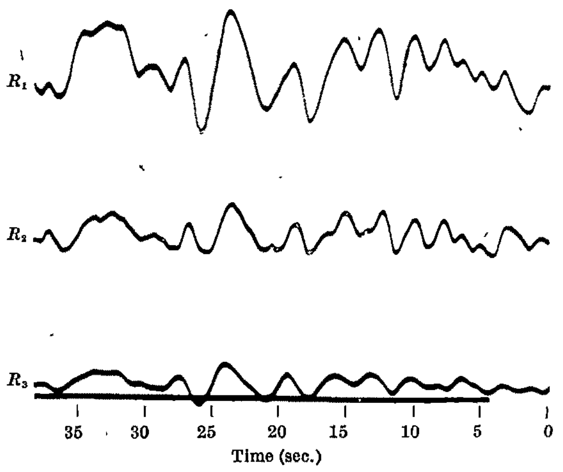

Fig. 1

A typical record obtained with this arrangement on October 30, 1955, from 0900 hr. is shown in Fig. 1. It can be clearly seen that the pattern is almost identical in all the three records with a slight time displacement. From the known data of the critical frequencies and the maximum usable frequency factor it was inferred that the reflexion is from the F_2-region of the ionosphere. The wind velocities and directions in the F_2 region are then determined from these time differences, which are attributed to the horizontal drift of the diffraction pattern on the ground produced by irregularities in the ionosphere. Results obtained for wind velocities in the F_2 layer are found to be in the range 40–90 metre/sec., the direction of wind movement being predominantly in the range of 150°–230° east of north. These observations are in agreement with the values obtained by us using the spaced-receiver pulse technique. We have also tested the reliability of this method by determining the wind velocities and directions from records taken almost simultaneously using the transmissions on the 31-metre band from Calcutta and Madras which are situated to the north and south of Waltair. The values thus obtained for both the records agree very well.

The method has the unique advantage of simplicity of technique, because no pulse transmitter and the associated trigger circuits and oscillographs required for the spaced-receiver pulse method are needed. The only disadvantage is that the transmission must be so chosen that fast magneto-ionic fading and periodic fading due to multiple reflexions are not present. We have chosen the times of observations and the frequencies of transmissions such that only the single-hop reflexion from one layer is prominent.

A detailed report of these investigations will shortly be published elsewhere. We thank the Radio Research Board for sponsoring this research scheme, and the Council of Scientific and Industrial Research for financial assistance.

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Sudden Decrease in Low-frequency Atmospheric Noise during the Cosmic-Radiation Storm of February 23

At Churchill, Manitoba (lat. 58·8° N., long. 94·2° W.), an unusual event occurred on the 100-kc./s. atmospheric noise recordings on the morning of February 23. Churchill is situated near the region of maximum intensity of the auroral zone.

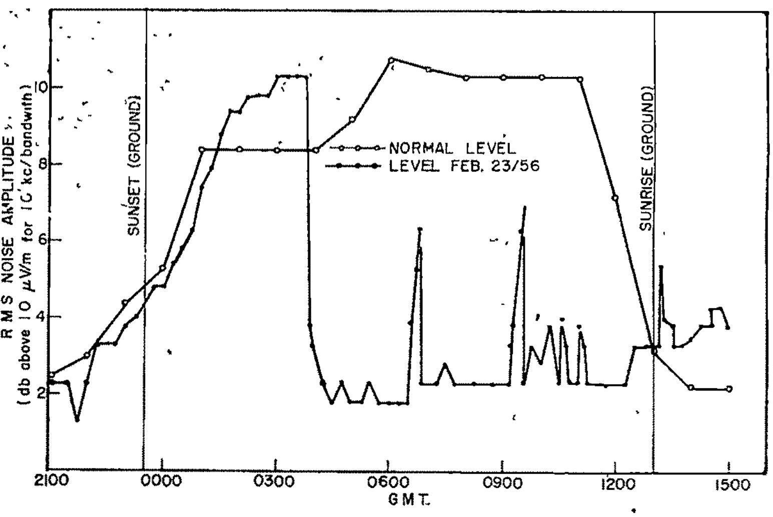

Fig. 1 Atmospheric noise at Churchill, Manitoba

In Fig. 1 two graphs of the root-mean-square atmospheric noise amplitude (decibel above 1·0 µV./m. for a 1-kc./s. band-width) versus time (G.M.T.) are plotted, from 2100 hr. February 22 to 1500 hr. February 23. One of the curves shows the normal variation of noise at Churchill for this particular time of year. The other curve shows a sudden decrease of atmospherics beginning at 0345 G.M.T. on February 23.

This decrease of atmospherics is the first of its kind to be recorded in Canada at a high-latitude station. The largest part of this decrease is a drop in noise amplitude of 6 db. in less than 10 min. The noise continued to fall another 2 db. in the next half-hour to its normal day-time level. The noise continued at this day-time level except for a few short bursts until the early hours of February 24 when the noise-level increased 3–4 db. The atmospheric noise-level did not return to its full normal condition until February 27.

During this same period, in the sunlit half of the hemisphere, Tokyo reported a large solar flare of 'Importance 3', beginning at 0334 and ending at 0414 G.M.T. The time of maximum intensity of this flare was not recorded. During this same period and coinciding in time with the decrease of noise at Churchill, the National Bureau of Standards, Colorado, reported an exceedingly large increase in cosmic-ray activity beginning at 0345 G.M.T.

During the winter months, the nearest sources of atmospheric noise to Churchill are Central America and the northern part of South America. At the time of this sudden fadeout, propagation from these sources was entirely through the dark half of the hemisphere, which makes this particular record unique and, as such, it cannot be termed a normal S.I.D.

The vertical-incidence sweep-frequency ionospheric recorder at Churchill, operating the range of frequencies 0·6–20 Mc./s., did not show signs of increased absorption until 1 hr. later. At 0445 G.M.T. the minimum frequency of $f0F2$ began to increase until 0530 hr., when a total blackout condition existed. During the next 65 hr. a total of 53 hr. of full blackout was recorded. Farther north at Baker Lake (lat. 64·3° N., long. 96·0° W.), the ionospheric recorder did not show blackout condition until 0600 hr. G.M.T., which is one half-hour later than the commencement of the blackout at Churchill. For the same 65-hr.

period a total of 47 hr. of total blackout was tabulated. The more southerly stations, Winnipeg (lat. 49·9° N., long. 97·4° W.) and Ottawa (lat. 45·4° N., long. 75·9° W.), did not show any immediate effect of the ionospheric storm except for a high degree of absorption at the minimum frequency of *f0E* and an unusual amount of sporadic *E* during the daylight period of February 23. The ionospheric tabulations from Kjeller, Norway, which is in approximately the same geomagnetic latitude as Winnipeg, Canada, show that the storm there began near 0500 G.M.T., which is the same time as at Churchill, Canada. However, it was much less severe, with only two hours of total blackout condition at 0700 and 0800 hr. G.M.T.

For this solar flare there appeared to be a sudden increase in the *D*-region absorption on the darkened half of the hemisphere which cannot be attributed to ultra-violet radiation. It also appears that this condition may occur only at high latitudes situated near the auroral zone.

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Termination of Chains in Vinyl Polymerization by Metal Salts

In a recent communication, Bamford, Jenkins and Johnston[1] have stated that ferric chloride dissolved in non-aqueous solvents is reduced by polymer radicals according to the equation:

$$m_j + \text{Fe(III)} \xrightarrow{k'_t} P_j + \text{Fe(II)} \qquad (1)$$

and that in certain circumstances the rate of formation of divalent iron can be identified with the rate of initiation of polymerization. Our purpose is to report very briefly some recent results obtained in these laboratories, some of which have already been published[2], which (*a*) indicate that the oxidation and reduction of organic radicals by metallic salts is a general phenomenon which can take place in a variety of media, (*b*) confirm that the rate of the reaction depends on the polymeric radical, (*c*) show that the rate depends on the nature of the metal ion, (*d*) show that in a polymerization system in which the probability of chain transfer is low this reaction can be used for determining the number average degree of polymerization, and (*e*) demonstrate that reaction (1) is useful in studying post-irradiation effects.

As regards (*a*) and (*c*), we have pointed out elsewhere[2] that polyacrylamide radicals dissolved in water will reduce the following ions: Fe^{3+}_{aq}, $\text{Fe}^{3+}\text{OH}^-$, and Cu^{++}. We have recently measured the velocity constants for some of these reactions, and the values at 25° C. for the first two of these ions are $2 \cdot 2 \times 10^{-3}$ and $1 \cdot 4 \times 10^4$ l.mole^{-1} sec.$^{-1}$ respectively[3]. There is evidence that radicals derived from some simple organic molecules such as alcohols and aldehydes by the attack of hydroxyl radicals will reduce ferric ions, whereas those from acetone or acetic acid oxidize ferrous ions[4], and phenyl radicals appear to be capable of either reaction[5], in aqueous solutions. The study of the X- and γ-ray irradiation of de-aerated dry alcoholic solutions of ferric chloride demonstrates the great ease with which this solute is reduced by organic free radicals in this medium[6].

In discussions of the mechanism of these reactions[7], we have emphasized that the lower the ionization potential of the reducing ion the more likely is the organic radical to be reduced, and have cited in support of this the capacity of chromous ions to reduce polyacrylonitrile radicals in water[8]. The hypovanadous (V^{2+}), vanadous (V^{3+}), molybdenous (Mo^{3+}), titanous (Ti^{3+}), uranous (U^{3+}) and azide ions react in a similar way[9]. It has also been pointed out that the reactivities of organic free radicals towards inorganic ions depend on the oxidation-reduction potentials for the processes $R \rightarrow R^+ + e$ ($E_{(-e)}$), and $R + e \rightarrow R^-$ ($E_{(+e)}$)[10].

Recently, we have been re-investigating the behaviour of various polymer radicals in water and now find that, whereas polyacrylonitrile radicals and polyacrylamide radicals will reduce ferric perchlorate, polymethyl methacrylate radicals react only slowly if at all[11]. The implication is that the oxidation potentials, $E_{(-e)}$, of the radicals from acrylonitrile and acrylamide are less positive (on the European scale), while the potential $E_{(+e)}$ of the radical from methyl methacrylate is more positive, than the potential of the ferrous/ferric system under the conditions obtaining.

When the rate of polymerization is proportional to the monomer concentration and the radiation intensity (with ultra-violet light or ionizing radiation) and is inversely proportional to the weighted sum of the concentrations of the ferric species present, the rates of initiation and termination of the chains are equal to the rate of formation of ferrous species in the latter reaction. This relation may be used in two ways. First, the rate of chain initiation can be evaluated in the manner described by Bamford *et al.*[1] and by us[2,3]. Secondly, when the transfer constants are so negligible that the kinetic chain-length is equal to the number average degree of polymerization ($\overline{DP}$) we may write:

$$\overline{DP} = R_p \bigg/ \frac{\text{d Fe(II)}}{\text{d}t} \qquad (2)$$

and $\overline{DP}$ may be found directly from the measured rates of polymerization and of ferrous ion formation. This is the state of affairs referred to in (*d*) above, and it obtains when acrylamide is polymerized in aqueous solutions containing ferric salts, the polymerization being initiated with light of wave-length 3130 A., X-rays or γ-rays[2,3]. In these systems there is no detectable transfer to the solvent, the ratio of the monomer-transfer constant to the propagation constant[3] is 10^{-5} and the ferric ion present restricts the value of $\overline{DP}$ to $< 10^4$.

In both the catalysed and the radiation-initiated polymerization of acrylamide and acrylonitrile in aqueous solutions, certain long-lived after-effects are observed, the origin of which does not concern us here[3,11]. In the study of these effects it is important to know the rate of initiation, and this may be found quite simply by measuring the rate of ferrous ion formation in systems containing sufficient ferric salt to ensure that chain termination is exclusively by reaction (1). The values of the rates of initiation so obtained agree with those calculated from other properties of the after-effect[3].

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Change of Hardness in Steel due to Hydrogen

A change in the hardness value of a steel due to the presence of diffusible hydrogen has been detected and found to be in agreement with that predicted from the change in the work-hardening characteristics of the particular steel. This change in hardness has not previously been observed[1–3].

Maximum embrittlement of a steel containing a given amount of hydrogen has been shown by numerous investigators to be dependent on the rate of strain and the temperature of tensile testing. These factors indicate dependence on diffusion. It follows, therefore, that the rate of loading of the indentor in hardness tests must also be critical. A slow-loading hardness test has been devised and has shown changes of hardness dependent on the hydrogen content of the steel.

Specimens were prepared from a wrought, low-carbon (0·17 per cent) mild steel. Hydrogen was introduced cathodically using a 10 per cent aqueous solution of sulphuric acid containing a trace of arsenious oxide and a current density of 0·2 amp. per sq. in. Hardness tests were carried out at room temperature using a ball indentor of 1-mm. diameter and a load of 10 kgm. An oil dashpot device in the hardness tester was adjusted so that the time taken to form the indentation was 60 sec., the load being applied for a further 15 sec. The hardness tests were carried out at fixed intervals of time after charging, the loss of hydrogen with time having been previously determined for similar conditions. The results of the initial tests made immediately after charging, together with conventional hardness determinations, are as shown in Table 1. A plot of the change of hardness with time and hydrogen content is shown in Fig. 1.

Table 1

Method of test	Diam. of ball indentor	Load (kgm.)	B.H.N. of as-received steel		B.H.N. of hydrogen-charged steel		Difference
			Range	Av.	Range	Av.	
Normal	2 mm.	120	116–118	117	115–119	117	—
Slow loading	1 mm.	10	108–111	110	123–130	127	17

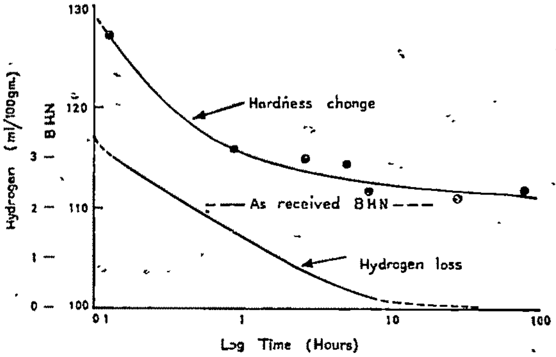

Fig. 1. Decrease in hardness and loss of hydrogen with time

The results show that an increase of 17 B.H.N. was obtained after hydrogen-charging, and that a reversion to the normal hardness values occurred after sufficient time has elapsed for the hydrogen to diffuse from the steel. This change in hardness compares favourably with the increase in slope of the work-hardening part of the stress–strain curve as predicted by Seabrook *et al.*[1] and shown by Vaughan and de Morton[4]. The use of high current densities for cathodic charging produces surface blisters and permanent surface cold-work resulting in a permanent increase in hardness which tends to obscure the above effect.

It would appear from these tests that hydrogen does increase the work-hardening characteristics of mild steel, presumably by the inhibition of slip. A theory relating to embrittlement by the locking of dislocations by hydrogen atmospheres is envisaged and a detailed account will appear elsewhere[4].

It is thought that slow-load hardness testing may be of value in investigating strain ageing phenomena in other systems, provided loading-rate and temperature are adjusted to conform to the rate of diffusion of the solute elements under consideration.

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Separation of Hydrocarbon Isomers by Thermal Diffusion

Recent work on the transport properties of gaseous hydrocarbons[1] has suggested that highly flexible molecules undergo 'wrestling' intermolecular collisions, involving less persistence of forward velocity than collisions between other molecules. Since a straight-chain paraffin molecule is always more flexible than a branched chain, this effect gives rise to differences in the transport phenomena shown by isomeric hydrocarbons. Such differences might be expected to enable separation of a mixture of isomers by thermal diffusion. One view of the mechanism of separation by thermal diffusion is that those molecules which move faster when leaving the hot zone push the slower molecules towards the cold zone[2]. It is, in any event, clear that thermal diffusion must depend, not only on the mass and diameter of the molecules, but also on the nature of the intermolecular collisions. If a mixture of an *n*-paraffin with a branched-chain isomer is subjected to thermal diffusion, the former, which is the more flexible, will leave the hot zone with lower forward velocity, and would thus be expected to concentrate in the cold zone.

Experiments have been made on thermal diffusion in mixtures of *n*-pentane with *neo*-pentane, and show that a striking degree of separation occurs. Mixtures were admitted to a Clusius column, 1 metre long, consisting of concentric 'Pyrex' glass tubes. The inner tube, of outer diameter 8 mm., was heated to approximately 300° C. by an internal electrical heating element; the outer tube, of inside diameter 16 mm., was cooled by a water jacket at room temperature. The top of the column ended in a 2-litre reservoir; the bottom was connected by capillary tubing to a 20-ml. gas pipette. Samples were taken in the pipette both before running the column and after equilibrium had been attained, and were analysed by mass spectrometer. Equilibrium was reached within four hours. The results are shown in Table 1. The separation factor appears to be sensibly constant over the whole range of concentrations.

Table 1

Total pressure in column (mm. mercury)	Percentage of *n*-pentane: in initial mixture	Percentage of *n*-pentane: at bottom of column after separation	Separation factor*
225	43	60	2·04
175	43	64	2·44
175	11	21	2·31
175	91	96	2·37

$$* \text{ ratio}: \frac{\%\ n\text{-pentane at bottom}/\%\ neo\text{-pentane at bottom}}{\%\ n\text{-pentane at top}/\%\ neo\text{-pentane at top}}$$

Experiments are being continued with other mixtures of isomeric hydrocarbons, and full details will be published elsewhere.

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Emission of Photo Radiations by the Impact of Positive Ions of Helium on Nickel

The emission of secondary electrons from metals by positive ions has been studied by a number of workers[1], and it has been established that the efficiency of this process depends upon the work function of the metal, the ionization potential of the ion and their kinetic energy. It is believed that a positive ion becomes neutralized before it actually comes into contact with the metal by extracting an electron from it and is in the excited state when it enters its surface. The energy of excitation of the atom is handed over to another free electron of the metal as it settles down to its ground-state in a radiationless process[2]. This electron escapes from the metal as a secondary emission.

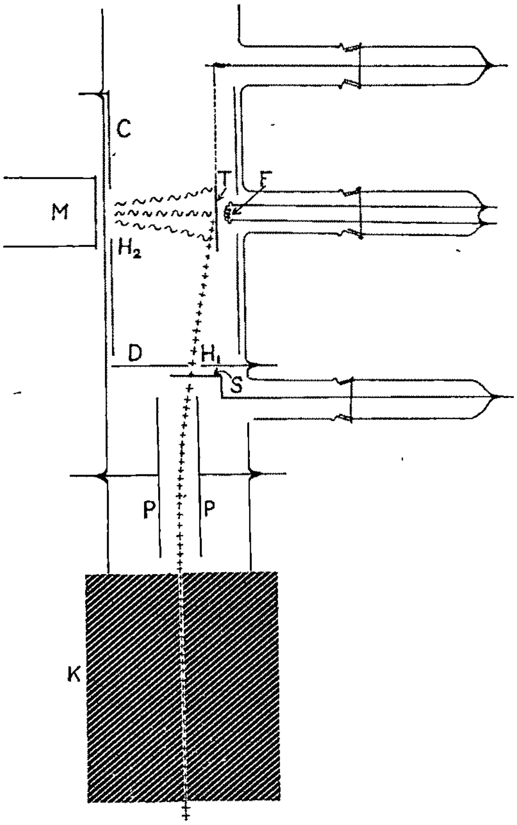

Fig. 1

We have carried out experiments with helium ions to see if their excited atoms formed in the manner described above would undergo transition to the normal state by emitting photo radiations on impact with a nickel surface.

A well-defined beam of ions is obtained from a discharge tube and is allowed to pass between two parallel metal plates *P* in an analysing chamber in which a high vacuum is maintained (Fig. 1). A little beyond these plates is placed a selector disk *D* with an eccentric circular hole H_1. By applying a suitable potential between the plates, the ion beam is deflected to pass through this hole and is made to strike the nickel target *T*, which is suspended from a ground-glass joint in a long nickel cylinder *C* with its lower open end resting just above the disk *D*.

The radiations from the target reach a photoelectron multiplier *M* through a circular hole H_2 made in the cylinder opposite *T*. The flow of ions to the target is stopped, when desired, by an adjustable nickel plate *S* without disturbing the discharge or any other condition of the experiment. The target was made of a degassed nickel sheet supplied by Messrs. Johnson Matthey and Co., Ltd., of London. It was further degassed by the filament *F*.

The pressure in the analyser was kept below 10^{-3} mm. mercury by two fast oil-diffusion pumps working in parallel and backed by a rotary oil pump. Two liquid-air traps, one between the analyser and the pumps and the other between the gas reservoir and the discharge tube, were used for condensing the impurities and preventing them from reaching the systems.

It has been observed that positive ions of helium give out photo radiations on impact on nickel surface. The energy of the ions used was 200–2,500 volts. That the photo radiations resulted from the impact of ions on the nickel target was verified: (1) by reversing the electrostatic field between the plates P, which deflected the positive ion beam in the reverse direction, and (2) by bringing the nickel plate S in front of the hole H_1 in the selector disk D to cut off the ion beam from the target.

Precautions were taken to ensure that light from the discharge tube or any other part of the apparatus did not affect the photomultiplier.

The apparatus was made of 'Hysil' or 'Pyrex' glass and was washed with helium before observations were taken. The discharge was passed in a cylindrical 'Pyrex' glass tube with a circular nickel disk as anode. The cathode K was made of brass and a hole 1·5 mm. in diameter was drilled along its axis and was water-cooled during the experiments. Spectroscopically pure helium, supplied by the British Oxygen and Acetylene Co., London, was fed into the discharge tube through a fine glass capillary leak from a reservoir maintained at a constant pressure.

Details of the experiments will be published elsewhere. Our thanks are due to Prof. M. L. Oliphant for his interest in these experiments.

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Viscosity of Liquids and Ultrasonic Studies

THE Debye–Sears diffraction fringes of light, produced by ultrasonic waves from a generator, in the ordinary organic liquids are generally about the same in number. In strong contrast to this, it is found that the number of spectral orders observed in viscous liquids like castor oil, olive oil, etc., are appreciably smaller in number for the same electrical set-up.

To check up experimentally that the electrical condition remained unchanged in these two types of liquids, the oscillator was tuned to a non-resonant frequency of the quartz, midway between the fundamental and the third harmonic, so that vibrations were not set up. The quartz behaved as an additional condenser of the oscillating circuit only. It was noted from measurements that the electric power radiated, and thus, also, the oscillatory electric power of the circuit, remained approximately the same for the different types of liquids. This means that there has been no electrical effect produced by the change of liquids.

On the other hand, according to Raman and Nagendra Nath's theory[1], which has been verified experimentally, the smaller number of spectral orders in some liquids, as compared to others, indicates a smaller change in the refractive index of these liquids produced by the ultrasonic waves. The theory, primarily intended to give the variation of intensity in spectral orders, has been shown by Sanders[2] as well as by Samal and others[3] to give an approximately linear relation between the observed order number and the maximum change of refractive index of the liquids, particularly for order numbers higher than the third.

The experimental results for the set of liquids, on which observations have been made with a particular oscillator generating ultrasonic waves of 3 Mc./sec. frequency, within a distance of 1 cm. from the quartz, are recorded in Table 1. In noting the number of spectral orders, we have observed that in many of the liquids a definite number cannot be set with certainty. It often happens that a lower number appears with certainty and the higher number occasionally sets in. This indicates that the maximum variation of refractive index $\Delta\mu$ has an intermediate value between that required to produce the lower or the higher number of fringes. Under such conditions of observation, we have indicated the number of fringes by the two limits.

It will be observed that the values of $\Delta\mu$ decrease rapidly with the viscosity of the liquid. That the decrease in $\Delta\mu$ in any particular liquid is not caused by the strong absorption in the liquid can be seen by calculating the expected amplitude of change of pressure due to absorption. Since Δp is equal to $V^2.\Delta\rho$ and V, the velocity of sound, is constant in a liquid; also since $\Delta\rho$ is proportional to $\Delta\mu$, any change in amplitude of the pressure will give rise to a corresponding change in $\Delta\mu$ for a liquid. One may thus find that, except in the case of castor oil, where the corrected value of $\Delta\mu$, or n, would increase by one-third of its observed value, the other liquids will suffer negligible change for the experimental distance. The value of $\Delta\mu$ for castor oil, recorded in Table 1, is corrected for absorption.

Table 1. ULTRASONIC SPECTRAL NUMBER IN RELATION TO OTHER LIQUID PROPERTIES, AT 35° C.

Liquid	Density ρ	Velocity in m./sec. (V)	Compressibility.	Viscosity (η)	Spectral order $n = \varkappa \, . \, \Delta\mu$
Castor oil	0·957	1,460	49·0	3·16	3–4
Paraffin oil	0·876	1,393	58·8	0·765	5–6
Olive oil	0·911	1,398	56·2	0·465	6–7
Coconut oil	0·918	1,365	58·5	0·126	8–9
Turpentine oil	0·871	1,285	69·5	0·012	11–12
Toluene	0·851	1,263	73·6	0·005	13

It will be seen that the results can be incorporated into a fairly smooth relationship between $\Delta\mu$ and η, in the form $\eta = A \exp(-B\Delta\mu)$. No smooth relation occurs between $\Delta\mu$ and compressibility, which might have been the other possibility. The question regarding the decrease of $\Delta\mu$ with increasing η has to be critically considered. The decrease of $\Delta\mu$ could have been caused by the decrease of the amplitude of vibration of the quartz, due to the resisting viscous medium, or it could have been caused by the viscosity effect in the medium, without any change on the vibrating quartz. The effect of viscosity on the propagation of pressure amplitude in the form of absorption has been already considered. No other effect is likely on theoretical grounds. We are thus obliged to accept the view that the decrease of $\Delta\mu$ is due to the damping of the quartz by the viscous liquids.

This would mean that the different media would damp the vibrations of the quartz differently, by a resistance or opposing pressure π, inherent as a characteristic of the liquid. The damping of vibration and π would be larger the larger the viscosity. This also explains the observed fall of power in castor oil, previously recorded in the work of one of us[4]. The observed values of $\Delta\mu$ would thus decrease with the increasing values of π. Thus the relation between $\Delta\mu$ and π for a small range can be represented by $\Delta\mu = a - b\pi$. This would transform the viscosity relation into the form, $\eta = \alpha \exp(\beta\pi)$. It is premature at this stage to make critical observations on α and β, which, within the conditions of experimental limitations, appear to be constants.

It may, however, be noted that Frenkel[5], from considerations of the kinetic theory of liquids, obtained the viscosity relation in the form $\eta = A \exp(\beta p)$, where p is the external pressure and η gives the viscosity of a particular liquid. It appears that the external pressure increases the stiffness of the liquid, measured in terms of π, and so increases the viscosity of the liquid.

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Indentation Hardness of Diamond

RECENTLY, S. Tolansky and V. R. Howes[1] published some data on indentation compression strength with a diamond ball (0·39 mm. radius) on differently orientated diamond faces. They obtained values for the pressure which caused cracking on different diamond faces ranging from 1·2 to $1·8 \times 10^{11}$ dyne-cm.$^{-2}$ (1,200–1,800 kgm./mm.^{2}). By comparing these values with those quoted in the literature it appears that they are extremely low: F. Auerbach[2], absolute hardness of diamond 2,200 kgm./mm.^{2}; Knoop, hardness[3] of diamond 6,500–8,500 kgm./mm.^{2}; Russian tests with triangular pyramids[4] and my own tests[5] with the same type of indenter indicated hardnesses greater than 14,000 kgm./mm.^{2}. Recent tests with double cone indenters (radius 2 mm., included angle 154°) showed that diamond surfaces could be loaded to well over 3,000 kgm./mm.^{2} without showing any form of cracks even when investigated with the electron microscope (by courtesy of Mr. M. Seal, Cambridge).

It is astonishing that these high average pressures, usually called hardness, should behave so differently with diamond surfaces. An explanation of this phenomenon may be given by the Hertzian formulæ[6] for the maximum pressure $p_{\max}$ between the surfaces.

The values of the average pressure and of the maximum pressure are shown in a histogram (Fig. 1) for a number of tests with various indenters. The average pressures with triangular and elongated pyramids are high, but with spheres and double cones relatively low. However, the relative stress factor was based on the highest maximum pressure $p_{\max.}$ obtained with triangular pyramids, and made equal to 13,000 kgm./mm.^{2}, which is the average of the average pressures for tests a, b and c. For test e we obtain a value of 6,350 kgm./mm.^{2}, which is close to the experimental value. For test f the value 1,350 kgm./mm.^{2} is about half the experimental pressure; but here no plastic deformation or any kind of fracture was observed. In contrast to this, in test g where elastic deformation was always followed by fracture, the maximum pressure is almost 50 per cent higher than the maximum average value recorded; this obviously indicates that the elastic limit has been well exceeded.

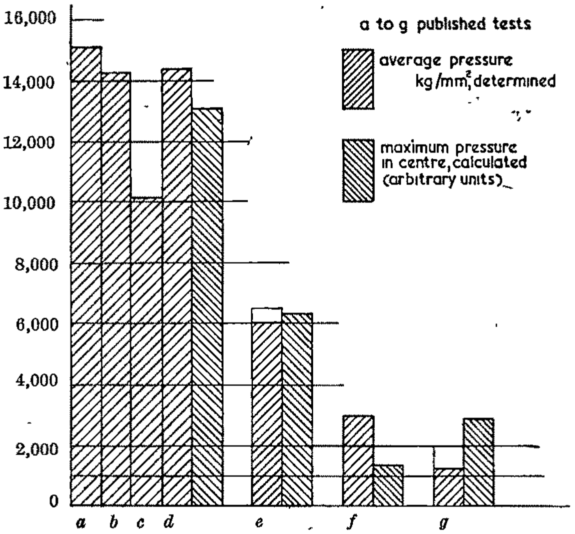

Fig. 1. Histogram of experimental values comparing average with maximum pressures.
a–c, M. M. Khrushchov and E. S. Berkovich (triangular pyramid). *d*, P. Grodzinski and W. Stein (triangular pyramid). *e*, Nat. Bur. Standards (Knoop elongated pyramid). *f*, P. Grodzinski (double cone, $r = 2$ mm., $a = 77°$). *g*, V. R. Howes and S. Tolansky (sphere, $r = 0·39$ mm.)

In this way the widely differing values of average pressures in kgm./mm.^{2} of diamond indenters against diamond surfaces can be explained. Obviously, different mechanisms are involved. In the tests with a pointed indenter (triangular and square base pyramids), there is plastic flow at shear stresses, whereas with tests with the double cone and spheres mainly elastic deformations occur up to the moment of fracture, the latter being due to tensile stresses. Therefore the average stress usually designated as hardness has no physical significance without knowing the shape of the indenter and the load. It may also be suggested that this applies to the usual hardness of materials of lower hardness than diamond.

A more detailed account of this work will be published elsewhere. I thank Mrs. A. Hoselitz for carrying out the tests with the double-cone diamond and Prof. S. Tolansky and V. R. Howes for useful comments.

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A New Apparatus for Cathodic Sputtering

The cathodic sputtering process has been almost completely replaced in recent years by the vacuum evaporation technique for the production of thin solid films. However, renewed interest in the sputtering technique has been created by the discovery that films of metal oxide can be deposited by sputtering from a metal cathode in a glow discharge containing oxygen. Such films are usually required in combination with metal and other dielectric films for interferometry, etc. It is a simple procedure to deposit multi-layer coatings by vacuum evaporation, whereas their preparation is tedious when using the conventional form of sputtering apparatus. This is because it is necessary to break the vacuum and insert a new disk cathode of the required metal for each fresh layer. I have recently developed apparatus for the deposition during one coating cycle, on to plane receivers, of several sputtered films in sequence or for laminating sputtered deposits with vacuum-evaporated films. It is also possible to dispense with the need for rectification of the high-tension output without loss in the sputtering efficiency.

The new sputtering apparatus is shown in Fig. 1 (subject of a patent specification). The glow-discharge electrodes consist of two V-shaped elements made of the material to be sputtered and connected to the output of a high-voltage transformer. The leakage current from the supply to earth must be a minimum, otherwise sputtering can occur from earthed metal fittings in the chamber. Each of the V-electrodes operates as a cathode electrode on alternate cycles and deposits material on the plane receiver, which is rotated to ensure uniform deposition. The V-electrodes are mounted on earthed V-shaped shields with a gap of smaller dimension than the depth of the cathode dark space, so that a glow discharge cannot be sustained on the electrode side remote from the receiver surface. A V-shaped electrode operated from a d.c. supply has been used in Germany for glow-discharge cleaning prior to vacuum evaporation[1]; but it has not to my knowledge been used in the a.c. form described above for sputtering.

Experiments have shown that V-electrodes with arcs subtending an angle from 10° to 180° at the centre of the work plane produce very uniform deposits on a 12-in. diameter receiver when connected to a 3 kV. 500 m.amp. a.c. supply. By shaping the electrodes, it is possible to increase or decrease the thickness of the deposit at the centre of the receiver. The angular gap between electrodes must be such that one electrode does not penetrate the cathode dark space of the other and thereby interfere with the current density distribution over the cathode surface. This can be avoided by mounting the pair of V-electrodes diametrically opposite as in Fig. 1. Several such pairs of electrodes can be mounted above a rotary receiver for deposition of films in sequence.

To obtain uniform evaporated films on plane receivers, it is desirable to rotate the receiver and mount the vapour source in an offset position as shown in Fig. 1[2]. Sputtering electrodes can then be arranged with vapour sources for deposition of multi-layers. The vacuum pump used on this latter apparatus must be capable of obtaining low gas pressures for evaporation (0·1 micron mercury) and operate at high pressures (0·1 mm. mercury) with a controlled gas leak into the chamber during sputtering. Suitable pumps, commonly known as booster-diffusion pumps, are commercially available for this purpose.

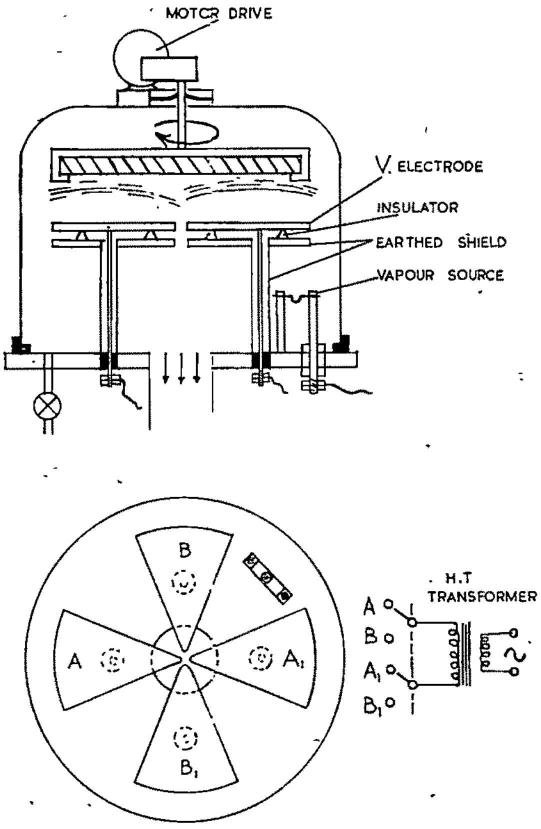

Fig. 1. Sputtering apparatus with V-electrodes

The new sputtering apparatus is being used in my laboratory for: (i) preparing durable multi-layer interference filters consisting of sputtered metal oxide films laminated with vacuum-evaporated magnesium fluoride films (titanium oxide films prepared in the laboratory by sputtering in pure oxygen have been found to have a refractive index of about 2·5 and are highly tenacious to glass); (ii) the sputtering of transparent conducting gold films on sputtered bismuth oxide base layers; the properties of this film combination have been described by Gillham and Preston[3] and others[4].

It should also be possible to prepare coatings of alloys and mixtures by sputtering from two V-electrodes of dissimilar metals operated from an a.c. supply.

A full account of the new sputtering technique and its uses will be published shortly. Acknowledgments are made to Mr. G. Siddall for his assistance in the construction of a prototype apparatus, and to Mr. A. S. D. Barrett, technical director, for permission to publish this communication.

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Radioactivation Analysis of Phosphorus in Iodine

An important method in the preparation of pure silicon for semiconductor devices is the silicon iodide process[1]. In this method silicon tetraiodide is formed from the elements and purified by fractional distillation before being decomposed by passage over a heated tantalum filament. We have found by radioactivation analysis[2] that the predominating *N*-type impurity in silicon produced by this method in our laboratory is phosphorus, and that its concentration seems to be largely independent of the phosphorus content of the 'crude' silicon. This could be explained if there was an appreciable phosphorus-level in the iodine used, as the mass ratio of silicon to iodine in the above reaction is about one to twenty. Therefore we developed the following method for estimating the phosphorus content of iodine.

On irradiating iodine which contains phosphorus in a thermal neutron flux, the following nuclear reactions take place.

$$^{127}\mathrm{I}\,(n,\gamma)\,^{128}\mathrm{I} \xrightarrow{\beta'+\gamma} {}^{128}\mathrm{Xe}\ (t_{1/2} = 25\cdot0\ \mathrm{min.}) \qquad (1)$$

and

$$^{31}\mathrm{P}\,(n,\gamma)\,^{32}\mathrm{P} \xrightarrow{\beta'} {}^{32}\mathrm{S}\ (t_{1/2} = 14\cdot3\ \mathrm{days}) \qquad (2)$$

The half-life values show that if we allow sufficient time for the iodine activity to die away, the activity in the specimen will be entirely due to phosphorus and other long-lived impurities present. This is of considerable advantage in the handling of the activated samples, as no radiation shielding is required.

The reaction used for determining the phosphorus content is the following:

$$2\mathrm{P} + 5\mathrm{I}_2 + 8\mathrm{H}_2\mathrm{O} = 10\mathrm{HI} + 2\mathrm{H}_3\mathrm{PO}_4 \qquad (3)$$

It is of paramount importance that the carrier added to the irradiated sample be in the same chemical form as the active element which is to be determined. This is achieved in the above reaction, as the phosphorus, whether present originally as the element or the iodide, ends up as an orthophosphate ion. The method also has the rather novel feature that the inactive phosphorus takes part in the reaction and, after conversion to phosphate, also acts as a carrier.

The details of the method are as follows. About 0·5 gm. samples of iodine were sealed in silica ampoules and irradiated for a week in the pile at Harwell together with 30 mgm. of diammonium hydrogen phosphate to act as a standard. On return, the ampoules were allowed to stand for a day to let the activity due to the iodine decay and were then cracked open and crushed in a percussion mortar. The mixture was transferred with great care into about 20 ml. of distilled water containing a suspension of 55 mgm. of red phosphorus (a weight in excess of the amount required for the reaction). As the reaction proceeded, iodine was dissolved in the hydriodic acid solution, giving an intense colour. The solution was warmed on a water bath until the iodine coloration had completely disappeared. The residual red phosphorus was then dissolved by adding excess inactive iodine, and standing the solution on the water-bath overnight. The fragments of the silica ampoule were then removed by filtration and the filtrate treated with hydrogen peroxide. Iodine crystals slowly appeared as the iodide complex was broken down and the iodine solubility consequently decreased. These crystals were filtered off. Chloroform was then shaken with the filtrate in a separating funnel to remove final traces of iodine. The procedure was repeated until the final aqueous solution was colourless.

The phosphate was then determined as the magnesium pyrophosphate in the same manner as we have previously reported[2]. Three methods were used for establishing the identity of the activity thus isolated. Absorption and decay measurements were made showing it to be a pure β-radiation with a half-life of fourteen days, and in some cases the solution and precipitation stages were again repeated, the results showing no loss in activity per gram. These facts indicate that, using the above technique, the phosphate isolated is radiochemically pure. The overall efficiency of the method is 70–80 per cent.

If one assumes that the maximum efficiency of the counting system is 25 per cent and that its detection limit is 20 counts per min. above background, then it can be shown that, for irradiation for a week at a pile factor of 10, the limit of the method is about 0·003 part per million on a gram sample.

Phosphorus concentrations, which we have measured in iodine from various sources, have been found to vary between 10 and 0·1 parts per million. A sample of 'Analar' grade iodine was found to contain 0·18 p.p.m. of phosphorus.

We are indebted to colleagues in this laboratory for encouragement and assistance.

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Crystal Structure of *p*-Chlorbenzene Iododichloride

The unexpected bond distances observed by Archer and van Schalkwyk[1] in benzene iododichloride have indicated a class of organic compounds about which few structural data are at present available. We have therefore sought to confirm their findings by the examination of a related compound, *p*-chlorbenzene iododichloride.

Light-yellow needles of this compound are obtained by passing dry chlorine into a dry chloroform solution of *p*-iodochlorbenzene. Like other iododichloride compounds with an electrophilic group in the *para* position, giving rise to a dipole moment directed away from the iodine atom, *p*-chlorbenzene iododichloride appears to be moderately stable and certainly more so than unsubstituted benzene iododichloride (Table 1). It seems possible that the tendency of electrons to drift away from the iodine atom partially increases the positive charge on the iodine and so makes possible a greater resonance stabilization of the molecule[4].

Single-crystal X-ray oscillation and Weissenberg photographs, taken with copper and molybdenum K_α radiations, indicate a triclinic unit cell: $a = 10\cdot1_0$; $b = 4\cdot13$; $c = 11\cdot0_3 \pm 0\cdot04$ A.; $\alpha = 96°\ 42'$; $\beta = 107°\ 27'$; $\gamma = 91°\ 12' \pm 36'$; where b is the needle axis. With the observed density, 2·31 gm./c.c., this corresponds to two molecules per unit cell. The centrosymmetric test[5] was used for deciding between the two alternative space groups. This shows clearly that the (*h0l*) projection must be centrosymmetric,

Table 1

Compound	Melting-point difference, $t_{\frac{1}{4}\text{hr}} - t_{1\text{hr}}$ after preparation[a]	Approximate dipole moment[b] of parent iodobenzene
p-$NH_2\varphi ICl_2$	Rapid decomposition*	+ 2·8
p-$CH_3\varphi ICl_2$	2° C.	+ 1·7
φICl_2	2	+ 1·3
p- φ-φICl_2	2	+ 1·2
p- $I\varphi ICl_2$	1	0
p- $Br\varphi ICl_2$	1	− 0·2
p- $Cl\varphi ICl_2$	0	− 0·4
p-$NO_2\varphi ICl_2$	0*	− 2·6

[a] See ref. 2 for all values except the two marked *.
[b] Calculated from values given in ref. 3.

and that therefore the space group must be $P\bar{1}$. The space group has agreed satisfactorily with more detailed considerations of the structure, which place the iodine atom at (0·040, 0·280, $\overline{0{\cdot}175}$).

The orientation of the molecules is such that there is very little atomic overlapping in the ($h0l$) projection. This projection is at present being refined to give accurate x and z co-ordinates for all the atoms. The y-co-ordinates are being determined from the ($hk0$) projection and from n-layer line data[6].

The main features of the present structure are in agreement with the reported dimensions and symmetrical linearity of the —ICl_2 group[1], with the third valency approximately at right-angles to it. Presumably dsp^3 or d^3sp bonds are formed, but not fully used. The plane of the —ICl_2 group appears to be more nearly that of the benzene ring than is the case in benzene iododichloride, where they are at right-angles. It is also clear that the main cohesive forces in the crystal are between the iododichloride groups.

Our results are the more interesting because a linear bond configuration around iodine is clearly not possible for the closely related cyclic compounds, such as that formed from o-iododichlor-benzoic acid by the elimination of hydrogen chloride[7].

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Ultrasonic Relaxation in Unsaturated Aldehydes

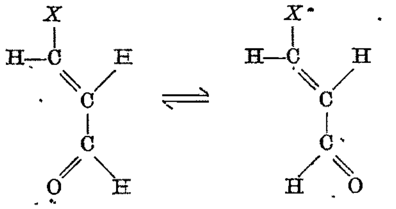
Recent measurements[1] of the absorption of ultrasonic waves in some unsaturated aldehydes over the frequency-range 100 kc./s. to 1 Mc./s. have shown that relaxation occurs in crotonaldehyde and cinnamaldehyde. If α is the absorption coefficient relating to the excess pressure of the sound wave, then in the absence of relaxation the quantity (α/f^2) remains constant with frequency, f. In the region of a single relaxation having a relaxation time, τ, we have[2]:

$$\frac{\alpha}{f^2} = \frac{A}{1 + (f/f_c)^2} + B \tag{1}$$

provided that the velocity dispersion is negligible. Here $f_c = 1/2\pi\tau$, and the parameters A and B depend upon temperature.

A decrease in the quantity (α/f^2) from its low-frequency value was found for crotonaldehyde and for cinnamaldehyde towards the upper end of the above frequency-range. No such change was found for acrolein.

We attributed the relaxation in crotonaldehyde ($X = CH_3$) and cinnamaldehyde ($X = C_6H_5$)[1] to perturbation by the sound wave of the equilibrium



(2)

These planar configurations are stabilized by resonance, and we suggested that the relaxation in acrolein occurs at frequencies greater than 1 Mc./s.

We have now extended this work by measuring the absorption of sound waves in these liquids at frequencies up to 100 Mc./s. The results confirm the previous explanation and are shown in Fig. 1. The parameters of the relaxations evaluated from the ultrasonic data are given in Table 1, which includes the velocity of sound, c, and the maximum absorption per wave-length due to the relaxation, $\mu_m = \frac{1}{2} Acf_c$.

In order to derive the parameters for acrolein, measurements are required at frequencies greater than 100 Mc./s., and we are in progress of obtaining these with our present apparatus. We are also studying the behaviour in these and related liquids over an extended temperature-range.

It is of interest to note that construction of the scaled molecular model for the ketone, mesityl oxide

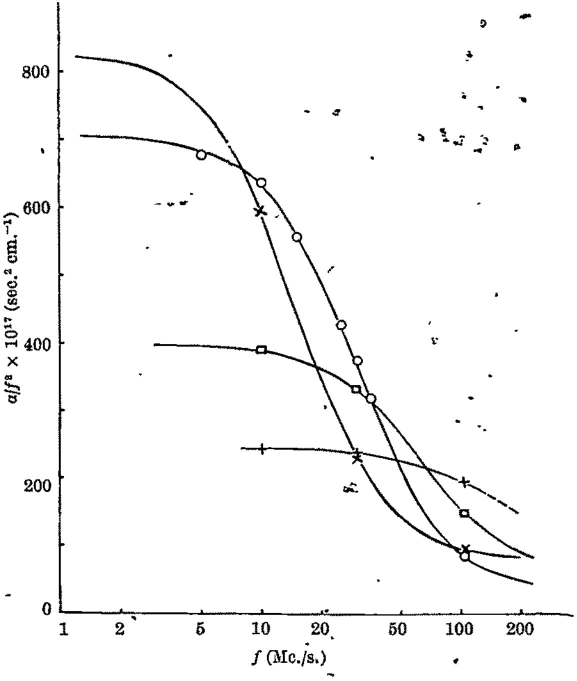


Fig. 1. Sound absorption in acrolein (+ — + —), crotonaldehyde (○—○—) and cinnamaldehyde (×—×—) at 25° C., and in crotonaldehyde (□—□—) at 50° C. The points are experimental, and the curves are calculated from equation (1) using the values of the parameters given in Table 1

Table 1

Liquid	T ° C.	$A \times 10^{17}$ sec.^{2} cm^{-1}	$B \times 10^{17}$ sec.^{2} cm.$^{-1}$	f_c (Mc./s.)	$c \times 10^{-5}$ cm. sec^{-1}	$\mu_m \times 10^2$
Crotonaldehyde	25 50	674 338	32 60	30 0 61 4	1 268 1 165	1·28 1 21
Cinnamaldehyde	25	746	80	15·1	1 561	0 88

[$(CH_3)_2C : CH\,CO\,CH_3$], shows that the higher-energy state to the right of the corresponding equilibrium (2) is untenable owing to the size of the interacting CH_3 groups. In accordance with this, we have not observed a relaxation in this liquid. Over the frequency-range 100 kc./s. to 1 Mc./s. we found previously that $(\alpha/f^2) = 35 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ at 25° C. The value $(\alpha/f^2) = 36 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ at 100 Mc./s. has been obtained in this laboratory by Mr. E. H. Heasell, to whom our thanks are due.

We acknowledge financial assistance from the Department of Scientific and Industrial Research in support of this research programme. We also appreciate the interest shown in this work by the Koninklijke/Shell-Laboratorium, Amsterdam, by which one of us (M. S. G.) is employed.

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Coupled Oxidation of Keto-Acids with Glutathione

When glutathione is oxidized by copper ions or the cytochrome c – cytochrome-oxidase system in the presence of pyruvate, the added pyruvate is partially oxidized to acetic acid and carbon dioxide[1]. It was suggested that this reaction occurred by the production of a hemimercaptol compound between pyruvate and glutathione which is oxidized instead of free glutathione. Slater[2], disproving the hemimercaptol hypothesis, emphasized a model similar to that found by one of us[3] for the coupled oxidation of pyruvate by ascorbic acid, which involves the intermediate production of hydrogen peroxide. But the two points made by Slater in support of his postulate have been found to be inconsistent: (1) the chromatic effect of the methylglyoxal – glutathione complex in the ultra-violet, not shown by the pyruvate – glutathione complex, is mainly due to the enediol compound in equilibrium with the thioester resulting from the interaction[4]; enediols and thioesters are not likely to be produced by the interaction of glutathione with pyruvate, which forms only mercaptols; (2) the effect of catalase has been thoroughly investigated and we have been unable to reproduce the inhibitory effect reported by Slater. Moreover, (3) we now present evidence that in our experimental conditions a complex between glutathione and pyruvate is actually formed.

As Fig. 1 shows, the presence of 0·2 mgm. catalase does not appreciably affect the coupled oxidation of pyruvate. Similar results are obtainable by changing the concentration of the reactants or increasing the amount of catalase up to 0·5 and 1 mgm.

In order to test whether, in our conditions of dilution and pH, pyruvic acid is really bound to glutathione, we have taken advantage of Schubert's finding that in slightly alkaline solution the nitroprusside reaction of an R—SH complex with carbonyls is depressed[5]. Fig. 2 shows that this is the case also with glutathione and pyruvate, and curve 3 represents the curve obtained with the amounts of reactants used in the present experiments. Nitroprusside was added 10 min. after mixing the glutathione solution with the other reactants. The photometric readings were taken in a Coleman spectrophotometer using square cuvettes with prisms leaving a layer of 0·1 cm. cell-length. The unstable coloured reaction was followed under controlled conditions of time.

The coupled oxidation of pyruvate with glutathione occurs also with other keto-acids, though there are some peculiar differences (Table 1). In any event, when the coupled oxidation occurs, it is not appreciably modified by the presence of catalase.

Though the inactivity of catalase seems unquestionable, nevertheless this finding should not be taken as a conclusive indication that the coupled oxidation goes through the hemimercaptol complex; indeed, the peroxidative activity of catalase is well known[6]. The hemimercaptol hypothesis may still hold as a tentative explanation, being supported by the following considerations: (1) the activity of the cytochrome c – cytochrome-oxidase catalytic system, which does not produce peroxide; (2) the peculiar

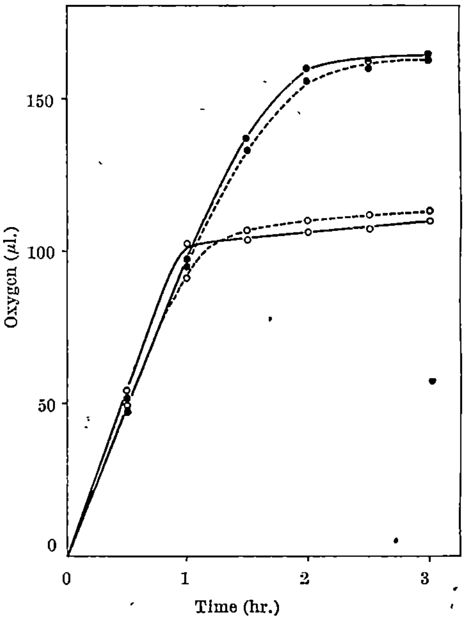

Fig. 1. Coupled oxidation of glutathione with pyruvate: with (dotted line) and without (full line) added catalase. ○, Oxygen uptake of glutathione alone ●, Oxygen uptake of glutathione plus pyruvate. Glutathione, 0 02 m.mol.; pyruvate, 0 04 m.mol.; cupric chloride, 0 0002 m.mol.; crystalline catalase (Kat. f. = 17,700), 0·2 mgm. phosphate buffer 0·067 M, pH 7·4, 1 ml., plus 0 4 ml. 0 1 N sodium hydroxide. Total vol. 3 ml. Temp. 38°. Final pH, 8·4

Table 1. COUPLED OXIDATION OF KETO-ACIDS BY GLUTATHIONE AND THE EFFECT OF CATALASE

Experimental conditions as in Fig. 1. Values in µl. oxygen exceeding the oxygen uptake of glutathione without the added keto-acid. Time of experiment: at exhaustion of oxidation (3–4 hr.)

Keto-acid	Extra oxygen uptake: without catalase	with catalase
Pyruvic acid	51	47
Phenylpyruvic acid	42	43
α-Keto butyric acid	36	29
α-Keto *iso*valeric acid	13	13
α-Keto *iso*caproic acid	12	12
Mesoxalic acid	80	76
α-Keto glutaric acid	23	21
α-Keto adipic acid	5	6

behaviour of cysteine, which, forming a thiazolidine ring with pyruvate, is effective only in part, presumably in the form of an addition product; (3) the known ability of mercaptans to give hemimercaptols with carbonyl functions; (4) the actual production of a complex between glutathione and pyruvate in our conditions.

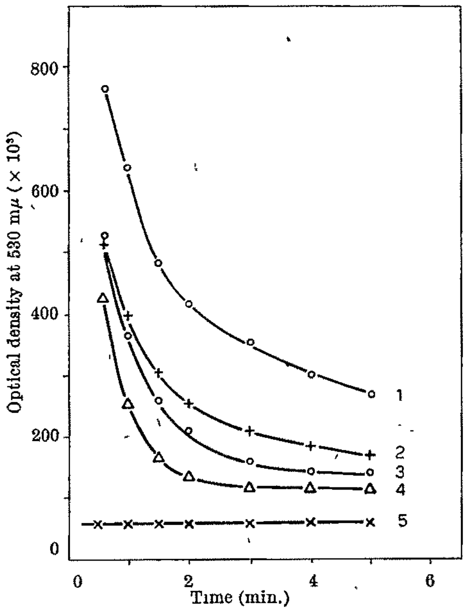

Fig. 2. Nitroprusside reaction of glutathione in the presence of different amounts of pyruvate. Conditions as in Fig. 1, with cupric chloride omitted. (1) Glutathione alone; (5) nitroprusside alone; (2), (3), (4), as (1) with 0·02, 0·04, 0·1 m.mol respectively of added pyruvate. At zero time, 0·2 ml. of 25 per cent nitroprusside was added to the test solution

At present, since the discovery of coenzyme A and lipoic acid, and of all the reactions leading to the oxidative decarboxylation of pyruvate, the resemblance between the coupled oxidation of glutathione with keto-acids and their biological oxidation by thiamine derivatives is, of course, out of date. Nevertheless, some biological oxidations seem to follow this path[7].

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Anticoagulant Specificity and Physiologically Inactive Beta-Prothromboplastin

A SMALL number of hæmophilic patients at first benefit by blood or plasma transfusions but later develop in their blood an anticoagulant which renders further transfusions temporarily ineffective. It is believed that the anticoagulant is an antibody due to the transfused antigen[1], but positive precipitin tests have been obtained infrequently.

A seven-year old boy, *MJ*-1, whose plasma was completely deficient in β-prothromboplastin (*P.T.C.*[2] or Christmas-factor[3]) had received nine blood transfusions. When examined by us for the first time nine months after the last transfusion, his plasma contained a potent anticoagulant which inhibited the formation of blood thromboplastin. It was thought that the anticoagulant was active against β-prothromboplastin, but serological tests were negative and the following procedure was developed: β-prothromboplastin from plasma or serum was adsorbed on barium sulphate suspension. The adsorbate was washed with 0·15 *M* sodium chloride until free of protein and drained. To the deposit 1 ml. of the isolated anticoagulant from plasma of *MJ*-1 was added and stirred frequently for 1 hr. at room temperature. The supernatant was tested for anticoagulant activity with a thromboplastin generation test[4] or by thrombin formation[5]. The results obtained are given in Table 1.

Table 1. MODE OF ACTION AND SPECIES SPECIFICITY OF AN ANTICOAGULANT AGAINST BETA-PROTHROMBOPLASTIN

Anticoagulant treated with barium sulphate adsorbate prepared from:	Remaining activity as percentage of original anticoagulant
(*A*) Untreated barium sulphate suspension	100
(*B*) Normal human oxalated plasma	44, 39, 23, 32, 34, 28
(*C*) Normal human oxalated plasma free of β-prothromboplastin	100
(*D*) Normal human serum	32
(*E*) Normal rabbit plasma	76
(*F*) Congenital β-prothromboplastin deficiency (*MB*-1)	100
(*G*) Congenital β-prothromboplastin deficiency (*MA*-2) 51 and 69 days after plasma transfusion	49, 50
(*H*) Congenital β-prothromboplastin deficiency (*MD*-1) 36 months after blood transfusion	92

From these results, it is seen that the anticoagulant reacts specifically with β-prothromboplastin of human origin (*B* and *D*), but shows little activity with that of rabbit's plasma (*E*). The anticoagulant is not removed by barium sulphate adsorbate prepared from human plasma which has been freed artificially of β-prothromboplastin (*C*).

Barium sulphate adsorbates were prepared from plasma of several patients (*F*, *G*, *H*). *MJ*-1 and *MA*-2 do not suffer from different deficiencies because admixture of their plasma freed of inhibitor did not result in any correction of the clotting deficiency. *MB*-1 has never had a blood transfusion; *MA*-2 and *MD*-1 had received a number of blood plasma and serum transfusions which were always beneficial to them clinically, and laboratory tests showed no evidence of an inhibitor in their blood. Whereas barium sulphate adsorbates prepared from plasma of patients *MB*-1 and *MD*-1 removed little or no anticoagulant activity (*F* and *H*)—as expected—the barium sulphate adsorbates prepared from plasma of *MA*-2 removed 50 per cent of anticoagulant activity; which is only a little less than that removed by normal plasma adsorbates. This puzzling finding cannot be due to transfused β-prothromboplastin, because it was not detectable by coagulation studies.

Patients who have prothromboplastin deficiencies present instances of genetically determined abnormalities of protein synthesis. Our observations suggest the following conclusions. It seems that a proportion of such patients can produce substances closely related to the prothromboplastins in their antigenic properties but which are inactive in the formation of blood thromboplastin. Other patients are unable even to produce a prothromboplastin with antigenic properties or physiological activity. Because of this they are the most likely ones to develop antibodies following the transfusion of the particular prothromboplastin they lack. The adsorbate technique shows to which of these two groups a patient belongs. These ideas are in agreement with the observation that only a fraction of hæmophilics develop anticoagulants and that these suffer severe clinical disease, thus implying that they have a complete prothromboplastin deficiency[6].

Complete clinical and laboratory studies will be reported elsewhere. This investigation was carried out with the financial support of the National Health and Medical Research Council of Australia.

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Action of Chlorpromazine on Oxidative Phosphorylation of Liver and Brain Mitochondria

Investigations of recent years have shown that mitochondria, irrespective of their source, are the site of oxidative phosphorylation; but it is not known to what extent the metabolism of these structural units is specific for a particular organ.

We wish to report on the difference in action of chlorpromazine (10-(3-dimethylaminopropyl)-2-chlorphenothiazine) on oxidative phosphorylation in mitochondria from liver and brain, and on some properties of these particles from the two organs observed in the course of this work (cf. ref. 1). The mitochondria from liver were prepared according to, and from brain by a modification of, the method of Schneider[2]. Chlorpromazine inhibited the phosphorylation accompanying the oxidation of rat liver mitochondria with α-ketoglutarate, succinate, glutamate and pyruvate + malate as substrates, whereas it did not do so with mitochondria from rat brain cortex (Table 1). Essentially the same results were obtained with particles from guinea pig and monkey brain cortex. 2,4-Dinitrophenol was effective in suppressing phosphorylation with mitochondria from both organs.

In order to investigate the site of uncoupling by chlorpromazine, phosphorylation resulting from the oxidation of cytochrome *c* was studied with ascorbic acid or adrenaline as substrates according to the procedure of Maley and Lardy[3]. Table 2 shows that the presence of 2×10^{-4} *M* chlorpromazine uncoupled oxidative phosphorylation with liver mitochondria. In some cases phosphorylation was completely inhibited by the drug, whereas the oxidation was either the same or greater than that of the controls. When the experiment was repeated with mitochondria from rat brain cortex in the absence of chlorpromazine, little, if any, phosphorylation was obtained with cytochrome *c* and either ascorbate or adrenaline, but oxidation was unimpaired.

Table 1. Effect of Chlorpromazine on Oxidative Phosphorylation of Mitochondria from Liver and Brain Cortex (Rat)

	Liver			Brain		
	ΔP (μmoles)	O (μatoms)	P : O	ΔP (μmoles)	O (μatoms)	P : O
α-Ketoglutarate	29·3	10·4	2·8	7·9	2·6	3·0
+ chlorpromazine	21·9	11·6	1·9	6·6	2·2	3·0
Succinate	24·9	11·3	2·2	8·2	5·0	1·6
+ chlorpromazine	12·1	10·5	1·1	7·1	4·6	1·5
Pyruvate + malate	20·7	8·2	2·5	14·7	5·5	2·7
+ chlorpromazine	13·2	7·5	1·7	15·1	5·5	2·8
Glutamate	31·3	13·4	2·3			
+ chlorpromazine	19·8	11·6	1·7			

The reaction vessels contained (in μmoles): phosphate buffer, *p*H 7·4, 60; magnesium sulphate, 20; adenosine triphosphate, 6·5; cytochrome *c*, 0·02; sodium fluoride, 10–15; substrate; mitochondrial suspension, 0·5 ml. (average nitrogen, 1·3 mgm.); glucose, 50; hexokinase (Pabst), 0·4 mgm; and potassium chloride solution (0·15 *M*) to a final volume of 3 ml. (when brain mitochondria were used, diphosphopyridine nucleotide at 0·2 mgm. per flask was added). Levels of substrates: α-ketoglutarate, 30; succinate, 30; glutamate, 60; pyruvate, 60 + malate, 3. Chlorpromazine = 2×10^{-4} *M*. Temperature 37° for liver, 30° for brain, incubation, 20–30 min. in air.

Exposing liver mitochondria to hypotonic sucrose with low levels of cytochrome *c*[4] resulted in phosphorus/oxygen ratios of 0·5–0·8 for the one-step oxidative phosphorylation. Practically no phosphorylation was obtained with brain mitochondria under the same experimental conditions. (Phosphorus/oxygen ratios averaging 0·1 (50 min. incubation) were obtained in experiments with commercial horse heart cytochrome *c* (Sigma). Upon column purification[5], this cytochrome *c* or cytochrome *c* prepared from beef brain gave higher phosphorylation values (phosphorus/oxygen ratios averaging 0·25), which were still far below those obtained with liver mitochondria.)

The observation that chlorpromazine appeared to uncouple oxidative phosphorylation in liver at the cytochrome *c* step was further supported by preliminary findings that the drug had no effect on phosphorus/oxygen ratios when ferricyanide was used as the electron acceptor. The failure of chlorpromazine to affect brain cortex mitochondria may be connected with their poor utilization of external

Table 2. Phosphorylation coupled to the Oxidation of Cytochrome *c*

			2×10^{-4} *M* chlorpromazine		
ΔP (μmoles)	O (μatoms)	P : O	ΔP (μmoles)	O (μatoms)	P : O
Ascorbic acid (30 μmoles)					
5·3	6·5	0·81	3·1	6·9	0·45
3·4	6·8	0·50	0	7·6	0
4·9	4·9	1·0	1·1	5·1	0·22
Adrenaline (10 μmoles)					
5·8	5·8	1·16	0	4·9	0
4·6	5·6	0·82	0	7·4	0

The reaction vessels contained in addition (in μmoles): adenosine triphosphate, 6; phosphate buffer, *p*H 7·4, 30, magnesium sulphate, 30; sodium fluoride, 40; cytochrome *c* (Sigma), 0·3; glucose, 40, hexokinase, 0·4 mgm.; liver mitochondrial suspension, 0·5 ml. (average nitrogen, 1·7 mgm.); and sucrose solution (0·25 *M*) to a final volume of 3·0 ml. Gas phase, air; incubation at 30° with adrenaline for 10 min., with ascorbic acid 20 min.

cytochrome *c* for oxidative phosphorylation. This may point to a basic difference in the surface configuration of these structural elements of liver and brain cells. It may also be argued that the observed uncoupling of oxidative phosphorylation in liver mitochondria by chlorpromazine is secondary to the effect of the drug on mitochondrial structure.

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Effects of Pituitary Growth Hormone on the Insulin and Hyperglycæmic-glycogenolytic Factor extractable from the Pancreas of Obese-Hyperglycæmic Mice

IN two separate experiments it has been found that, 24 hr. after the administration of bovine pituitary growth hormone to mice with the hereditary syndrome of obesity and hyperglycæmia (1 mgm. of growth hormone per mouse), changes had occurred in the amounts of insulin and hyperglycæmic-glycogenolytic factor extractable from the pancreas using a standardized acid alcohol technique[1]. In each experiment values for insulin and hyperglycæmic-glycogenolytic factor values were compared in the following four groups of animals (ten or twelve animals per group): obese-hyperglycæmic mice and their non-obese sibs treated with growth hormone, and two groups of the same description but not treated with growth hormone.

The growth hormone treatment resulted in significant rises of 37 and 169 per cent in the average (non-fasting) blood-sugar level in the groups of obese-hyperglycæmic mice above pre-injection non-fasting levels. For the hyperglycæmic-glycogenolytic factor assays, concentrations of test materials were measured on a logarithmic scale, and the above rises were associated with logarithmic increases in the factor of 1·52 and 2·42 respectively, relative to untreated obese controls. The insulin extractable from the pancreas decreased by 48 and 86 per cent in the two experiments. No consistent changes were observed in the hyperglycæmic-glycogenolytic factor or insulin extractable from the pancreas of the non-obese mouse following injection of growth hormone.

Rise of the concentration of glucose in pancreatic blood plasma results in increased release of insulin by the pancreas in the rat[2] and in the dog[3,4]. The fall in the extractable insulin of the pancreas which followed the rise in blood-sugar level in the obese-hyperglycæmic mouse, treated with growth hormone in our experiments, may signify that the pancreas of these animals is not able, following a sudden increase in demand, further to increase insulin production[5] to compensate for the increased rate of release. The alternative explanation for the fall in the extractable insulin, namely, that it resulted principally from decreased insulin production without increased insulin secretion, is not, in our opinion, so well supported.

Mice with the obese-hyperglycæmic syndrome have a turn-over of liver glycogen several times faster than their non-obese sibs[6] and have six times as much liver phosphorylase activity as their non-obese litter-mates (Shull, K. H., and Mayer, J., unpublished work). In view of Sutherland's findings concerning the action of hyperglycæmic-glycogenolytic factor on liver phosphorylase[7], these observations are consistent with the previously postulated hypothesis[8] of a hypersecretion of the factor in these animals. These obese mice are unusually sensitive to the hyperglycæmic action of growth hormone[9], which has been observed to cause the release of a hyperglycæmic factor by the pancreas in rats and cats[10] and in dogs[3]. In spite of apparent differences between the conditions of action of this agent and the extracted hyperglycæmic factor of pancreas[11], the hypothesis that growth hormone in the obese hyperglycæmic mouse leads to a rise in blood-sugar level due to a hyperglycæmic factor originating in the pancreas is still supported. The observed co-existent increase in the hyperglycæmic-glycogenolytic factor extractable from the pancreas apparently indicates that growth hormone administered to the obese hyperglycæmic mouse caused the rate of production of extractable hyperglycæmic-glycogenolytic factor to exceed its rate of disappearance from the pancreas. Experiments which are in progress will, perhaps, provide more information than is available at present on these processes.

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Mechanism of Anorexia in Vitamin-deficient Hyperphagic Animals

RECENT findings[1] have demonstrated that the ventromedial hypothalamic nuclei act as 'satiety' brakes which, in response to certain stimuli (particularly metabolic), inhibit a constantly activated 'feeding' mechanism. This mechanism, in turn, appears to be initiated at the level of the anterolateral nuclei[2]. Destruction of the ventromedial nuclei does not increase hunger (as measured by rate of ingestion); it shortens the pauses between 'meals' which, in normal animals, steadily increase during the day so as to constitute a 24-hr. feeding cycle marked with a definite 'satiety' pattern[1]. A method for the destruction of these centres in the rat[3], the mouse[4] and other species is through the use of stereotaxic instruments. In the mouse, it has also been shown recently[5] that administration of gold thioglucose leads to obesity through injury to the ventromedial nuclei. Such mice and 'hypothalamic' rats and mice can thus be used for elucidating whether vitamin deficiencies act by permanently activating the 'satiety' mechanism or by inactivating the 'feeding' mechanism. For example, one could visualize that thiamine deficiency, the anorexic effect of which is classic, permanently activates the ventromedial nuclei because of the constant elevation of blood concentration of intermediaries of carbohydrate metabolism, or inactivates the feeding mechanism through the action of toxic accumulation of noxious products or because of the lack of carboxylase *per se*.

The following experiment was carried out. Twenty-one adult female mice were studied; eleven of these were obese, having been made hyperphagic by a single intraperitoneal injection (1 mgm./gm.) of gold thioglucose 147 days previously. The mean weight of these eleven hyperphagic mice was 50 gm. (range 40–63 gm.), and that of the ten controls was 32 gm. (range 29–36 gm.). All the mice were fed a synthetic diet[6] plus essential vitamins for a conditioning period of twelve days; then the eleven hyperphagic mice were fed restricted amounts of this diet so that after a restriction period of fourteen days their weights (mean 33 gm., range 31–34 gm.) approximated to those of the non-hyperphagic controls. At this point, half the control mice and six of the eleven hyperphagic mice were fed a thiamine-deficient diet until there were no survivors; the other controls and the other five hyperphagic mice being fed the diet plus thiamine for the same period.

The hyperphagic thiamine-deficient mice died earlier (20·5 ± 4·4 days) than the non-hyperphagic thiamine-deficient controls (24·2 ± 2·6 days); this difference was statistically significant ($p < 0{\cdot}05$ but $> 0{\cdot}02$). By the time the last of the mice receiving the thiamine-deficient diet had died, the hyperphagic mice that had been fed the diet plus thiamine had returned to approximately the same weights as previously, their mean weight at the end of the experiment being 52·4 gm. (range 40–61 gm.).

It is clear from the results that, in this case, the hyperphagic tendency of the gold thioglucose animals was instantly eliminated by the deficiency. Indeed, the deficiency—and the anorexia—were in effect earlier in these animals than in their controls, doubtless because for a few days the caloric intake of the hyperphagic animals was greater, thus increasing the requirement[7]. In view of the absence of functional 'satiety' tissue[5], the deficiency must have caused anorexia through direct inactivation of the 'feeding' mechanism.

The specificity of this effect of thiamine deficiency is further demonstrated by the following experiment involving a chronic deficiency of vitamin A. Requirement for this vitamin is not related to caloric intake[8], nor is decrease in food intake the earliest observable effect of the deficiency[9]. Sixteen 21-day old female rats were placed at weaning on a vitamin A-deficient semi-synthetic diet[10] on which their mothers had been maintained during lactation. Eight controls received 1,200 I.U. of vitamin A per week whereas the experimental group received only one dose of 100 I.U. at weaning. Three and a half months later, this group exhibited a permanently keratinized vagina, eyelids partly denuded and red, and a body-weight steady at 50 gm. below the control-level. Both groups were subjected to hypothalamic lesions. In each group, five animals became markedly hyperphagic. In particular, in the deficient group, the five successfully operated animals increased their weights within the next two months by 70–200 gm. (maximum weight recorded 545 gm.). Having reached the maximum weight, the animals then lost weight and survived 1–2·5 months, a total survival no less and probably greater than that of unoperated deficient animals maintained in comparable conditions. Thus, in this type of deficiency, with presumably no direct effect on the feeding mechanism, removal of the satiety centres leads to marked and lasting hyperphagia. This observation would also suggest that considerable fat deposition can be accomplished in the face of advanced depletion of vitamin A, which would tend to preclude an active role for vitamin A in fatty acid synthesis.

The experiments reported above indicate that the use of hyperphagic animals in nutritional deficiency studies can permit the beginning of an analysis of the mechanism of the anorexia associated in various degrees with many of them.

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Lactose as a Lipotropic Agent

INCORPORATION of a small amount of lactose in the diet of young albino rats increases their food intake and they grow better than the control rats fed on sucrose. This increased food intake leads to greater weight and increased fat content of their liver and kidney[1]. If the food intake of lactose-fed rats is equalized to that of the sucrose-fed rats by the paired-feeding technique, the liver and kidney fat content decreases in the lactose-fed rats.

A batch of forty-eight young albino rats weighing 30–35 gm. was divided into four groups, one group receiving a lactose-free complete diet with added cystine (casein 15, sucrose 58, coconut oil 15, salt mixture 4, cod-liver oil 5, cystine 0·4 and vitamin mixture except choline), and the other three groups receiving the same diet except for the partial replacement of sucrose by 10, 20 and 30 per cent lactose.

Table 1. Distribution of choline, sphingomyelin, lecithin, cephalin and phospholipid (in mgm./gm.) of wet weight of tissue and fat per cent in rats fed different amount of lactose (C_1, C_2, C_3 groups receiving 10, 20, 30 per cent lactose) as compared with that of sucrose-fed rats (C_0 group)

Analysis	Liver C_0	Liver C_1	Liver C_2	Liver C_3	Kidney C_0	Kidney C_1	Kidney C_2	Kidney C_3
Choline	1·32	2·02	2·31	2·51	1·57	2·04	2·57	2·75
Sphingomyelin	0·75	0·69	0·50	0·41	0·91	0·75	0·58	0·44
Lecithin	8·0	12·7	14·9	16·3	9·5	12·8	16·5	17·9
Cephalin	8·9	8·3	12·8	10·3	11·9	13·7	14·9	12·2
Phospholipid	16·9	21·0	25·6	26·6	21·4	26·5	29·8	30·1
Fat (per cent)	11·3	10·1	10·4	9·7	12·4	10·4	10·4	9·8

All the lactose-fed rats were pair-fed with the C_0 group eating the sucrose diet. After four weeks of experimental feeding they were killed and livers and kidneys analysed for fat, choline, phospholipid and sphingomyelin[2] (see Table 1).

The lactose-fed rats had greater choline and phospholipid and less fat and sphingomyelin content n liver and kidney. This experiment shows that actose not only acts as a sparer of choline, but also as a lipotropic agent by virtue of this effect, provided the food intake is controlled to the same level. This has an important bearing on the kwashiorkor syndrome, where lack of milk and absence of lactose n the diet of the young after early weaning may be esponsible for the fatty liver, which is caused as a esult of the lack of choline-sparing and lipotropic effects of lactose. The mechanism of increased food ntake in lactose diet is being investigated.

I am indebted to Dr. S. Datta, director of veterinary ervices and animal husbandry, West Bengal, for his nterest and valuable suggestions.

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Utilization of the Carboxyl Carbon of L-Phenylalanine for the Synthesis of the Amino-acids of Silk by *Bombyx mori*

PREVIOUS observations in this laboratory conerning the content of free amino-acids in the silk land of *Bombyx mori* seemed to indicate that silk lanine might be derived from phenylalanine. In rder to check this possibility, it was decided to nject silkworms with L-phenylalanine labelled with arbon-14 in the carboxyl group, before they spin heir cocoons.

The L-phenylalanine was prepared from glycine abelled with carbon-14 in the carboxyl group, following the method of Bergmann *et al.*[1]. Acetylglycine was allowed to react with benzaldehyde and the zlactone obtained was coupled with L-glutamic acid ; he product of the reaction was hydrogenated and he acetyl-L-phenylalanyl-L-glutamic acid was separated by crystallization from the acetyl-D-phenyllanyl-L-glutamic acid. After hydrolysis of the cetyl-L-phenylalanyl-L-glutamic acid, the two aminocids were separated on a starch column following tein and Moore's procedure[2]. The radioactive -phenylalanine was crystallized in water/ethanol and he purity checked by paper chromatography phenol/water ; butanol/N hydrochloric acid) ; Kjeldahl nitrogen analyses (8·61 per cent; theor., 8·48 per cent), and optical activity determination ($[\alpha]_D^{20} = -34\cdot5°$, litt. $-35\cdot1°$). The scanning of the paper chromatograms showed that the radioactivity was exclusively localized at the phenylalanine spots. That the radioactivity was indeed in the carboxyl group of the radioactive phenylalanine was shown by ninhydrin decarboxylation following the method of van Slyke *et al.*[3] (see Table 1).

0·2 mgm. of this carboxyl-labelled L-phenylalanine was injected into each of ten silkworms after they had stopped eating and were ready to spin their cocoons. It must be emphasized that, at this time, the silk glands are already swollen with secretion.

Fibroin was isolated from the ten cocoons, following the procedure described by Dunn *et al.*[4]. The fibroin was then hydrolysed by refluxing in 32 per cent hydrochloric acid for eight hours. The tyrosine, glycine and alanine were isolated following Stein and Moore's method[5].

The glycine was isolated as the *p*-azobenzene sulphonate and the alanine as the nitronaphthalene sulphonate ; these sulphonates were recrystallized in water. The amino-acids were obtained by passing the sulphonates on an 'Amberlite' *IR*-120(H) resin and then eluting with 3 N ammonia ; the amino-acids were crystallized in water/ethanol/ethyl ether and found to be chemically pure by paper chromatography (phenol/water ; butanol/N hydrochloric acid) and Kjeldahl nitrogen analyses (18·75 per cent for the glycine and 15·75 per cent for the alanine ; theor. 18·66 and 15·72 per cent respectively). Both glycine and alanine were radioactively inactive (Table 1).

The tyrosine was purified by starch chromatography following Stein and Moore's procedure[2]. The radioactivity of this purified tyrosine was determined, and the compound was found to be active. It was felt that it could not be precluded that the radioactivity of the tyrosine might be due to traces of the very radioactive phenylalanine that had been injected. To examine this possibility, ordinary phenylalanine was added to the purified tyrosine and the mixture separated by chromatography on a starch column. The eluted tyrosine was dissolved in sodium hydroxide solution and crystallized by addition of acetic acid to pH 5 and ethanol ; the radioactivity was again measured and found to be slightly higher than previously ; there was, moreover, no detectable radioactivity in the eluted phenylalanine. Both results show that the radioactivity of the tyrosine sample was not due to the contamination by carbon-14-phenylalanine and was most probably within tyrosine molecules. The chemical purity of the purified tyrosine was proved by paper chromatography

Table 1

	Specific activities*	
	Amino-acid (c./min./m.mole)	Carboxyl group of amino-acid (c./min./m.equiv.)
Injected L-phenylalanine	$13\cdot$[illegible]$ \times 10^6$ $\sigma = 1$ per cent	$13\cdot5 \times 10^6$ $\sigma = 1$ per cent
Silk glycine	0	
Silk alanine	0	
Silk tyrosine	$23\cdot$[illegible]$ \times 10^3$ $\sigma = 1$ per cent	$23\cdot8 \times 10^3$ $\sigma = 1$ per cent

* All determinations were performed on barium carbonate deposits.

(phenol / water; butanol / *N* hydrochloric acid) and Kjeldahl nitrogen analyses (7·75 per cent; theor. 7·73 per cent). The radioactivity of the isolated tyrosine was localized exclusively in the carboxyl group as it was entirely in the carbon dioxide evolved by ninhydrin decarboxylation (Table 1).

From these results, it is concluded that phenylalanine is converted to tyrosine by the silkworm and that the conversion is a fairly direct one, since the radioactivity was exclusively localized in the carboxyl group of the injected phenylalanine and the isolated tyrosine. About 15 per cent of the injected phenylalanine radioactivity was found in the tyrosine of the silk fibroin.

On the other hand, the carboxyl carbon of phenylalanine is not utilized for the synthesis of alanine or glycine of the silk by *Bombyx mori*; the tyrosine results make it very unlikely that the phenylalanine could not reach the site where such transformation occurs.

This work was nearly completed when Fukuda published results[6] showing that he had isolated radioactive tyrosine from silk after injection of 2-^{14}C-phenylalanine into silkworms; he found only a very small activity in glycine and alanine.

We wish to thank Ch. Jeuniaux for his help in looking after the silkworms and injecting them with the radioactive compound.

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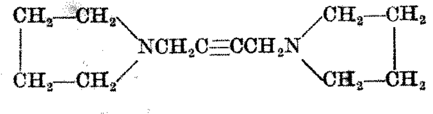
Tremor produced by Drugs

IN the routine screening of drugs in mice, we have found only ten out of ten thousand compounds which produce sustained tremor. One of these, 1-4 dipyrrolidino-2-butyne, 'Tremorine',



in doses of 5–20 mgm./kgm. produces tremor, salivation, meiosis, slight muscular weakness and rigidity lasting several hours. The effects are similar in mice, rats, guinea pigs, cats, dogs and monkeys. In the last-named species the picture is strikingly similar to human Parkinsonism. The antagonism of these effects is complete with various drugs used for treating Parkinsonism. Atropine, scopolamine and others are highly effective in small doses of 1–2 mgm./kgm. In contrast, hypnotics, anticonvulsants and ganglionic blocking agents were without effect on tremor in doses below those causing marked depression. It thus offers a specific method for the testing of possible anti-Parkinson agents.

Methantheline ('Banthine') controlled the parasympathetic signs of salivation and diarrhœa but had no effect on the tremor, demonstrating the distinct peripheral and central actions. The tremor appears to be primarily of subcortical origin. Decerebrate animals develop tremor after 'Tremorine'. The drug also causes a profound fall in body temperature. The chemical structure producing tremor is highly specific within this chemical type. Twenty analogues showed no such action. Other tremor-producing drugs are of widely diverse chemical structures. Nicotine tremor has been studied by Bovet *et al.*[1] and suggested as a test method for anti-Parkinson drugs. While this method is useful, the nicotine tremor is fleeting, has both central and peripheral components and is blocked by a number of drugs not effective in Parkinsonism[2]. Another drug, 'Harmaline', produces sustained tremors but no signs of parasympathetic involvement, and is not antagonized by a variety of anti-Parkinson drugs, blocking agents or sedatives.

It is hoped that the discovery of 'Tremorine' and its further study will reveal it to be a useful tool in the investigation of tremor and the search for more effective agents against Parkinsonism.

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Auto-oscillations in Extracted Muscle Fibre Systems

IN the course of work on relaxing factors[1], Goodal and A. G. Szent-Györgyi[1] observed that with fibre showing less than maximal activity for the creatine phosphate – adenosine triphosphate relaxing system an auto-oscillation of tension developed if the creatine phosphate was increased to 30–100 m*M*. These oscillations (Fig. 1) were observed on several occasions under the above conditions. They are independent of a *p*H change from 6·8 to 5·9 which produces a 50 per cent fall of tension, as compared to 90 per cent for 'active fibres. However, it is not certain that this 'deactivation' is an essential part of the extraction procedure

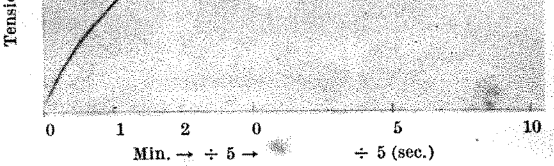

Fig. 1. Rabbit psoas muscle fibre extracted with 40 per cent ethylene glycol – water for seven days, developing oscillations in 4 m*M* adenosine triphosphate, 100 m*M* sodium creatine phosphate, 4 m*M* magnesium chloride, at *p*H 7·0. Drum-speed increased five times at each break in record

afterwards I found that 40 per cent ethylene glycol – water extraction at −5° C. produced oscillating fibres in a matter of a few days. The significant fact about such fibres appears to be their high elastic modulus.

The frequency, 2·8 sec.$^{-1}$, was 1·75 times the free oscillation of the recording lever alone, while with fibre coupled in the absence of substrate, it was about twice. Since, however, the elastic modulus falls by a factor of more than three times in the presence of adenosine triphosphate alone, it seems that the tension generator is driving the system somewhat above its natural frequency, that is, under conditions of inertial load. The compliance of the system was such that the shortening during one cycle was only 0·1 mm., or 0·3 per cent of the length of the fibre. Thus if the feedback mechanism works through length (rather than tension), only a small change is required.

The interest of this phenomenon would appear to be twofold. First, it closely resembles the situation in the flight muscles of insects, studied by Pringle[2] and Boettiger and Furshpan[3]. Secondly, it supports the hypothesis of a direct action of lengthening on activation in muscle, which has been proposed[4] as a result of a study of activation[5] in intact muscle, where it is shown that auto-oscillations can then occur only with an inertial load. In this connexion the latency relaxation of Sandow[6] was considered to be an expression of essentially the same mechanism.

Auto-oscillations with another phosphate donor system have been found by Lorand and Moos (personal communication; see following communication), whose extraction procedure is also effective with the creatine phosphate system.

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In connexion with our studies on the relaxing effect of the pyruvate phosphokinase system[1], the following procedure was used for preparing the muscle fibres. Rabbit psoas is washed in 50 per cent (v/v) aqueous glycerol (as in the original treatment of Szent-Györgyi[2]) for two days at 0° C., then stripped into bundles of approximately $\frac{1}{4}$ mm. diameter and shaken at room temperature (about 25° C.) in 20 per cent (v/v) glycerol for various lengths of time. After one to two hours extraction, the fibres develop maximal isometric tension in a bath consisting of 0·1 *M* potassium chloride, 4 m*M* magnesium chloride, and 4 m*M* adenosine triphosphate, and there is no sign of spontaneous relaxation. However, addition of 10 m*M* phosphoenolpyruvate brings about immediate relaxation. Further details on the relaxation with phosphoenolpyruvate will be published elsewhere; here, we wish to report on the results obtained by extracting psoas fibres in 20 per cent (v/v) glycerol for at least 24 hr. If such an exhaustively washed fibre is placed in a bath containing the above concentrations of potassium and magnesium chlorides and adenosine triphosphate, maximal tension develops, and upon the addition of phosphoenolpyruvate a spontaneous oscillation occurs as shown in Fig. 1.

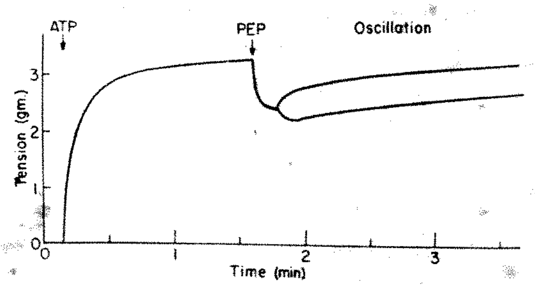

Fig. 1. Oscillating response of glycerinated psoas fibre in the presence of 0·1 *M* potassium chloride and 4 m*M* magnesium chloride. Bath at *p*H 7. ATP = addition of 4 m*M* final concentration of adenosine triphosphate. PEP = addition of 10 m*M* final concentration of phosphoenolpyruvate. Oscillation frequency, 2·8 c./s. Details are not resolved by slow kymograph drum. Double line represents envelope of oscillation

Phosphoenolpyruvate seems to be essential for maintaining the oscillation, as it stops if the fibre is transferred to a bath containing only potassium and magnesium chloride and adenosine triphosphate, but it starts anew in a bath having phosphoenolpyruvate as well. The frequency of oscillation is about 2·5–3 c./s., which in our case coincides approximately with the resonant frequency of the recording lever system loaded with the muscle fibre. In a batch of fibres washed in 20 per cent (v/v) glycerol for 24 hr., usually about 25 per cent of the fibres display the oscillating behaviour. An apparently identical phenomenon has been observed by Goodall (personal communication; see previous communication), who employed creatine phosphate instead of phosphoenolpyruvate.

By dialysing and freeze-drying the 20 per cent (v/v) glycerol solution used for the 24-hr. extraction of the muscle fibres, a preparation is obtained which stops the oscillations very effectively when added to the bath. Oscillations are resumed, however, if the fibre is transferred to a fresh bath without the muscle extract. An equally active preparation for stopping oscillations may be obtained by extracting freshly homogenized rabbit muscle with an equal volume of 0·15 *M* potassium chloride. The active factor (or factors ?) for inhibiting oscillation is non-dialysable and thermolabile.

This oscillation of glycerinated fibres is very reminiscent of the behaviour of the bumble bee wing muscle[3]. Indeed, one wonders if the oscillation observed in the insect muscles might not be due to the absence of a 'damping factor' similar to that shown here to exist in the rabbit psoas.

This work was aided by a grant from the Muscular Dystrophy Association of America, Inc.

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Plasma Factor(s) influencing Red Cell Production

There is an accumulating body of evidence of the existence of a humoral substance(s) in the plasma of animals with induced anæmia which stimulates erythropoiesis in recipients[1].

We have found that when young adult rats are hypophysectomized by a standard technique (from Hormone Assay Laboratories, Inc., Chicago), erythropoiesis is reduced to a minimum by 10–14 days after the operation as shown by a tenfold reduction in the incorporation of iron-59 into the red cells and by a fivefold reduction in the number of reticulocytes. When this level of erythrocyte production is reached, the administration of plasma (2 ml. daily for three days) from rats made anæmic by repeated bleeding (anæmic plasma) results in a three- to seven-fold increase in the amount of iron-59 taken up by the erythrocytes (Table 1) and in a three- to eight-fold increase in the number of reticulocytes in the recipients. As previously described[2], the iron-59 solution is injected through the tail vein 2 hr. after the last plasma injection; 16 hr. later, a 1-ml. sample of blood is withdrawn from each rat and the radioactivity is counted in a well-type scintillation counter. No significant change is observed in the incorporation of iron-59 into the red cells of the control hypophysectomized rats given normal plasma or saline under these experimental conditions. The blood volume and red-cell mass of hypophysectomized rats, as determined by chromium-51 studies, remain within normal limits during this initial two-week period. A single intravenous or intraperitoneal injection of 2 ml. of anæmic plasma given 24 hr. before the injection of iron-59 elicits a significant increase in the incorporation of iron-59 into the red cells of hypophysectomized rats. Two injections of 2 ml. each of anæmic plasma from other species (for example, rabbit, dog or human being) evoke a positive erythropoietic response in the hypophysectomized rat. Six or more daily 2-ml. injections of normal rat plasma must be given to produce a definite increase in iron-59 taken up by the red cells of hypophysectomized recipients.

The plasma from hypophysectomized rats subjected to hæmorrhage (hæmatocrit less than 25 per cent) exerts an effect on the uptake of iron-59 in hypophysectomized rats that is comparable with that observed after the administration of anæmic plasma.

At this stage of our investigations we prefer not to debate the question raised by others as to whether there is a specific pituitary factor that has a direct control on erythropoiesis; but it is an established fact that the red-cell mass falls slowly to a new equilibrium-level within a period of two to three months after hypophysectomy[3].

The simplest explanation for our findings may be summarized as follows: Within a few days after hypophysectomy, an overall reduction occurs in the metabolic processes of the animal. With the reduced metabolic requirement and before the red-cell mass has fallen to its new level of equilibrium, the hypophysectomized animal is more or less comparable to an animal that has been made polycythæmic by red-cell transfusion. It may be postulated that, in these circumstances, the production of the plasma factor(s) responsible for maintenance of the steady state of circulating erythrocytes is reduced to a minimum since a plethora of red cells already exists. Thus, there is a situation that in essence is the reverse of that which obtains when a normal animal is bled. As a consequence, red-cell production is reduced to a minimum. When anæmic plasma is administered under these conditions, there is an exaggerated response in terms of the production of new red cells. As final and complete equilibration of red-cell production and the new reduced red-cell mass slowly become established in the hypophysectomized animal, one finds, as would be expected, that the number of reticulocytes and the uptake of iron-59 have risen from the low values found shortly after hypophysectomy to values that are consistent with the new steady state. As reported by others[4], we have found that producing a polycythæmia in normal animals (mice, rat, rabbit) by repeated transfusion of red cells reduces erythrocyte production. The response to anæmic plasma in these polycythæmic animals in terms of the incorporation of iron-59 into the red cells or the increase in reticulocyte values is comparable with that observed in hypophysectomized animals.

Table 1. Uptake of Iron-59 by Erythrocytes of Hypophysectomized Rats after Administration of Normal or Anæmic Plasma

Average percentage iron-59 uptake into red-blood cells of rats*				
Plasma injected	No. of animals	Prior to hypophysectomy	No. of animals	10 days post-hypophysectomy
Normal	8	37	17	3·7 ± 2†
Anæmic	5	48	16	20·4 ± 6†

* 16-hr. sample. † Standard deviation of the mean.

Note: While the number of animals prior to hypophysectomy is small, the results are in excellent agreement with those reported on a large number of rats (see ref. 2) when the sampling time was 20 hr.

We assume for the sake of simplicity that the factors in normal plasma and in the plasma of normal or hypophysectomized animals subjected to bleeding that stimulate erythropoiesis in hypophysectomized and in polycythæmic assay preparations are one and the same. Further study may, however, reveal a somewhat more complicated picture. Nevertheless, with this sensitive assay method, it should be possible to make more rapid progress in determining the source, the identity, and the physiological role of the plasma factor(s) under discussion in conditions of health and disease. Our studies will be published in detail elsewhere.

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Embryology, Epigenetics and Biogenetics

In his stimulating review of Prof. C. H. Waddington's "Principles of Embryology", Dr. Julian Huxley[1] expresses the hope that Prof. Waddington will write a sequel, and, following his earlier impulse, call it "Principles of Epigenetics". While the term 'embryology' suggests a field far more restricted than that which this department of science is now concerned with, the suggested alternative, 'epigenetics', has disadvantages of another kind. It still reverberates with the overtones of a *cause célèbre*, a controversy in which, as it now appears, neither 'epigenesis' nor 'preformation' gained a decisive victory. For whereas identifiable organized units, whether organs or tissues, appear successively from an apparently undifferentiated mass, there is now no question but that the material determinants of these new structures are preformed in the chromosomes recognizable before the beginning of embryonic life. That this caution is not a matter of mere historical pedantry is evidenced by the fact that another worker of long experience in this field, M. Jean Rostand, has recently[2] referred to the "extravagances du préformationnisme" and the "naïvetés de l'épigenèse".

In another place[3] I made the suggestion that the whole field comprising the problems of the 'genesis' of organisms could appropriately be styled as 'biogenetics', with subdivisions, 'ontogenetics' (the development of individual organisms), 'phylogenetics' (theories of descent) and 'stoichiogenetics' (quantitative 'genetics' *sensu strictu*), thus bringing out the unitary character of the field. It seems highly regrettable that no one was looking when those responsible for launching the new discipline concerned with the sub-field of the relation between adult 'characters' and transmitted determinants arrogated to it the higher-level name of 'genetics'. Whence my suggestion that, despite the high authority of the sponsors of the term 'epigenetics', the latter should not be too hastily accepted.

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[2] Rostand, *J. World Hist.*, **2**, 134 (1954).
[3] Wightman, *J. World Hist.*, **2**, 734 (1955).

THE fact that the word 'epigenetics' is reminiscent of 'epigenesis' is to my mind one of the points in its favour. As Dr. Wightman points out, in the old controversy, now stilled, between the theories of epigenesis and preformationism, neither side emerged completely victorious. We all realize that, by the time development begins, the zygote contains certain 'preformed' characters, but that these must interact with one another, in processes of 'epigenesis', before the adult condition is attained. The study of the 'preformed' characters nowadays belongs to the discipline known as genetics; the name 'epigenetics' is suggested for the study of those processes which constitute the epigenesis which is also involved in development. Admittedly the word 'genetics', which was coined by Bateson to cover "the physiology of descent", might have been used so as to embrace both aspects of development; but in practice it has not been widely employed in that sense.

Incidentally, it was not entirely from diffidence, as Huxley suggested, that I named my book the "Principles of Embryology"; I did so mainly because it devotes some space to the descriptive anatomical data relating to development, and is not confined wholly to that analysis of causal mechanisms for which the name 'epigenetics' is appropriate.

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Effect of Some White Pigments on the Actinic Degradation of Cotton

THE action of solar radiation in reducing the strength of cotton is well known. In our experience, 12-oz. grey cotton duck exposed to weather in a non-industrial atmosphere near Melbourne, Victoria, loses about 25 per cent of its strength in twelve months, due solely to the action of light. Although fungal growth is commonly observed on exposed cotton fabrics, the species isolated have always been non-cellulolytic; fibres from exposed fabrics when examined microscopically by the modified congo red test[1] show actinic damage but no fungal damage.

The rotproofing treatments customarily applied in Australia to cotton duck intended for use in tentage are based on copper compounds all of which accelerate actinic action[2]. Fabrics treated with copper soaps and cuprammonium solutions may lose 70–80 per cent of their strength during twelve months exposure; copper naphthenate and copper 8-quinolinolate are less severe in their effects, but fabrics treated with them lose 40–50 per cent of their strength in that time. To reduce the effects of the copper compounds, Australian rotproofed tentage fabrics are given a protective pigment coating. Iron and chromium pigments have generally been used; but there is some demand for a white as well as a coloured finish. Zinc oxide has been tried; but it is difficult to incorporate in the coating emulsions used and it gives a grey colour rather than white. Other white pigments are easily incorporated in synthetic resin emulsions, and limited trials were arranged to determine the effect of the pigments that could be used in this way, the pigments being used singly or in mixtures.

The pigments were incorporated in synthetic resin emulsions and the various emulsions applied to 12-oz. grey cotton duck. The treated fabrics were exposed for twelve months (June 1954–May 1955) at Reservoir, near Melbourne, in a non-industrial atmosphere.

Table 1

Pigment used in emulsion	Chemical analysis of unexposed fabrics				Loss of strength after 12 months exposure (per cent)
	$BaSO_4$ (per cent)	ZnS (per cent)	TiO_2 (per cent)	Other (per cent)	
Series I					
Lithopone (30 per cent)	2·4	1·1	—	—	29
Lithopone (60 per cent)	1·2	1·1	—	—	38
Anatase	—	—	2·8	—	93
Rutile *A*	—	—	3·6	—	2
Antimony oxide	—	—	—	Sb_2O_3: 3·8	24
White lead	—	—	—	Pb: 2·8	26
Zinc sulphide	—	3·5	—	—	38
Series II					
Lithopone (60 per cent)	1·3	1·2	—	—	29
Lithopone and anatase	1·0	0·8	0·2	—	68
Lithopone and anatase	0·6	0·6	0·8	—	81
Anatase	—	—	3·3	—	87
Lithopone and rutile *A*	1·4	1·2	0·2	—	31
Lithopone and rutile *A*	0·8	0·6	0·8	—	15
Rutile *A*	—	—	3·2	—	5
Lithopone and rutile *B*	1·2	1·1	0·2	—	20
Lithopone and rutile *B*	0·7	0·7	0·8	—	14
Rutile *B*	—	—	3·4	—	4
Untreated	—	—	—	—	27

The pigments used, the results of chemical analyses of the unexposed fabrics, and the losses of breaking strength after exposure, are set out in Table 1.

The effect of anatase is startling. Fabrics containing about 3 per cent of this pigment lost 90 per cent in strength. Lithopone alone has only a slight effect on the loss of strength, but when small amounts of anatase are added the loss of strength is greatly increased. On the other hand, the presence of rutile retards the loss of strength. The other pigments used have little or no effect.

Fibres from the exposed materials examined by the congo red test showed varying degrees of actinic degradation but no damage from other causes. The intensity of the staining of the fibres increased with increasing loss of strength. The fabrics containing rutile showed only the faintest signs of actinic action; but all the fabrics containing anatase showed severe actinic damage.

These results indicate that anatase accelerates the actinic degradation of cotton and that rutile has a protective effect. The effect of anatase on cotton is consistent with its effect on fibres such as nylon and 'Perlon'. We have recently examined some deteriorated fabrics made from these fibres in which anatase had been used as a delustrant. Exposure of the fabrics to sunlight for a short time (about three months) had produced great losses of strength; this effect does not occur with bright (undelustred) nylon. The different effects of anatase and rutile in paints exposed to weather are well known[3]; paints containing anatase chalk rapidly and heavily, but paints containing rutile chalk only very slowly. We suggest that this may be due to the different reactions of the two pigments to light, and may be similar to the differences observed in Australia between chalking and non-chalking grades of zinc oxide[4]. The generally accepted explanation of the different effects is based on deficiencies in the spatial arrangement of the oxygen atoms in the crystal, whereby anatase can be reduced in the presence of oxidizable compounds; light provides the necessary stimulus for the reduction and atomic oxygen is liberated and attacks the oxidizable material. Cellulose can be readily oxidized with accompanying loss of strength, and it appears that the accelerating effect of anatase on the actinic degradation of cotton could be explained in the same way.

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A Gas Phase in Viable Fungal Spores

WHEN the dark ascospore of *Sordaria fimicola* is examined dry, a round paler zone in the middle is invariably seen. If the spore is flooded with water, it is clear that this zone is a gas bubble which disappears in a few minutes. If the spore is again allowed to dry, very shortly after the last visible trace of external water has disappeared, a tiny intracellular gas bubble 2–3μ in diameter suddenly appears and rapidly enlarges. With further drying, as well as the enlargement of the bubble, the spore itself caves in to some extent. The separation of a gas phase seems to be an invariable concomitant of drying. It is easy to show that dry spores containing gas bubbles are fully capable of germination when placed in a suitable solution.

Exactly the same behaviour has been seen in ascospores of *Pleurage curvicolla* (Fig. 1) and *Hypoxylon fuscum*.

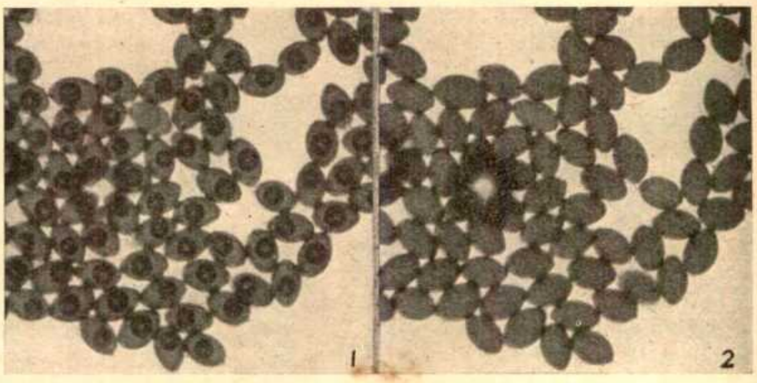

Fig. 1. (1) Freshly discharged spores of *Pleurage curvicolla* caught on a dry slide and photographed 15–20 sec. after flooding with water; each contains a gas-bubble. (2) The same spores 60 sec. later; the gas phase has disappeared. × 420

It seems likely that the gas bubble originates within the spore just as it does during spore discharge in the annulus cell of a drying fern sporangium or in the elater of a leafy liverwort. That is to say, as evaporation proceeds, the volume of the spore tends to be reduced; but this reduction is resisted by the rigidity of the cell wall, so that the aqueous contents pass into a state of tension which increases until a point is reached when rupture occurs and a gas phase, presumably water vapour, suddenly appears. That the bubble is water vapour is supported by the fact of its rapid disappearance when the spore is placed in water.

The gas phase can also be produced in *Sordaria* spores by dehydrating with glycerol. This can easily be observed if a small drop of water containing spores on a microscope slide is mixed with a larger drop of pure glycerol. A gas phase separates in most of the spores, although some simply collapse.

The sudden separation of a gas bubble on drying might be expected to produce a movement of the whole spore; but no such movement is seen in *Sordaria*, possibly because the spore is so firmly glued to the microscope slide by its sheath of mucilage.

There does not seem to be any biological significance in the occurrence of a gas phase in ascospores. If, however, the separation of gas in plant cells without loss of viability is at all general, it may be important. Thus, if a gas phase were suddenly to appear on drying in a spore finely perched on a conidiophore, the jolt night well be enough to discharge it into the air. Possibly the temporary appearance of gas in living lant cells with rather rigid walls may be of common ccurrence; in hard-leaved xerophytes, for example. However, since the gas would very quickly disappear n sections mounted in water, it would not normally be observed.

So far as I know, the pseudovacuoles of some blue-reen algae are the only previously recorded examples f a gas phase in living plant cells.

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Septate Fibres in Angiosperms and their Length

Recently, Govindarajalu and Swamy[1] have reported that the septate fibres are longer than the non-septate fibres in the secondary xylem of *Pithecolobium dulce* Benth. Since this is the first record of the difference between the length of septate and non-septate fibres in a wood, one is likely to get the impression that what has been found in *P. dulce* is true for all the Dicotyledons; but this is not so. In the course of our investigation, during the past five years, on septate fibres of Angiosperms, we find that in a large number of species there is little difference in length of these two types of fibres. Only in a few cases are septate fibres found to be either shorter or longer than non-septate fibres (Table 1).

Table 1. Length of Septate and Non-septate Fibres in Angiosperms

Family	Species	Mean length in mm.* Septate fibres	Non-septate fibres
Anacardiaceae	*Dracontomelum mangiferum* Blume	1·32	1·34
Bignoniaceae	*Heterophragma sulfureum* Kurz	1·22	1·23
Celastraceae	*Celastrus spinosa* Royle	0·54	0·73
Combretaceae	*Terminalia tomentosa* W. and A.	1·37	1·36
Elaeocarpaceae	*Elaeocarpus serratus* Linn.	1·53	1·47
	Elaeocarpus simplex Kurz	1·40	1·49
Lauraceae	*Cinnamomum glanduliferum* Meissn.	1·34	1·50
	Machilus fruticosa Kurz	1·33	1·58
Leguminosae	*Albizzia lebbeck* (L.) Benth.	1·17	1·19
	Peltophorum ferrugineum Benth.	1·16	1·10
	Pithecellobium dulce Bth. (Syn. *Pithecolobium dulce* Benth.)	0·80	0·55
	Samanea saman (Jacq.) Merr.	1·22	1·19
Lythraceae	*Lagerstroemia speciosa* (L.) Pers.	1·11	1·08
Meliaceae	*Swietenia mahagoni* Linn.	1·10	1·02
Myristicaceae	*Myristica angustifolia* Roxb.	1·14	1·07
Oleaceae	*Ligustrum compactum* Hook. f. and Th.	0·89	0·92
Punicaceae	*Punica granatum* Linn.	0·57	0·57

* Based on more than 150 measurements.

In *Dendrocalamus strictus* Nees of the Gramineae, septate fibres occur both in the xylem and the phloem caps. Preliminary examination shows considerable difference between the length of septate and non-septate fibres found in the vascular bundles of the periphery and those of the interior (Fig. 1). Towards the interior the septate fibres are shorter than the non-septate fibres, whereas in the periphery they are longer.

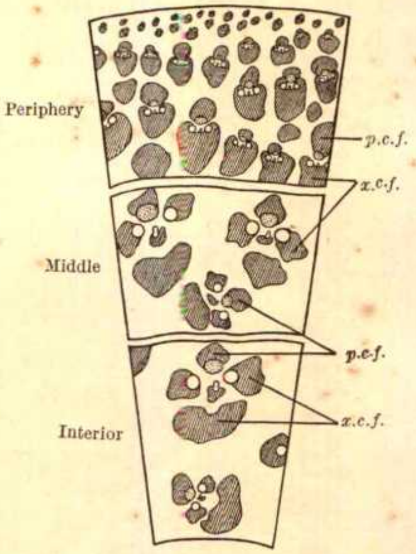
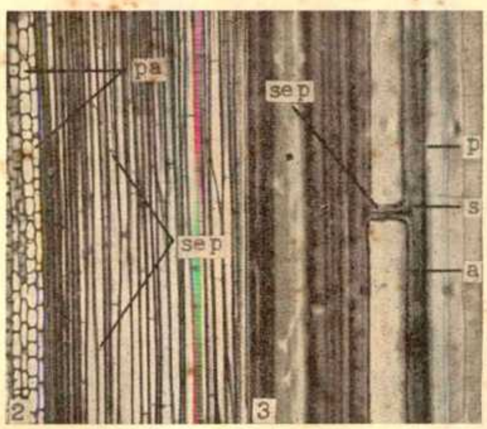


Fig. 1. *Dendrocalamus strictus* Nees, transverse section, internode, in part; *p.c.f.*, phloem cap fibres; *x.c.f.*, xylem cap fibres (× 15, diagrammatic)

Vestal and Vestal[2] first demonstrated the development of septate fibres in *Hypericum androsaemum* Linn. Purkayastha has worked out the development of septate fibres in some tropical trees. In the course of his investigation he has found that some crystalliferous fibres are related to septate fibres[3]. Again, Chowdhury has reported that in some genera there is little effect of environment on the frequency of occurrence of septate fibres, whereas in others, formation of septate fibres varies from locality to locality[4]. Recently, our work on bamboo (*Dendrocalamus strictus* Nees) has shown that the protoplasts in these fibres mostly live for a long time, often even after laying down the secondary wall (Fig. 2). Occasionally an additional layer is also deposited both on the vertical wall as well as on the septum. As a result, the septum is quite thick and consists of three distinct layers (Fig. 3).

The function of the septate fibres is at present not clearly understood. To say that the special function



D. strictus Nees, longitudinal section, internode. Fig. 2. *pa*, parenchyma; *sep*, septa (× 60). Fig. 3. *p*, primary wall; *s*, secondary wall; *a*, additional layer; *sep*, septum (× 500) of the septate fibre is to give mechanical strength and serve for storage of food material is not quite correct[5]. In tropical woods, non-septate and septate fibres, and even vessels, have been observed to serve as storage tissues in living trees (Chowdhury, K. A., unpublished work).

A detailed account of this investigation will be published elsewhere.

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Effect of Hormone Herbicides on the Growth of *Rhizobium trifolii*

IN view of the widespread use of hormone-type herbicides on mixed stands of crop plants containing clover as an essential constituent, it would appear to be of considerable importance to determine the effect of these substances on the growth of the clover nodule-forming organism. This is particularly true of the phenoxybutyric compounds which have been recommended for use as herbicides where clover is present, since they have been shown by Wain[1] and other workers to have no harmful effect on clover due to the latter's lack of the β-oxidizing enzyme system.

The substances investigated in this experiment were the sodium salts of 24*D* (2 : 4-dichlorophenoxyacetic acid), *M.C.P.A.* (2-methyl-4-chlorophenoxyacetic acid), 245*T* (2 : 4 : 5-trichlorophenoxyacetic acid), 24*DB* (γ-(2 : 4-dichlorophenoxy)butyric acid), and *M.C.P.B.* (γ-(2 methyl-4-chlorophenoxy)butyric acid). They were incorporated in a yeast–mannitol agar[2] in the appropriate concentration of acid equivalent. Two agar plates were prepared for each concentration. A standard suspension of a known effective strain of rhizobium (*Rh. trifolii* 157) was prepared in sterile distilled water and three loopfuls were streaked on each Petri dish of agar. The plates were incubated at 24° C. for four days.

From the results it is clear that the herbicides had no effect on the growth of *Rhizobium trifolii* at concentrations up to 25 p.p.m. Beyond this level, the growth was moderate to poor up to 500 p.p.m. The bacteriostatic point lies beyond 500 p.p.m. but has not yet been determined. It will be noted that the butyric-acid compounds 24*DB* and *M.C.P.B.* were slightly less toxic than the acetic-acid compounds 24*D*, *M.C.P.A.*, and 245*T*.

Table 1

Substance / Conc. p.p.m.*	24*D*	*M.C.P.A.*	245*T*	*M.C.P.B.*	24*DB*
0	+++	+++	+++	+++	+++
1·0	+++	+++	+++	+++	+++
5·0	+++	+++	+++	+++	+++
25·0	+++	+++	+++	+++	+++
50·0	++	++	++	+++	++
100·0	+	+	+	++	++
200·0	+	+	+	++	++
300·0	+	+	+	+	+
400·0	+	+	+	+	+
500·0	+	+	+	+	+

* Acid equivalent. + poor growth; ++ moderate growth; +++ good growth.

Relating these figures to soil conditions, 1 acre of topsoil to 8–9 in. depth contains approximately 3 million pounds of moist soil. This refers to 'mineral' soil with about 3–12 per cent of organic matter. A convenient figure for the weight of topsoil of an arable field to the deliberately vague specification of 'plough depth' would be 2¼ million pounds or 1,000 tons. If the actual content of active growth substance in an application, on reaching the soil, is as much as 1 lb., the momentary concentration in the topsoil (assuming even distribution) is 0·5 p.p.m. approximately.

These are the concentrations over the whole mass of soil. But the substance is effective against plants or microbes only to the extent that it dissolves in the soil water. Assuming no adsorption but complete solution, and a 20 per cent water content of soil, the concentrations become 2–2·5 p.p.m. = 1 lb./acre approximately. Since the growth of *Rhizobium trifolii* is unaffected by concentrations up to 25 p.p.m. (= 10 lb./acre), it can be assumed that the concentrations used in agricultural practice (usually 1 lb. of the acid equivalent per acre) will have no adverse effect on the growth of *Rhizobium trifolii* even assuming that all of it reaches the soil.

Thanks are due to Messrs. May and Baker, Ltd., for supplying the *M.C.P.B.* and 24*DB* for experimental purposes.

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Growth of Lettuce Seedlings

THE methods of growth analysis[1] have been applied to comparatively few horticultural crops; yet, as stated by Gregory at the Thirteenth International Horticultural Congress in 1952 [2], these techniques open up a wide field in horticultural research and are an essential basis of any attempt to understand the control of growth by environmental factors.

The following results were obtained with lettuce (*Lactuca sativa*, Linn.), variety Cheshunt 5*b*, during the course of an investigation of the rate of recovery of seedlings from the check of transplanting, full results of which will be reported elsewhere. The study was confined to the first three or four weeks of growth; that is, up to or beyond the normal stage for planting out. Plants were raised at various seasons in growth rooms and also during mid-winter in a heated glasshouse. In the growth rooms, plants were grown at constant temperatures of 70°, 60° and 50° F., day-lengths of 16 and 9 hr., and light intensities, at plant-level, of approximately 650, 400 and 250 ft. candles, using fluorescent daylight tubes. Net assimilation-rates were obtained by the usual formula[3], leaf areas being calculated from length and breadth measurements, excluding the petiole. Good

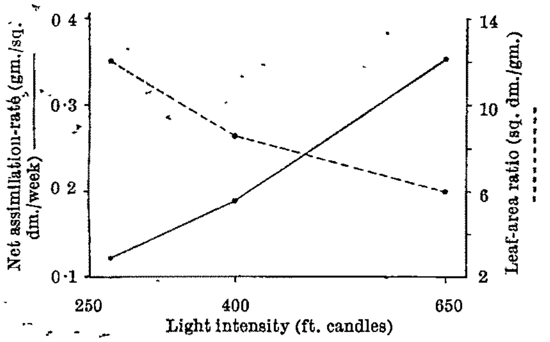

Fig. 1. Temperature, 70° F.; day-length, 16 hr.; period, 14–23 days from germination

correlation was obtained between actual leaf area and the products of length and breadth measurements when determined in small samples.

Net assimilation-rate varied with environmental conditions, values ranging from 0·06 gm. per sq. dm. per week, under natural light in a glasshouse in mid-winter (temperature-range 50–60° F.), to 0·35 at 70° F. with 16-hr. days and a light intensity of approximately 650 ft. candles. As found by Blackman and Wilson for several species[4], net assimilation-rate increased with light-intensity over the range tested (Fig. 1). Higher net assimilation-rates were recorded in long than in short days; but a negative relationship was indicated between temperature and net assimilation-rate (Table 1).

Table 1

Day-length: 16 hr. Light-intensity: 400 ft. candles

	70° F.	60° F.	50° F.	S.E.
Mean net assimilation-rate during first four weeks of growth	0·145	0·174	0·197	± 0·0077

Leaf area ratios, on the other hand, were significantly increased at higher temperatures, but decreased at higher light-intensities. Fig. 1 illustrates the relationship between light intensity, net assimilation-rate and leaf-area ratio, and effects of temperature and light-intensity on leaf-area ratio are shown in Table 2.

Table 2

Day-length: 16 hr 14–23 days from germination

Temperature (° F.)	Light intensity (ft. candles)	Leaf-area ratio (sq.dm./gm.)
70	650	6
50	400	6
70	400	9
70	250	12

Abundant water was made available to all plants by means of a system of constant sub-irrigation. Conditions of high temperature and low light-intensity, which induced high leaf-area ratios and low net assimilation-rates, were accompanied by increased moisture content, as shown by the ratios of wet to dry weights.

Relative growth-rate is the product of net assimilation-rate and leaf-area ratio. Plants grown at the lowest light-intensity had a low net assimilation-rate, but a high leaf-area ratio which, to some extent, had a compensatory effect on relative growth-rate. Values of relative growth-rate ranged from 0·09 to 0·32 gm. per gm. dry weight per day, and it is believed that the latter is the most rapid rate of growth recorded for a crop plant. Rapid growth-rates do not necessarily produce the best type of plant, since this is dependent on a suitable balance between leaf-area ratio and net assimilation-rate. For example, plants with high leaf-area ratios had long petioles and the leaves were thin and soft in texture.

These results emphasize the importance of maintaining a suitable balance between temperature and light-intensity for satisfactory growth. This applies particularly to the culture of plants in glasshouses during winter, when light-intensity is low and where high temperatures cannot compensate for lack of light.

Growth analysis provides a means of examining and evaluating the effects of horticultural practices. The present investigation has clearly shown that severe reduction of the root or shoot during transplanting at the cotyledon stage checks growth, but that the effect is temporary. Under good growing conditions, the shoot/root ratio, net assimilation-rate, leaf-area ratio and relative growth-rate rapidly reassume values comparable with those of an uninjured plant. Lettuce seedlings showed considerable modification in their habit of growth under the conditions to which they were subjected in these experiments.

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Soil Thermometers

FOR the measurement of soil temperatures at depths of 1 ft. or greater, it is established practice in many parts of the world to use a specially modified thermometer which is hung in a tube and withdrawn for reading. So that its indication will not change appreciably during the process of reading, the bulb is surrounded by a mass of paraffin wax to give it a high lag coefficient.

We have recently had occasion to check the calibration of a number of these thermometers and found that at 40° F. and below their indications were considerably in error. At 40° F., errors of between 1° and 2° F. were not uncommon, and at 20° F. the errors might be as large as 6° or even 8° F. In all cases the thermometers were reading high. The thermometers themselves, when removed from the wax, had negligible errors, that is, they were within the limits of accuracy laid down for this class of thermometer.

When the thermometers were subjected to an external hydrostatic pressure of several hundred pounds per square inch, the bulbs were reversibly deformed sufficiently to cause errors of the above magnitude. It is clear from this, and other tests, that the errors are caused by pressures developed on the bulbs by thermal contraction of the wax at low temperatures. The errors so caused are not repeatable and depend on the previous thermal history of the thermometer, presumably because of plastic flow in the wax.

Only thermometers of one maker have been checked; but since the trouble is due to a fundamental weakness in the design specification, the products of other makers using similar waxes will presumably be affected to a greater or lesser degree.

In view of the fact that thermometers of this design are fairly widely used, it was thought desirable to bring the situation to the notice of as wide a group of interested people as possible: particularly those interested in using these instruments for studying long-term trends in earth temperature.

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Periodicity of the Laminariaceae around Scotland

During 1946–55, an extensive survey of the Laminariaceae growing around the coast of Scotland has been in continuous operation. The whole of the marine coast of Scotland—more than 6,000 miles—has been photographed (through the co-operation of the Royal Air Force) and, with the aid of these stereoscopic aerial photographs, quantitative assessments of the Laminariaceae have been made by using ecological factors which the data, collected from detailed sub-littoral surveys, have revealed[1].

Detailed surveying, using methods of quadrat sampling with calibrated spring grabs[2], was operated from boats on charter from the fishing fleet, during all times of the year.

Over sub-littoral areas of the north-east, north-west, south-east and south-west mainland of Scotland, the Orkney Islands and the Isle of Skye, eighty-six detailed surveys have been completed and analysed, and of these more than half have been re-surveys (for example, Girvan to Bennane, six times). This work has involved the measurement of 100,000 quadrats from more than 67,000 acres (27,000 hectares) of the sea bed.

It has been found that changes in the quantity as well as the ratio of species occurred over a number of years; it is now possible to indicate the trend. By far the greater quantity of the Laminariaceae was found above five fathoms (nine metres) and consisted of *Laminaria cloustoni* Edm., *L. saccharina* Lamour and *L. digitata* Lamour. Based on all quadrat values obtained from eighty-six surveys, mean fresh weight per unit area of the three Laminariae, found between one and five fathoms, in each calendar year, from 1946 until 1955, was:

	lb./sq. yard (× 0·54 for kgm./sq. metre)		lb./sq. yard (× 0·54 for kgm./sq. metre)
1946	9·1	1951	5·4
1947	13·4	1952	3·7
1948	11·2	1953	2·8
1949	8·0	1954	3·4
1950	5·0	1955	4·7

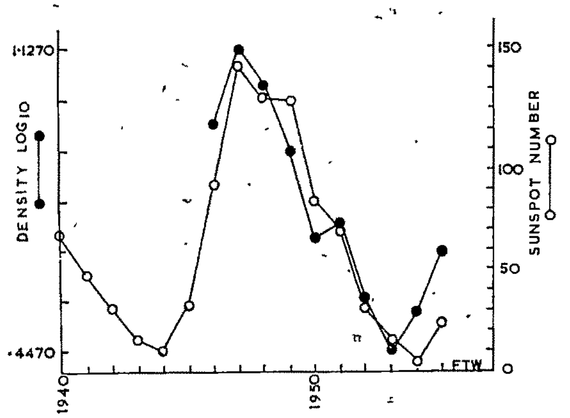

Fig. 1. Relationship of the fresh weight of Laminariaceae and the frequency of sunspots

These values when plotted logarithmically show the trend over the past ten years (Fig. 1).

Extrapolation of the graph backwards in time gives a trough in 1942 of the same level as 1953; and forwards in time gives a crest in 1958 of the same level as 1947. Ecological factors combining to produce an eleven-year cycle would appear to be controlling the reproduction, colonization and growth of the Laminariaceae around Scotland.

Mention of an eleven-year cycle brings to mind sunspot activity. The annual mean of monthly sunspot numbers, published by the Federal Observatory, Zurich, have also been plotted in Fig. 1. The Royal Greenwich Observatory finds there is a satisfactory parallelism between these mean sunspot numbers and the sunspot areas which they measure. It will be seen that the two graphs show a surprising degree of correlation.

The laminarian periodicity is not thought to be the direct consequence of sunspot activity, but rather the indirect result of such activity producing meteorological conditions which in turn are reflected in the marine environment.

I wish to thank Mr. W. H. Newton, of the Royal Greenwich Observatory, for supplying the information on sunspot activity.

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A Marlin in Angola, with a Note on *Makaira herschelii* (Gray), 1838

Marlin fishes of the genus *Makaira* Lacépède, 1801, in which the dorsal fin is lower than the body, are found over wide areas of the three main oceans in a broad equatorial belt, mostly within the 20° isotherms. In the Atlantic proper there has so far been found only the so-called 'blue' marlin, generally named *Makaira ampla* (Poey), 1860. This fish, doubtfully distinct by full specific rank from the Indo-Pacific 'black' marlin, *M. herschelii* (Gray), 1838, is said to occur also in the Pacific. In the Atlantic the blue marlin has been recorded in scientific literature chiefly from the region of the West Indies, and from the north-western coastal areas of South America. It has also been reported from off south-western Europe, and from St. Helena (lat. 16° S., long. 5° 40′ W.) in the south Atlantic. The other smaller marlin of the Atlantic, and confined to that ocean, *Lamontella*[1] *albida* (Poey), 1860, has a somewhat similar but less extensive distribution than *M. ampla*, while the 'mystery' marlin, *Orthocraeros*[1] *bermudae* (Mowbray), 1931, is known from only one specimen, photographed but regrettably destroyed.

As marlins are known to travel widely, it is astonishing to find that the range of these fishes in the Atlantic is far more restricted than might be supposed. Up to the present, there has not appeared in scientific literature any report of the occurrence of any species of marlin anywhere near the whole length of the extensive western coast of Africa. Colonel J. K. Howard, of Miami, has informed me privately that he caught a marlin (unspecified) at Cape Verde, and that natives told him that marlins had been seen off Accra, Gold Coast (4° N.); but no confirmatory evidence is available.

What is remarkable is that I cannot find any evidence of a single marlin of any kind having ever been reported from a vast area of the Atlantic, extending north-west from the Cape, bordered on the east by the west coast of Africa, and including the enormous area of the Gulf of Guinea. This is certainly an astonishing gap, for it is an area with notable concentrations of the comparable tunny fishes, where marlins might well be expected to occur and even to abound.

Partly as a result of the publicity attending recent marlin discoveries in South African seas, a considerable amount of interesting information has reached me. One item is a photograph of a large marlin thrown ashore at Lobito Bay, Angola (lat. 12° 30′ S., long. 13° 10′ E.). The fish had been damaged by sharks and from the photograph was patently putrescent; but it certainly falls in *Makaira* Lacépède, and is thus the first marlin ever to be reported in the eastern Atlantic area defined above. No dimensions of any kind were apparently taken of the fish itself, but the photograph contains sufficient detail to enable the principal dimensions to be estimated, and by careful compilation and deduction these would have been very close to the following: total length, 144 in.; standard length, 124 in.; depth of body, 22 in.; height of dorsal lobe, 17 in.; suprapectoral height, 17 in.; length of head, 42 in.; spear before eye, 28 in.; tip of spear to tip of lower jaw, 15 in.; estimated weight, about 450 lb.

This information alone does not clearly settle the identity of the fish as a 'black' or a 'blue' marlin, though the relatively elevated dorsal lobe indicates 'blue'. On the other hand, that fin in this case falls within the upper limit recorded for the 'black', while the relatively short stout spear is more characteristic of the latter fish.

The discovery of this fish at Lobito opens up several interesting possibilities. It may have been a black marlin, the presence of which in the Atlantic I have long suspected. Also this Lobito fish does not necessarily indicate that marlin are abundant along the west coast of Africa, for no others have been reported there and this may have been a stray. On the other hand, anglers in Angolan waters not infrequently have strong tackle ripped away by unknown monsters that might well be marlin, and careful search may reveal that they are normally present there.

The third undoubted marlin to be reported in scientific literature was *Tetrapturus herschelii* (Gray), 1838, based on an 11-ft. fish thrown up in Table Bay. Some American workers have suggested that *herschelii* was of Atlantic origin and hence of uncertain identity in relation to its position as the first valid type of the black marlin, which most name either *mazara* Jordan and Snyder, 1901, or *marlina* Jordan and Evermann, 1926.

Although nominally on the border of the Atlantic Ocean, the Cape is, faunistically, almost completely isolated from the Atlantic by the wide belt of cold water that lies along the coast of South-West Africa. Because of the powerful westward warm Mozambique Current, the Cape is indeed connected far more closely with the tropical Indian Ocean than with any comparable even much closer area of the Atlantic. There is little doubt that *herschelii* travelled westwards with that current to and beyond Agulhas, where it was doubtless killed by the cold water. A comparable marlin was recently found floating dead in False Bay, Cape, and I have been sent a photograph, faded, but amply clear, of an approximately 10-ft. undoubted 'black' marlin found in Table Bay in 1923.

The original description and figure of *herschelii* accord quite satisfactorily with all marlins of comparable size found in southern Africa at and eastwards of the Cape, all of them 'black' marlins, apparently identical with those found in the Pacific and Indian Oceans. Among numerous specimens in South and East African waters, ranging from 45 to 450 lb. in weight, I have not yet found a single undoubted 'blue' marlin.

There is thus little doubt that if the 'black' marlin be accorded full specific distinction from the 'blue', it should bear the name *Makaira herschelii* (Gray), 1838.[1] This adds another to the long list of fishes first found at the Cape and later discovered over wide areas of the globe.

J. L. B. Smith*

Rhodes University,
Grahamstown,
South Africa.
April 19.

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* S.A. Council for Scientific and Industrial Research Fellow in Ichthyology.

[1] See Smith, Dept. Ichthy. Rhodes Univ. Bull. 2 (1956).

Death of Flamingoes in the Camargue

The sudden onset of cold weather in the Camargue during February of this year is reported to have killed off the wintering colony of flamingoes, *Phoenicopterus ruber roseus* Pall. There were said to be between 3,000 and 4,000 birds in the region. On a tour of the area during April 29–May 4, I saw at least 1,000 birds either in the air or settled around what appeared to be two nesting sites on the extreme eastern and western flanks of the Reserve. Mr. Luc Hoffmann, director of a private research station at Tour du Valat, is of the opinion that about 3,000 nests were occupied at the end of May. Nevertheless, he considers that probably 2,000 and possibly 3,000 birds perished earlier. He says he counted 200 dead birds in a very restricted area, and it may be significant that more than half of them were immature. Some birds tried to emigrate when the temperature began to fall; frozen corpses were found about 100 km. to the west of the Reserve; but a few partly frozen birds, recovered near his laboratory, were revived by warmth. Apparently no specific cause of the death of the birds can yet be given. One local observer said the legs of the flamingoes froze in contorted positions in mid-air. However, the present breeding stock is reported to be rather more than a good average.

John Hillaby

85 Cholmley Gardens.
London, N.W.6.
June 3.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, July 3

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. D. A. Denton (University of Melbourne): "Regulation of Sodium Ion Content in Sheep with Parotid Fistulae".*

Tuesday, July 3—Friday, July 6

Institute of Physics (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C 2)—Conference on "The Physics of Nuclear Reactors".

Wednesday, July 4

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. R. W. Riddell: "Mycology".* (Further lectures on July 18 and 25.)

Friday, July 6

British Psychological Society, Industrial Section (in Room 425, Birkbeck College, Malet Street, London, W.C.1), at 6 p.m.—Dr. C. Sofer: "Possible Contributions of Social Science to Industry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Guide Lecturer at the Geological Museum, London, S.W.7, for duties which include giving lectures and lecture-demonstrations to the general public—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No S.4601/56/7 (July 4).

Shell B.P. Research Fellow in the Department of Aeronautical Engineering—The Secretary and Registrar, The University, Southampton (July 4).

Research Assistant (with research experience in biochemistry or the chemistry of natural products) in Chemical Microbiology in the Department of Botany—The Secretary, University College, Gower Street, London, W.C.1 (July 11).

Analytical Chemist (with a degree or higher national certificate in chemistry) mainly for plant material—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 14).

Assistant Lecturer or Lecturer in Electrical Engineering—The Registrar, University College, Singleton Park, Swansea (July 16).

Assistant Lecturer in the Department of Philosophy—The Registrar, The University, Manchester (July 21).

Research Demonstrator in Zoology—The Registrar, The University, Reading (July 21)

Assistant Lecturer in Geology—The Registrar (Room 9 O.R.B.), The University, Reading (July 23).

Lecturer in Zoology; Lecturer in Mathematics; and a Lecturer in Physics, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (New Zealand, August 15).

Chair of Mathematics—The Registrar, University College of North Staffordshire, Keele, Staffs (August 31).

Senior Lecturer in Biochemistry at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 31).

Assistant Conservator of Forests, Class 1 (with a university degree in forestry and experience of teaching foresters) to administer the Forestry College at Prodromos, Cyprus, and to be responsible for the teaching of its syllabus—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD. 61/17/07.

Laboratory Technician (preferably with some photographic experience) in the Department of Physics to assist in radiation protection investigations—The House Governor, Royal Marsden Hospital, Fulham Road, London, S W.3.

Laboratory Technicians (with experience in research procedures including histology and laboratory animal dissection)—The Chief Technician, Clinico-Pathological Laboratories, Imperial Cancer Research Fund, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C 2.

Lecturer or Grade B Assistant in Inorganic Chemistry; and a Grade B Assistant in Organic Chemistry at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

Lecturer (preferably with special interests in entomology, physiology or protozoology) in Zoology, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C 1.

Organic Chemist (with a degree in chemistry or biochemistry and postgraduate laboratory or research experience) to work at the Low Temperature Research Station, Cambridge, on the chromatographic analysis of potatoes in relation to blackening—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Research Assistant (graduate in physics, engineering or mathematics, the latter with laboratory experience) for experimental work on the flow of stratified fluids—The Meteorology Department, Imperial College, London, S.W.7.

Research Assistants (2) (with a suitable degree or equivalent qualification) in (a) Chemistry or Biology; or (b) Telecommunications or Physics—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27.

Research Scholar in the Department of Textile Chemistry—The Registrar, College of Technology, Manchester 1.

Scientific Assistant (graduate, with proficiency in reading and abstracting foreign biological literature), and a Scientific Assistant (graduate in zoology, with experience in handling taxonomic problems and proficiency in reading foreign helminthological literature)—Prof. R. T. Leiper, Commonwealth Bureau of Helminthology, The White House, 103 St. Peter's Street, St. Albans, Herts.

Scientific Officer (with a first- or second-class honours degree in engineering or physics, and preferably with an interest in applied mechanics and thermodynamics) to work on wheel research and testing of crop driers—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

Senior Plant Physiologist, Principal Scientific Officer grade (with a special knowledge and research experience of plant physiology) to develop a Physiology Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick.

Soil Survey Officer (with a good second-class honours degree in natural science, geography or agriculture) in the Department of Soil and Land Use Survey, Gold Coast, to supervise the field work of the survey, assist in the compilation of soil survey reports and maps, and assist in the training of junior staff—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.79/13/01.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Imperial Cancer Research Fund. Fifty-third Annual Report, February–November, 1955. Pp. 44. (London: Imperial Cancer Research Fund, Royal College of Surgeons, 1956.) [274

Report of the Committee appointed to review the Provincial and Local Organisation and Procedures of the Ministry of Agriculture, Fisheries and Food. Pp. vi+108. (Cmd. 9732.) (London: H.M. Stationery Office, 1956.) 4*s.* 6*d.* net. [274

National Smoke Abatement Society. Year Book, 1956. Pp. 64. (London: National Smoke Abatement Society, 1956.) 1*s.* [274

Grassland Research Institute. Memoir No. 1: Lucerne Investigations, 1944–1953. Pp. ii+81+2 plates. (Hurley, near Maidenhead: Grassland Research Institute, 1955.) 10*s.* [274

British Electrical and Allied Industries Research Association. Thirty-Fifth Annual Report (1st January, 1955 to 31st December, 1955.) Pp. 141. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) [274

Other Countries

Bulletin of the American Museum of Natural History. Vol. 108, Article 4: Cretaceous System in Northern Peru. By Victor E. Benavides-Cáceres. Pp. 353–494+plates 31–66. (New York: American Museum of Natural History, 1956.) 3.50 dollars. [244

Comité International des Poids et Mesures Procès-Verbeaux des Séances, Session de 1954 (28 Septembre–14 Octobre); et Sessions des Comités Consultatifs—Définition du Mètre (1953)—Thermométrie (1954). (Deuxième Série—Tome 24.) Pp. iii+480+iii. (Paris: Gauthier-Villars, 1955.) [274

International Nickel Company of Canada Limited. Address to Shareholders, Annual Meeting, April 25, 1956. Pp. ii+21. (Toronto: International Nickel Company of Canada Limited, 1956) [274

Cawthron Institute. Lecture Series No. 30: The Production and Maintenance of Soil Tilth. By Dr. E. W. Russell. Pp. 20. (Nelson, N.Z.: Cawthron Institute, 1955.) [274

Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization Divisions and Sections as at 1st January 1956. Pp. 17. List of Publications to December, 1955. Pp. 36. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [274

Report of the Thirty-First Meeting of the Australian and New Zealand Association for the Advancement of Science (Melbourne, August, 1955). Part 1. (*Australian Journal of Science*, Vol. 18, No. 3A, January, 1956.) Pp 48+xvi. (Sydney: Fairway Publications Pty, Ltd, 1956. Published on behalf of The A.N.Z.A.A.S. Publications Committee.) [274

Sudan Government: Ministry of Agriculture. Bulletin No. 16: The Insect Pests of Vegetables in the Sudan. By D. G. Pollard. Pp. 72 (7 plates). (Khartoum: Ministry of Agriculture, 1955.) 40 P.T. [15

Directory of Aluminium, 1955. Pp. xvi+65. (Bangalore: India Section, Electrochemical Society, Inc.; Indian Institute of Science, 1956) [15

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[1] Determination of ribonuclease activity

Brown, Dekker & Todd, *J. Chem. Soc.* 2715 (1952)

Markham & Smith, *Biochem. J.* **52**, 552 (1952)

Richards, *Compt. rend. Lab. Carlsberg, Ser. chim.* **29**, No. 17, 315–21. (1955)

For general reference to cyclic nucleotides and their behaviour with enzymes see

Whitfield, Heppel & Markham, *Biochem. J.* **60**, No. 1, 15–19 (1955)

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Further details may be obtained from the Registrar, the University, Edgbaston, Birmingham, 15, and applications for admission should be sent to him not later than September 1.

G. L. BARNES,
Secretary

The University,
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Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications (six copies) must be sent by July 16, 1956.

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Applications are invited for the post of Lecturer in Engineering (Mechanical). Preference will be given to candidates with a major interest in heat transfer. A knowledge of some aspect of nuclear engineering would be an advantage. University regulations permit teaching staff to read for the degrees of M Sc. and Ph.D. Applications will also be considered from engineers who would be interested in a temporary appointment for two or more years. Salary scale: £650 to £1,350 per annum. Membership of F.S S U. and children's allowance scheme. Initial salary according to qualifications and experience.

Applications should be sent not later than July 9, 1956, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained Applications by airmail (no forms), will be considered from overseas candidates.

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Clerk to the Governo

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experience of the appointee. An allowance
made towards travelling expenses, and the su
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his duties on February 1, 1957, or at such ea
or later date as may be agreed on by the Colle
Council.

Further particulars and information as to
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Secretary, Association of Universities of t
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